Advisory Committee on Fishery Management **ICES CM 2002/ACFM:14**

REPORT OF THE

Working Group on North Atlantic Salmon

ICES Headquarters
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International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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TABLE OF CONTENTS

Section **Page**

1 INTRODUCTION

1.1 Main Tasks

At its 2001 Statutory Meeting, ICES resolved (C. Res. 2001/2ACFM11) that the Working Group on North Atlantic Salmon [WGNAS] (Chair: Dr N. Ó Maoiléidigh, Ireland) will meet at ICES headquarters in Copenhagen, Denmark, from the 3-13 April 2002 to consider questions posed to ICES by the North Atlantic Salmon Conservation Organisation (NASCO). The terms of reference and sections of the report in which the answers are provided, follow:

a) With respect to Atlantic salmon in the North Atlantic area:	Section
i. provide an overview of salmon catches and landings, including unreported catches by country and catch and release, and worldwide production of farmed and ranched salmon in 2000;	2.1 & 2.2
ii. report on significant developments which might assist NASCO with the management of salmon stocks;	2.4
iii. provide a compilation of tag releases by country in 2000.	2.6
b) With respect to Atlantic salmon in the North-East Atlantic Commission area:	Section
i. describe the events of the 2000 fisheries and the status of the stocks;	3.1-3.3
ii. update the evaluation of the effects on stocks and homewater fisheries of significant management measures introduced since 1991;	3.6
iii. further develop the age-specific stock conservation limits where possible based upon individual river-based stocks;	3.4
iv. provide catch options or alternative management advice with an assessment of risks relative to the objective of exceeding stock conservation limits;	3.5
v. Provide an estimate of by-catch of salmon post-smolts in pelagic fisheries based on the scientific information currently available;	3.7
vi. identify relevant data deficiencies, monitoring needs and research requirements.	3.8
c) With respect to Atlantic salmon in the North American Commission area:	Section
i. describe the events of the 2000 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. characterize the reliability of input data used to estimate the lagged spawner variable, with special emphasis on the Labrador region, and evaluate sensitivity of resulting pre-fishery abundance estimates	4.5
v. provide catch options or alternative management advice with an assessment of risks relative to the objective of exceeding stock conservation limits;	4.6
v. identify relevant data deficiencies, monitoring needs and research requirements.	4.8

d) With respect to Atlantic salmon in the West Greenland Commission area:	Section
i. describe the events of the 2000 fisheries and the status of the stocks;	5.1 & 5.2
ii. update the evaluation of the effects on European and North American stocks of the Greenlandic quota management measures and compensation arrangements since 1993;	5.4
iii. characterize the historical and current temporal and spatial distribution and relative abundance of North American and European Atlantic salmon and, where possible, smaller stock groups, in fisheries at West Greenland;	5.3
iv. provide catch options or alternative management advice with an assessment of risks relative to the objective of exceeding stock conservation limits;	5.6
v. provide a detailed explanation and critical examination of any changes to the model used to provide catch advice and of the impacts of any changes to the model on the calculated quota;	5.7
vi. evaluate the ad hoc management programme and advise on an appropriate management system for the fishery in future years, taking account of the stocks of both North American and European origin;	5.1
vii. identify relevant data deficiencies, monitoring needs and research requirements.	5.9

The Working Group considered 37 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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Holm, M.	Norway
Kanneworff, P.	Greenland
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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

The nominal catch of a fishery is defined as the round, fresh weight of fish which are caught and retained. Total nominal catches of salmon reported by country in all fisheries for 1960-2001 are given in Table 2.1.1.1. Catch statistics in the North Atlantic also include fish farm escapees and, in some north-east Atlantic countries, 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 has previously been undertaken and where the intent was to harvest all returns at the release site. While ranching does occur in other countries it is on a much smaller scale. Some of these operations are experimental and at others harvesting does not occur solely at the release site. The ranched component in these countries has therefore been included within a single figure for the nominal catch.

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

The provisional total nominal catch for 2001 is 3078 tonnes, which is the highest since 1996. This catch is 176 t greater than the updated catch for 2000 (2902 t) and although greater than the previous 5-year average (2609 t), it is 176 t less than the previous 10-year average (3254 t). In all, five countries reported an increase in the 2001 catch compared to the final 2000 values. Catches in nine countries were greater than the previous 5-year averages and catches in five were greater than the previous 10-year averages.

Several countries partition-reported nominal catches by size or sea-age category and these data, where available, are in Tables 2.1.1.2 and 2.1.1.3. The figures for 2001 are provisional and, as in Table 2.1.1.1, catches in some countries include both wild and reared salmon (excluding ranched fish from Iceland) and fish farm escapees. Different countries use different methods to partition their catches by sea-age class and 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.

Table 2.1.1.4 presents, where data are available, the nominal catch by country partitioned according to whether the catch was taken by coastal, estuarine, or riverine fisheries. In addition, fisheries in West Greenland and Faroes are exclusively coastal. The proportions accounted for by each fishery varied considerably among countries although overall proportions remained relatively stable. In total, coastal fisheries accounted for 54% of catches in North East Atlantic countries in 2000 compared to 52% in 2000, whereas in-river fisheries took 40% of catches in 2001 compared to 41% in 2000. In North America, coastal fisheries accounted for 15% of the catch in 2001 compared to 9% in 2000, while in-river fisheries took 76% of catches in 2001 compared to 77% in 2000 and 67% in 1999.

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 salmon in some areas of Canada and USA since 1984. Recent declines in salmon abundance in the North Atlantic have resulted in an increased use of this management option, either as a voluntary practice or through statutory regulation. The nominal catches presented in Section 2.1.1 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 1991-2001 for six countries that have records. Catch-and-release may be practiced in other countries while not being formally recorded. There are large differences in the percentage of the total rod catch that is released, from 12% in Iceland to 76% in Russia, reflecting the varying management practices among these countries. Within countries, however, this percentage has tended to increase in recent years, and rates in 2001 are the highest since 1991 for three countries and among the highest for two other countries.

2.1.3 Unreported catches

Unreported catches by year and Commission Area are presented in Table 2.1.3.1. A description of the methods used to evaluate the unreported catches was provided in ICES 2000/ACFM:13. The 2001 unreported catch can be compared to previous years values as the estimation method used by each country is relatively unchanged. However, it may not be appropriate to compare the unreported catch of one country to another as the same information may not be included in the estimate. For example, some countries include only the illegal landings in the unreported catch, other countries include unreported legal catch and illegal catches in their estimates, and the illegal catch is included with the nominal catch for France.

The total unreported catch in NASCO areas in 2001 was estimated to be 1170 t, a decrease of 8% from the 2000 estimate. Estimates were derived for the North American Commission Area (81 t), the West Greenland Commission Area (10 t), and North East Atlantic Commission Area (1079 t). Figure 2.1.3.1 shows that the unreported catch has remained a relatively constant proportion (30%) of the total catch since 1987. However, the proportion unreported declined since 1998.

Where available, data are presented by country for 2001 (Table 2.1.3.2). The individual inputs to the total North Atlantic catch range from 0% to 17%. While this broadly indicates the level of unreporting by each country relative to the total catch in the North Atlantic, it should be noted that these estimates are not precise and are difficult to validate. The percentage of the total national catches (reported + unreported) by country ranges from 0% to 68%.

In the period 1st April 2001 to 31st March 2002 a total of 26 airborne surveillance flights over the area of international waters north of the Faroe Islands, where salmon fishing by non-Contracting parties is known to have taken place in the past, were undertaken by Norwegian (23 flights) and Icelandic (3 flights) coastguards. No vessels were observed fishing for salmon. There was, however, only one flight over the area in the period from mid-September 2001 to mid-January 2002, i.e. a period of four months, when salmon fishing occurred. The Working Group therefore, did not include any estimate of catch from this but points out the possibility that some catch may have occurred, particularly in the period from mid-September 2001 to mid-January 2002.

2.2 Farming and Sea Ranching of Atlantic Salmon

2.2.1 Production of farmed Atlantic salmon

The production of farmed Atlantic salmon in the North Atlantic area was 704 177 t in 2001 (Table 2.2.1.1 and Figure 2.2.1.1), an increase in production over 2000 (658 952 t). The 2001 production was 27% higher than the 1996-2000 average (554 284 t) for the area. The countries with the largest production were Norway and Scotland, accounting for 61% and 23% of the reported North Atlantic total. Reported increases compared to average production for 1996 to 2000 (Table 2.2.1.1) ranged from 77% for the Faroes to 4% for Iceland and USA.

The worldwide production of farmed Atlantic salmon in 2001 was 961 120 t, an increase compared to 891 528 t in 2000 (Table 2.2.1.1 and Figure 2.2.1.1). Outside the North Atlantic area, Chile was the major producing country. The worldwide production of farmed Atlantic salmon compiled for 2001 was approximately 310 times the reported nominal catch of Atlantic salmon in the North Atlantic. As a result, aquaculture fish dominate world markets, and have probably contributed to the decline in commercial fishing effort in many countries.

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 2001 was 13.5 t, 2.5 t higher than in 2000 (11 t) and the second lowest value since 1984 (Table 2.2.2.1 and Figure 2.2.2.1). There was no production in Iceland because no smolts were released into ocean ranching in 1999 or 2000. Production of ranched fish was less than 10 t in each of the three other countries reporting (Ireland, UK(N. Ireland), and Norway). Production in these three countries includes catches in net, trap, and rod fisheries.

2.3 Review of the estimation of natural mortality at sea of Atlantic salmon

2.3.1 Methods and Estimates of Natural Mortality (M) at Sea

ICES has used an instantaneous rate of natural mortality of 0.01 per month in the NEAC and NAC models to estimate PFA of salmon. The assumed rate is from an analysis of catches at age and weight at age data from the River Bush (U.K.) and the Sandhill River (Canada) as developed by Doubleday et al. (1979). This rate of natural mortality has been used to calculate the number of fish immediately after the first winter, prior to the high seas fisheries, and between the high seas fisheries and returns to homewaters.

The Working Group reviewed theoretical and empirical methods for estimating M for Atlantic salmon. Theoretical methods are those based on life history characteristics such as lifetime fecundity, maximum age, age at maturity, and inverse-weight. Empirical methods are those based on actual measures of smolts and adult abundance at different life stages and two of these, the inverse-weight method and the maturity schedule method were applied to historical and recent data for stocks from the North Atlantic.

Theoretical methods

The theoretical methods can provide indications of integrated lifetime and lifestage specific survival rates. Most of the theoretical methods are based on prinicples defined across a large number of phyla or a large number of species within a group.

For a population at replacement, the reciprocal of the average life-time fecundity (in terms of female eggs) is equivalent to the average life-time survival rate:

$$S = (0.5 * \text{Fecundity})^{-1}$$

For example, in a totally semelparous (dies after spawning) population with an average fecundity per female fish of 5000 eggs, the integrated survival rate from eggs destined to be female to female spawner would be 1 per 2,500 (0.5 * 5000), or 0.04%. The higher the average fecundity, the lower the overall survival rate required to sustain the population (Figure 2.3.1.1). The relationship between egg-to-smolt survival and marine survival required to replace the spawners has a hyperbolic form. A halving of the egg-to-smolt survival requires a doubling of marine survival to generate replacement (Figure 2.3.1.1).

Using a data set of 134 species (84 fish species) with longevity and natural mortality rate estimates, Hoenig (1983) described a relationship relating mortality (Z as annual instantaneous mortality rate) to maximum age as:

$$\ln(Z) = a + b \ln(t_{max})$$

with $a = 1.46$

$b = -1.01$

At least to the age of first spawning, a species like Atlantic salmon with its relatively short life span would be expected to have high annual natural mortality rates, of 34% to 88% per year (3% to 16% per month), integrated over its lifespan (egg to spawning adult).

Jensen (1996) showed how three special relations, called Beverton and Holt life history invariants, could be derived from maximization of the fecundity function that optimizes the trade-off between survival and fecundity. One of those invariants has the form:

$$M * x_m = C1$$

where M = instantaneous natural mortality

x_m = mean age at maturity

$C1$ = constant (1.65; 2.0) (Jensen 1996).

For Atlantic salmon, the mean age at maturity and the longevity are almost synonymous since many populations are highly semelparous. The Beverton-Holt life history invariant mortality rate values are less than those from the longevity association but are still in the range of 24% to 42% per year for the most frequently encountered ages at maturity (3 to 6 years).

Inverse-Weight Method

Ricker (1976) described a method for estimating the natural mortality rate based on the assumption that M decreases with increased size because marine natural mortality is assumed to be primarily the result of predation. The allometric function relating mortality and weight has the form:

$$M = c\,W^{-x}$$

where M = mortality rate

W = body weight

c = initial mortality rate for fish of unit weight

x = dimensionless exponent

When considered across phyla (from pelagic invertebrates to whales; McGurk 1986), there is a negative association between mortality rate and body weight (dry weight) with the exponent in the order of –0.25 (McGurk 1986). Using juvenile and adult fish only, Furnell and Brett (1986) reported a wet weight exponent of –0.37. Lorenzen (1996) reported an overall wet weight exponent for fish in natural environments of –0.288 on average, ranging from –0.291 to –0.305 for lake to ocean specific environments. McGurk (1996) references several studies indicating that the weight exponent of mortality of fishes falls within the range of -0.25 to -0.40.

Lorenzen (1996) modelled mortality directly to body weight.

$$M_W = M_U\,W^b$$

where M_W = natural mortality rate at weight W (instantaneous annual)

M_U = natural mortality rate at unit weight (1 g)

b = allometric scaling factor

Based on data from 113 species/stocks for the ocean environment, Lorenzen (1996) derived the following parameter values:

M_u = 3.69 (2.84 to 4.49)

b = -0.305 (-0.351 to –0.257)

Using these parameter values and measures of weight at age of 1SW salmon and 2SW salmon returning to the Miramichi River during 1971 to 1990, the monthly mortality rate during the second year at sea was estimated to be about 2.6% per month (instantaneous monthly rate = 0.027) (Fig. 2.3.1.2).

Estimates of the inverse-weight coefficients

Preliminary estimates of M for Atlantic salmon during the second year at sea were presented by Doubleday et al. (1979) based on the approach of Mathews and Buckley (1976). The analysis by Doubleday et al. (1979) addressed two issues:

testing the inverse-weight hypothesis for Atlantic salmon

deriving estimates of M in the second year at sea based on the inverse weight hypothesis

Doubleday et al. (1979) suggested that the greatest mortality occurred in the initial stages when the fish were small compared with later in life (after one year at sea) when the fish were much larger. This is consistent with the inverse-weight hypothesis that $M \sim c/W$. Since smolts are about 1% the weight of salmon after one year at sea (20-40 g versus 2000 – 4000 g), then variations in integrated mortality would be defined mostly by smolt size. Using three years of two smolt group releases from the River Bush, Doubleday et al. (1979) demonstrated that there was a significant negative association between integrated marine survival for the cohorts and initial marine mortality determined by smolt size.

Having demonstrated some support for the inverse-weight hypothesis, Doubleday et al. (1979) proceeded to estimate M for intervals of time at sea. The analyses of Doubleday et al. (1979) were repeated using the data tabled in their document.

Using the exponential growth model, the monthly mortality rates for River Bush fish in the second year at sea (days 516 to 834) ranged between 0.1% and 0.3% per month, with survival of age-1 smolts less than that of age-2 smolts (Table 2.3.1.1). For the Sandhill River salmon, mortality rates in the second year at sea (months 14 to 24) ranged between 1.2% and 1.5% per month (Table 2.3.1.1). The growth rates of Sandhill River fish were lower than those of River Bush which is why the mortality rates on Sandhill River fish were higher (Fig. 2.3.1.3).

The exponential growth functions were not considered satisfactory representations of the weight at age of salmon at sea (Figure 2.3.1.3). For both stocks, weight at age of 1SW salmon was underestimated while that of 2SW salmon was overestimated (excessively so for River Bush). Simpler linear growth models were adjusted to the data from River Bush and North America. When these models were applied to the life stage recovery data, the mortality rate estimates in the second year at sea increased slightly to between 1.4% and 1.7% for the Sandhill River salmon. There was a greater increase for the River Bush fish, to between 0.8% and 1.8% (Table 2.3.1.1) resulting from the lower weight at age predicted for the older fish (Figure 2.3.1.3).

The inverse-weight model described by Doubleday et al. (1979) provides correct estimates of M (as determined by simulation) provided the assumption of the inverse-weight association is valid. The estimates of M are sensitive to the growth model used. The exponential models produce lower mortality rate estimates than the linear growth models but the linear models have provided a better fit to the observed weight at age data.

The inverse-weight model was applied to more recent observations from the River Bush as well as to growth and abundance data of the River Trinite, LaHave River, and Northwest Miramichi River (Canada). For the River Bush, the monthly mortality rates in the second year at sea of the 1999 hatchery one-year old smolts were estimated at more than three times the values in the 1970s, at 1% to 2% per month using the exponential growth model, and almost 3% per month with the linear growth model (Table 2.3.1.1). For the Canadian stocks, monthly mortality rates in the second year at sea for both hatchery smolts and wild smolts from River Trinite have risen above 3% in the 1990s (Fig. 2.3.1.4). The mortality rates on two wild stocks of the Maritimes in the 1990s were estimated to be between 2.4% and 3.2%, well above the 1.5% value estimated for the Sandhill River salmon between 1969 and 1971 (Figure 2.3.1.4). This suggests that there may have been an increase over time in the mortality rate during the second year however long-term data for individuals stocks are scarce.

Maturity Schedule Method

Ricker (1976) summarized a number of approaches which he termed "maturity schedule methods" to derive estimates of natural mortality at sea for stocks which mature at two or more different ages. A particular approach termed "Murphy's Method" (Ricker 1975) was used to estimate the ocean mortality of Icelandic ranched Atlantic salmon during the second year at sea (Jonasson et al. 1994). A variation of these methods which allows estimates of survival during the first and second years at sea is described by Chaput et al. (2002), was reviewed by the Working Group last year (ICES CM 2001/ACFM:15), and additional results are summarized below.

The model proposed by Chaput et al. (2002) allows for the estimation of survival rates during the first and second years at sea based on return of 1SW and 2SW salmon and sex ratios of outmigrating smolts. The model makes some general assumptions:

- survival rates at age for males and females are similar, and
- survival rates in the first year at sea of maturing and non-maturing salmon are similar.

Chaput et al. (2002) examined the sensitivities of the model to input parameters including sex ratio inputs and violations of the assumptions. They applied the model to data from four rivers in eastern Canada and additonally, the Working Group reviewed an application of the model to salmon from the River Scorff (France).

Estimates of Survival Rates

For the River Trinite, survival rates in the second year have improved from a low of 20% to 30% to recent levels of about 50% to 60%. The increased survival rates in the second year correspond to the period of moratoria on commercial marine salmon fisheries in eastern Canada (1992 to the present). The instantaneous mortality rates (monthly) during the second year at sea are presently between 3% and 7%, with lower values down to 1% estimated to have occurred for the 1994 and 1996 smolt classes (Figure 2.3.1.5; Table 2.3.1.2).

For the Saint John River at Mactaquac hatchery smolts (one-year-old smolt program), monthly mortality rates in the second year at sea range from 10% to 20% with rates nearest the maximum value in the recent years (Figure 2.3.1.5).

Returns to the Miramichi River since 1984 represent abundance of the age groups since the closure of the coastal marine commercial fisheries. Mortality rates during the second year at sea have been variable and high and show no reductions resulting from reduced marine exploitation outside the coastal waters (Figure 2.3.1.5). Monthly mortality rates have infrequently been less than 10% and generally around 15% per month. Tag returns from Greenland and Canadian marine fisheries indicated that this stock continues to be exploited at sea.

For the LaHave River, monthly mortality rates of the 1996 wild smolt cohort during the second year at sea was about 12% (Chaput et al. 2001).

For the River Scorff (France), mortality rates in the second year at sea were estimated at about 15% per month for the smolt cohorts of 1995 to 1997.

2.3.1.1 Comparison of Maturity Schedule and Inverse-Weight Estimates

The Working Group noted the differences in the mortality rate estimates using the inverse-weight method compared to the maturity schedule method for some stocks and time periods. The estimates for the River Trinite during the 1990s were similar, at about 3% per month using the two estimation methods (Figure 2.3.1.5). The estimates were very different in the 1980s when marine coastal exploitation was still occurring on this stock. It would appear that the inverse-weight method was insensitive to the marine exploitation, being driven primarily by the growth function, however violations of the assumptions of the maturity schedule method could also have produced the divergent results. The maturity schedule values for LaHave River and Miramichi River, and the Saint John River hatchery smolts are much higher than the inverse-weight estimates for corresponding years, by up to five times.

Both the inverse-weight and the maturity schedule models indicate that M in the second year of sea life is greater than 1% per month. Doubleday et al. (1979) used the exponential growth model to estimate the coefficients of the inverse-weight model, however, in most rivers examined the exponential model does not provide a good description of the marine growth function of Atlantic salmon, especially for months 12 to 24. A simple linear function fits the data more realistically than the exponential model. Based on this linear function of growth, the inverse-weight method produced monthly mortality rate estimates during the second year at sea which varied between 1% and 3.4% (range of median values) for stocks from the North Atlantic (Table 2.3.1.2). Over the entire time and stock series analysed, the inverse-weight models indicate that an M of 0.03 per month in the second year would be more appropriate than the previously assumed value of M = 0.01.

The maturity schedule method results suggest that for some stocks, mortality in the second year at sea may also be driven by size-independent factors. In contradiction to the inverse-weight method that assumes that size determines M, mortality in the second year at sea may also be modified by factors which are non-size selective, such as parasites, disease, temperatures, or even marine mammal predators which may not be constrained in their predation rates by the size range of salmon in the second year at sea. The differences in the estimated mortality rates determined by the two methods suggest further hypotheses should be examined to test the assumptions of the inverse-weight and maturity schedule methods and factors which are modulating marine mortality of salmon at all ages.

The size-selective mortality study reviewed in Section 2.4.3 provides evidence for changes in M over time which puts into question the constant mortality rate assumptions used in the run-reconstruction model. There are also indications that M may vary between stocks in different regions and between wild and hatchery origin salmon.

Based on the analyses reviewed, the Working Group decided to continue use of the inverse-weight method as the basis of estimating M because the maturity schedule method yielded values of M that varied temporally and spatially, and it was not clear whether it was appropriate to apply values from this method to all stocks and the entire time-series. However, the group determined that the most appropriate growth function for use with the inverse-weight method was linear rather than the previously used expotential function. This change in growth function, plus analysis of data from additional rivers, resulted in the instantaneous monthly mortality rate used in the run-reconstruction model for the North American and NEAC areas to be changed from 0.01 to 0.03.

Despite the continued use of the inverse-weight method, the Working Group noted the limitations of this method in assuming that mortality is driven entirely by size, and recommended further analyses to test assumptions of the inverse-weight and maturity schedule methods. Based on the results of these analyses, the two methods will continue to be examined for applicability in modelling by the Working Group.

2.3.2 Effects of higher values of M on PFA models, conservation limits and catch advice

As a result of the decision to change the value of M from 0.01 to 0.03 per month in the second year at sea, the Working Group reviewed the effects of increasing M to higher levels (0.015 to 0.05) on estimates of pre-fishery abundance and conservation limits in the NASCO-NEAC area and the implications for management advice.

The NEAC PFA and National CL models have been described by Potter et al. (1998) and are summarised in Section 3.5. Natural mortality enters into the estimation of the PFA model at the stage when the numbers of salmon alive at the beginning of the second sea year are back-calculated from the estimated numbers of fish returning to homewaters. Increasing M from 0.01 to 0.015 per month increases the estimated PFA of maturing 1SW salmon by about 4% and of non-maturing salmon by 9% (Table 2.3.2.1). Increasing M to 0.05 per month will increase the estimated PFA values by 38% and 97% respectively. The substantial difference between maturing and non-maturing 1SW salmon is due to the different lengths of time between the beginning of the second sea year and the return of the fish to homewaters.

Although these PFA values are then used in the estimation of the national CLs, this does not affect the position of the inflection point, relative to the x-axis (lagged egg deposition) because all PFA values are increased by the same proportion. This would not be the case if different values of M were used for different time periods.

The potential effects of increasing M to 0.03 on catch advice is illustrated in Table 2.3.2.2 for Southern European MSW salmon stocks (at hypothetical levels). As indicated, both the PFA and the Spawner Escapement Reserve will be increased by the same percentage (40%), and as a result the estimated harvestable surplus will also be increased by this margin. If a fixed proportion of this surplus is allocated to an interception fishery, any quota will also be increased by the same percentage. However, the survivors from the fishery (assuming that the full quota is taken) will also be subject to the higher level on M and so there will be no change in the estimated numbers of fish returning to homewaters.

The consequences to the fishery of using inappropriate values differ from the consequences to the resource. If the assumed M is higher than the realized value, then the quota will be set too high and the stock will suffer. If M is underestimated, harvestable surplus may be foregone but the stock will receive more spawners. More importantly, if M is very much higher than currently assumed, the beneficial effects of reducing or closing distant water fisheries towards increasing spawning escapements will be overstated, which may have major implications for our understanding of the reasons for recent stock declines. Our understanding of salmon stock dynamics may be further at error if M has changed over time; this would affect both PFA and CL estimates. It is important to note that PFA is a 'latent variable' (a value which can never be measured directly) but it has value as a means to conceptualise the stock status and develop management advice. It will not be possible, in the short term, to directly validate the assumed values of M.

Given the importance of M in the provision of catch advice and in the understanding of the dynamics of Atlantic salmon in the ocean, the Working Group recommends:

- further data sets be subjected to the inverse-weight and maturity schedule methods. Specifically, members of the Working Group are encouraged to estimate M for the broadest range of stocks and for the greatest number of years possible to assess the temporal and spatial variations in M.

- where possible, studies on size-selective mortality based on smolt size indices and survivors be undertaken which may lead to additional insights into temporal variability of M and population dynamics.

2.4 Significant Development Towards the Management of Salmon

2.4.1 Incidence of infectious salmon anaemia virus in the United States

Prior to 2001, infectious salmon anemia virus (ISAv) had not been detected in the United States. During 2001, outbreaks in the U.S. occurred in Cobscook Bay, Maine, the dominant marine rearing site for Atlantic salmon in the

United States. No other areas in Maine or the U.S. have been affected to date. The first reported case of ISAv in the US was in February 2001. The second and third reported cases occurred within 3 and 5 weeks. Despite industry's efforts to control the spread of the disease through biosecurity measures and voluntary depopulation of infected cages, by early September, 11 of 17 active Cobscook Bay culture sites reported at least one diseased cage.

On 10 September 2001, the State of Maine Department of Marine Resources (DMR) enacted an emergency rule that mandated the monthly ISAv testing for sites in Cobscook Bay and quarterly testing for all other U.S. sites, mandatory reporting of test results, and restrictions on the movement of aquaculture vessels and equipment out of or into Cobscook Bay. Despite voluntary depopulation of infected cages by the aquaculture industry, new cases occurred at previously diseased and uninfected sites through November. By December approximately 925,000 fish, year classes 1999 through 2001, had been removed from cage sites at an estimated production cost loss of $3.5 million (USD).

On 13 December 2001, the US Department of Agriculture, Animal Plant Health Inspection Service (USDA-APHIS) was designated the lead federal agency in controlling ISAv with two years of funding for eradication, disinfection, surveillance, and epidemiological programs. USDA-APHIS declared ISAv an exotic pathogen and on 7 January 2002, DMR and USDA-APHIS jointly ordered the eradication of the remaining 1.5 million salmon in Cobscook Bay that were infected with or exposed to ISAv in order to begin a fallowing period for the entire bay. The fallowing requires the removal of all the fish as well as all the associated net pens, barges, and equipment at all the farms and disinfection of nets, barges/boats, and equipment. The State's emergency rule became permanent rule in January 2002 and increases DMR's authority to depopulate ISAv exposed and diseased sites to conform with the USDA objective of eradication of the pathogen.

Bay-wide area management, indemnification and early reporting, single year class stocking, final stocking density and coordination with the New Brunswick ISAv management program are components of the ISAv management plan for the State of Maine. U.S. aquaculture production of Atlantic salmon declined by 19.3% from 2000 to 2001 primarily as a result of the ISAv outbreak, and production will likely be limited in 2002 due to fallowing strategies to be implemented in Cobscook Bay.

2.4.2 Escaped-farmed salmon of European ancestry in a Canadian river

The Magaguadavic River is located near the geographic center of the Canadian East Coast Atlantic salmon farming industry, and slightly north of the majority of Maine (USA) salmon farms. Fish entering the Magaguadavic River from the sea must pass through a fish ladder, where they can be enumerated and sampled. Fish counts here have been used since 1992 as an indicator of the potential number of wild and escaped-farmed salmon entering other rivers in the region. In addition, three commercial hatcheries producing about four million smolts per year are located in the watershed. Escaped juvenile smolts from these hatcheries have been documented in the river's smolt run in each year since monitoring began in 1998.

In Maine, European strains of salmon were legally imported for salmon farming, although the practice has now been stopped (Glebe 1998). By contrast, the use of European strains is prohibited in Canadian East Coast salmon farming, and at present New Brunswick's Department of Fisheries and Aquaculture only issues commercial culture permits for Saint John River stock. Restrictions on the use of foreign strains of salmon in fish farming are in place due to concerns that the unintended introgression of foreign genes into indigenous salmon populations could decrease the indigenous populations' fitness.

Tissue samples were obtained from Magaguadavic River adult wild salmon, Magaguadavic adult and juvenile (smolts) escaped-farmed salmon, European-origin farmed salmon broodstock, and adult wild salmon from other Bay of Fundy and Southern Uplands (Nova Scotia, Canada) rivers. They were used in a microsatellite tetranucleotide analysis to screen for escapees of European ancestry entering this Canadian river.

Three loci (1605, Ssa 202, Ssa 197) exhibited alleles characteristic of European salmon. In the sample of 88 wild Magaguadavic fish (30 smolts, 58 adults), none had the European alleles. Nor did the 1500 and 1000 wild salmon tested from inner Bay of Fundy rivers or the Southern Uplands, respectively. By contrast, of the 88 farmed-escaped salmon analyzed (35 smolts, 53 adults), three fish (two smolts and one 1 SW adult) were North American X European hybrids, and one other (a precociously maturing post-smolt) was largely if not wholly European in origin.

The adult and post-smolt farmed-salmon escapees of European ancestry might have originated from the contiguous Maine salmon farming industry. Salmon of at least partial European origin, progeny of the original legal importations, are believed to be currently under culture in Maine. However, no records exist on the companies culturing them or the degree if any to which they have been hybridized with North American strains (NRC 2002). By contrast, the escaped smolts with a partial European ancestry must have come from one of the commercial hatcheries in the Magaguadavic watershed.

2.4.3 Changes in size-selective mortality of migrating smolt

The total population of 1SW and 2SW Atlantic salmon in the northwest Atlantic has oscillated around a generally declining trend since the 1970s (ACFM, 2001). Abnormally high marine mortality, seemingly common to all North American Atlantic salmon populations, has been observed in recent years (O'Neil et al. 2000).

In the Trinité river, marine survival has fluctuated from a high of 4.53% for the 1988 cohort to a low of 0.69% for those of the 1999 cohort, the last one available. Mean 1984-1999 annual smolt survival rate is 2.21%, but has recently declined. For the period 1984-1991, average marine survival of 2.96% was considered normal compared to 1.40% for the period 1992-1999, a low-survival period.

One way to address the question of mortality patterns at sea is to analyse existing biological data for changes in size-selective smolt mortality over time to determine if size selectivity has changed in recent years. Patterns in size-selective mortality were examined for periods of normal and low marine survival, using 3-yr-old smolt from 1984 and 1985 (normal marine survival) and 1994 and 1995 (low marine survival) and the adults from these cohorts after 1 and 2 years at sea. Size at smoltification during outmigration was compared with size at smoltification, backcalculated from the scales of returning adults after one (1SW) and two years (2SW) at sea.

In all cases, mortality selected against the smaller smolts, resulting in a higher mean size for the smolt backcalculated from the adults. A second analysis was conducted to determine if these selective mortalities of smaller smolt were different between years of better (1984-1985) or poorer (1994-1995) marine survival. There was a significant increase in size-selective mortality for the 1SW fish ($P<0.003$) and the 2SW fish ($P<0.001$) between periods, particularly for 2SW salmon.

These preliminary results of increased mortality at sea of smaller smolt in recent years indicated that marine mortality had increased in recent years. The fact that commercial fishery was operating during the normal marine survival period and was closed during the poor survival period suggests that natural mortality (M) has increased in recent years. This may be explained by an increase in predation or a change in environmental conditions such as water temperature. The Working Group recommended that further studies on size-selective marine mortality covering additional rivers and more years be undertaken to test these hypotheses.

2.4.4 Setting biological reference points for Atlantic salmon stocks in the NEAC Area using SR data from index rivers

The analysis of stock and recruitment (SR) data is the most widely used approach for deriving Biological Reference Points (BRPs) for Atlantic salmon (*Salmo salar*) (Prévost and Chaput, 2001). SR data are routinely collected on a limited number of index rivers across the NEAC area. On these rivers, adult returns, spawning escapement, and sometimes smolt production are estimated yearly. Suitable SR series (both in terms of length and reliability of observations) are available for about 15 of these index rivers. It is important to know if the SR information from the index rivers can be used to set BRPs for all the NEAC salmon rivers while accounting for the major sources of variation among rivers.

When SR data are available from several rivers which are considered to be representative of an assemblage of rivers, inferences about the nature of the SR relationship for any new river of the assemblage based on data from the sampled rivers must be examined. There are two nested sources of uncertainty in this situation. The first level of uncertainty is associated with the fact that there is relevant SR information available from a limited number of rivers within the assemblage of rivers. The second level of uncertainty relates to the limited number of SR observations available within each river. Bayesian meta-analysis using hierarchical modeling (Bayesian Hierarchical Analysis) provides a framework for integrating these two levels of uncertainty. It incorporates the nested structure of the uncertainty to derive a posterior distribution of a parameter such as *Sopt*, i.e. the stock level that maximizes the long-term average surplus (MSY), for a river with no SR data. Prévost et al. (2001) illustrated this approach by a case study on the salmon rivers of Québec. It is now further applied and extended to the NEAC rivers. This work is undertaken within the SALMODEL project, a EU Concerted Action.

For semelparous species (i.e. which die after spawning), it is useful to express both *S* and *R* variables in the same unit (Hilborn and Walters, 1992) because it allows estimates of management-related parameters such as MSY, *Sopt,* or *hopt*, i.e. the exploitation rate at MSY. Although not strictly semelparous, Atlantic salmon can be treated as such for this analysis.

As the eggs represent the end product of a generation and the starting point of the next, both S and R variables were expressed in eggs. Using river-specific biological and fisheries information (biological characteristics of the fish, estimates of sea survival or exploitation rates, catch statistics) observed adult returns and smolt output can be used to derive spawning escapement and recruitment back to homewaters, expressed in terms of eggs. Recruitment accounts for any homewater fisheries removal, but not for distant fisheries (e.g. at Greenland and Faroes). Little information is available to correct for the effect of those fisheries. Therefore they were treated as an additional source of random variation of recruitment.

Only SR series with at least six SR data points since the 1985 year of hatch were retained for the analysis. The limitation to the most recent cohorts (after 1985) aims at providing BRPs relevant to the current status of the stocks. Non-stationarity in SR relationships is a well-known problem and early data often do not reflect current conditions (Walters and Korman, 2001). Data from 15 rivers have been retained for analysis (Table 2.4.4.1). They range from the South of France to Iceland, but 12 are located at a latitude between 50° and 60° north. The northern part of the NEAC area is little represented in this collection of data sets due to the lack of SR series in Scandinavia. All but one (the Burrishoole R., Ireland) are systems where the freshwater production occurs in the riverine habitat.

As described by Schnute and Kronlund (1996), under a Bayesian approach, each of the SR data sets can be used to derive a posterior probability distribution of management-related parameters, including BRPs. Such a probability distribution reflects our knowledge or uncertainty about SR-related parameters given the SR data. To address the issue of extrapolating the results obtained on the set of index rivers to the rest of the NEAC rivers, we must consider how the 15 rivers, taken as a sample of SR experiments, inform us about BRPs for a new river where no SR data are available. This amounts to deriving a probability distribution conditional on all the SR data collected.

Hierarchical modeling techniques provide a means of deriving appropriate probability distribution (Gelman *et al.*, 1995). The hierarchical SR model distinguishes two nested levels of randomness, i.e. within-river and between-rivers. At the lower level, the recruitment process can be modeled using classical functions, such as a Ricker function with lognormal process errors. The following formulation adapted from Schnute and Kronlund (1996) is used:

$$R_{i,j} \sim lognormal(log(Ricker(S_{i,j}), \sigma)$$

$$Ricker(S_{i,j}) = (exp(hopt_i)/(1-hopt_i))\ S_{i,j}\ exp(-((hopt_i/((1-hopt_i)\ Ropt_i))\ S_{i,j})$$

where:

$R_{i,j}$ is the recruitment of the cohort born in year j from the river i,

$S_{i,j}$ is spawning stock of year j from the river i,

$Ricker(S_{i,j})$ is the value of a Ricker function with parameters ($hopt_i$, $Ropt_i$) at $S_{i,j}$,

σ is the standard deviation of the normal distribution of $log(R_{i,j})$, with mean $log(Ricker(S_{i,j}))$

$hopt_i$ is the exploitation rate at MSY for the river i,

$Ropt_i$ is the value of the Ricker function at MSY for the river i.

Any other parameter can be calculated from $hopt_i$ and $Ropt_i$. For instance:

$$Sopt_i = (1-hopt_i)\ Ropt_i \qquad (1)$$

$Sopt_i$ is the standard Conservation Limit (S_{lim}) recommended by ICES (ICES 2001b) and NASCO (Potter, 2001).

At the upper level, the parameters of the Ricker function are assumed to be different between rivers, but drawn from a common probability distribution:

$hopt_i \sim beta(A, B)$ (2)

$Ropt_i \sim lognormal(M, \Sigma)$ (3)

where:

A and *B* are the parameters of the beta distribution of $hopt_i$,

M and Σ are the mean and standard deviation of the normal distribution of $log(Ropt_i)$.

The beta probability distribution is the standard for rates such as $hopt_i$ which vary between 0 and 1. The lognormal distribution of $Ropt_i$ is consistent with the lognormal distribution of $R_{i,j}$ and with the constraint that $Ropt_i$ must be positive. *A*, *B*, *M* and Σ, the parameters of the distribution of the $hopt_i$ and $Ropt_i$ parameters, are called the hyperparameters. In order to complete the full probability model, uninformative or little informative probability distributions are assigned to the hyperparameters and to σ.

This hierarchical SR model is an extension of a standard single river SR model. It acknowledges that all the NEAC salmon rivers are members of a family of rivers and thus any knowledge gained on the $hopt_i$ and $Ropt_i$ parameters for a given river inform us about the same parameters on another river. This transfer of information between rivers is made possible by the assumptions (2) and (3), assumptions which are essentially a mathematical translation of the statement "all NEAC salmon rivers are members of the same family of rivers". It is the transfer of information among rivers which allows to make inferences about SR-related parameters for any NEAC rivers on the basis of the SR information collected on the index rivers.

This basic model formulation can be improved by the use of additional co-variables which would be informative about SR-related parameters. In our case it is obvious that the river size must be most influential on $Ropt_i$, i.e. the bigger the river the higher $Ropt_i$ should be. This can be translated into replacing assumption (3) by:

$Ropt_i = ropt_i\ WA_i$ (4)

$ropt_i \sim lognormal(M, \Sigma)$ (5)

where:

WA_i is the wetted area accessible to salmon (m²), a measure of river size relevant in the context of salmon SR analysis (Prévost et al., 2001).

Other covariates can be introduced along the same line, as the link can be modeled with parameter(s) of interest. However, given the objective is to make inferences about SR-related parameters for any NEAC river, the number of variables which can be used effectively is limited. It is important to be able to measure the covariate for any NEAC river, and not just those which have been well studied. *WA* meets, or should meet this requirement in a foreseeable future.

Another candidate variable to consider for any river is the latitudinal position. This can be easily measured for any river and there is a well known latitudinal gradient in the age at smolting in Atlantic salmon (Metcalfe and Thorpe, 1990). This gradient reflects the influence of latitude on the riverine ecological processes of salmon production. A preliminary analysis showed that $ropt_i$ tended to increase with latitude. Consequently assumption (4) was replaced by:

$ropt_i \sim lognormal(\rho_i, \Sigma)$ (6)

$\rho_i = C + D\ lat_i$ (7)

where lat_i is the latitudinal location of the river *i*.

Under this updated version of the model, the hyperparameter *M* in equation (2) is replaced by two parameters *C* and *D*. Uninformative or little informative probability distributions are assigned to the *C* and *D*.

Denoting $\theta_{new} = (hopt_{new}, Ropt_{new})$ as the SR parameters for a new river with no SR data, then the probability distribution of ultimate interest of this analysis is:

$$p(\theta_{new} \mid SR, WA_{new}, lat_{new})$$

where:

SR is the set of SR series from the index rivers,

WA_{new} is the wetted area accessible to salmon of the new river with no SR data,

lat_{new} is the latitude of the new river with no SR data.

This probability distribution can be written as:

$$p(\theta_{new} \mid SR, WA_{new}, lat_{new}) = \int p(\theta_{new} \mid \Theta, WA_{new}, lat_{new})\, p(\Theta \mid SR, WA, lat)d\Theta$$

where:

$\Theta = (A, B, C, D, \Sigma)$, i.e. the hyperparameters,

WA and lat are the vectors of WA_i and lat_i of the index rivers.

$p(\theta_{new} \mid \Theta, WA_{new}, lat_{new})$ is known and is given by the equations (2), (4), (6), and (7).

$p(\Theta \mid SR, WA, lat)$, the posterior distribution of the hyperparameters, is the distribution through which the SR information coming from the index rivers is transferred to any other NEAC river. It can also be expressed as:

$$p(\Theta \mid SR, WA, lat) = p(\Theta) \int\ldots\int \Pi[p(\theta_i \mid \Theta, WA_i, lat_i)\, p(SR_i \mid \theta_i)\, d\theta_i]$$

In the last expression we see that the information provided by each of the SR_i series is incorporated through the likelihood $p(SR_i \mid \theta_i)$ of the parameters of the river *i*. In this way, the information coming from each index river is weighted according to how informative it is about the SR-related parameters.

The joint posterior probability distribution of all the model parameters, $p(\theta, \Theta, \sigma \mid SR, WA, lat)$, can be approximated using Markov Chain Monte Carlo (MCMC) sampling techniques. The techniques were implemented by means of the Winbugs® software (Spiegelhalter et al., 2000). Convergence of MCMC sampling was checked using the tools included in Winbugs. For any new river and its associated WA_{new} and lat_{new} values, $p(\theta_{new} \mid SR, WA_{new}, lat_{new})$ can also be sampled using Winbugs. Derivation of a sample of *Sopt* values from a sample of θ values is straightforward through equation (1).

Interpretation of the output

The posterior distribution of *D* (Figure 2.4.4.1) validates *a posteriori* the choice of introducing latitude as a covariate in the analysis. Conditionally, on the data from the index rivers, *D* is positive and different from 0, thus reflecting an increasing trend in *ropt*, i.e. the average recruitment at MSY per m² of riverine wetted area accessible to salmon, with latitude.

Posterior distributions of *sopt*, the egg deposition rate at MSY per m² of wetted area (*Sopt / WA*), are given in Figure 2.4.4.2. Knowing the wetted area accessible to salmon, *sopt* allows to compute the NASCO standard CL for any river. The posterior distributions of *sopt* for the index rivers indicate:

- a large within-river uncertainty

- significant variations among rivers, even within a relatively narrow latitudinal range.

Consequently, there is great uncertainty in *sopt* for a new river with no SR data. This is not unexpected. Recruitment is known to be a highly variable process and thus SR-related parameters cannot be estimated precisely with short SR series. In addition, many features, other than wetted area accessible to salmon and latitude, can cause variations in the recruitment process among rivers. More precise estimates of the SR parameters cannot be derived at this time, given that there are only 15 rivers in the NEAC area out of a possible 2,000 or more with SR data.

Setting CLs at a regional level

For providing scientific advice for the management of mixed stock fisheries, CLs determined at an aggregated regional level are most useful. Regional CLs are key elements in the procedures used at ICES to elaborate the scientific advice in response to NASCO demand.

A regional CL, CL_{reg}, can be defined as the sum of all the river CLs of a given region. The posterior distribution of CL_{reg} can be denoted:

$p(CL_{reg} \mid SR, lat_{reg}, WA_{reg})$

where:

SR is the set of SR series from the index rivers,

lat_{reg} is the vector of latitudinal positions of the rivers of the region of interest,

WA_{reg} is the vector of wetted areas of the rivers of the region of interest.

Under the model presented above, the CLs of the NEAC rivers for which no SR data are available are independent conditionally on the hyperparameters Θ. In other words, they depend on the SR data collected from the index rivers only through the hyperparameters. Therefore, it is straightforward to get a sample of CL_{reg} values to approximate the CL_{reg} posterior distribution (i.e. each draw of data within its posterior distribution equates to successive and independent draws of $Sopt_{new}$ for each river within the region of interest). Calculating the sum of these river conservation limits generates a CL_{reg} value.

Because CL_{reg} is a sum of variables with (conditionally) independent distributions, the precision of the posterior distribution of CL_{reg} will be reduced compared to that of an individual river CL. The rather imprecise SR related parameter estimates obtained for rivers with no SR data could be valuable information when aggregated at a regional level.

The case of the Brittany region (France) was treated as an illustration. There are 29 salmon rivers in Brittany of varying size (Table 2.4.4.2). They are located between 48° and 48.5° north. The posterior distribution of the Brittany CL (Figure 2.4.4.3) is more precise than that of its individual rivers' components: the coefficient of variation ($CV = 0.973$) is reduced by more than half when compared with that of a river located at 48° north ($CV = 2.559$) or at 48.5° north ($CV = 2.016$).

Development of broader scale conservation limits

The results presented above must be treated with caution because some of the data sets used are still under review and some modifications in terms of addition or removal of SR series may be necessary in future analyses. However, they are provided as an illustration of the potential of the approach for a broad scale CL setting exercise over the NEAC area. The same approach could be easily extended to the NAC area. It is especially relevant in the context of the need to provide scientific advice to NASCO. Regional CL probability distributions might be the most valuable output of this Bayesian Hierarchical

SR analysis in the context of this advice. This output compliments the type of risk analyses developed by the Working Group over recent years to provide the Greenland catch advice. It also relates the index rivers programs with the stock management issues arising from mixed stock fisheries.

2.4.5 Salmon stocks listed as "Endangered"

2.4.5.1 Canada

Wild Atlantic salmon of the inner Bay of Fundy (iBoF) are known to have occupied at least 32 rivers (22 rivers of SFA 22 in Nova Scotia and 10 rivers in SFA 23, New Brunswick). Additional populations were suspected to have occupied all rivers and streams where migration was not obstructed by natural barriers. Rivers in these areas have a variety of habitats and are well suited to the production of salmon. In general, habitat is impacted by forest harvesting and agriculture practices to varying degrees but because of the underlying geology, waters in rivers of the iBoF are not susceptible to acidification. Some rivers have lost their salmon production because of man-made barriers to migration, reduced fish passage and resulting loss in productive capacity, e.g. the Petiticodiac, Shepody, and Avon rivers. The Petiticodiac River represents about 22% of the salmon production potential of the inner Bay of Fundy. Moderate-to-high production of wild Atlantic salmon has been documented in many of these rivers as recently as 1985 and no widespread degradation of freshwater habitat is known to have occurred since.

Wild Atlantic salmon of the iBoF are composed of at least two population segments with independent phylogenetic evolutionary histories and are distinct from other North American or European populations. The distinctness of salmon in iBoF rivers has been recognized for over a century. This early recognition was based on observations that salmon usually enter these rivers in the fall of the year, have a high proportion that return to spawn after one winter at sea, and annual population abundance did not correspond with other North American salmon stocks. Historic tagging of wild and hatchery smolts indicated that other than the Gaspereau River, salmon from iBoF rivers were rarely detected outside of the Bay of Fundy and Gulf of Maine. Genetic analysis has confirmed this early recognition.

On the basis of data collected to 1999, salmon of the iBoF were classified as "endangered" by the Committee On the Status of Endangered Wildlife in Canada (COSEWIC) in May, 2001. In an attempt to prevent the extirpation of inner Bay of Fundy salmon a live gene bank program was initiated in 1998. Large numbers of fish and eggs of various ages are presently held in the Biodiversity Facilities. These fish originate from two river stocks (Stewiacke and Big Salmon) and a combined total of 122 parr collected from the Economy, Great Village, Portapique, Folly and Debert rivers. Releases of juvenile salmon to the Stewiacke, Big Salmon, and Petiticodiac rivers began in 2001.

2.4.5.2 USA

Based on geographic areas with different riverine-marine ecosystems that likely exert different selective pressures, historic USA Atlantic salmon populations were probably comprised of at least three population segments: Long Island Sound, Central New England, and Gulf of Maine. The only persistent wild populations of Atlantic salmon remaining in the USA are currently found in eight rivers within the Gulf of Maine. Major threats to salmon continue to be poor marine survival, water withdrawals, disease, and aquaculture impacts.

Review of genetic and demographic data by federal agencies and the National Research Council determined that the Gulf of Maine population segment is distinct from other populations in North America. While it is unlikely that any Atlantic salmon populations in the USA exist in a genetically pure native form, present populations are considered descendants of aboriginal stocks and their continued presence in indigenous habitat indicates that important heritable local adaptations still exist. This information, along with low abundances, contributed to listing the Gulf of Maine Distinct Population Segment (DPS) as a federally endangered species on December 17, 2000. The DPS includes all persistent naturally-reproducing remnant populations of Atlantic salmon from the Kennebec River downstream of the former Edwards Dam site, northward to the mouth of the St. Croix River. Eight populations are currently recognized as meeting this definition.

River-specific broodfish are currently used to supplement six of the eight endangered populations. All broodfish are genetically characterized which helps managers maintain the genetic integrity of wild and captive fish, prevent irreversible losses of genetic diversity, and evaluate the stocking program. Salmon taken from DPS rivers for hatchery broodstock purposes, and captive progeny from these salmon, are protected as endangered species. However, these hatchery-held fish do not count toward a delisting or reclassification goal as this goal refers to the status of the salmon in the wild. Estimated total returns of DPS salmon in 2001 was 98 (95% CI = 81-122; see section 4.2.1).

2.5 Biological reference points used by the Working Group

In order to ensure consistency of advice being provided to ACFM, the Working Group considered it appropriate to compare and review the biological reference points (BRP) adopted by ICES for other fisheries assessments and those currently used in the provision of catch advice for Atlantic salmon by ACFM.

Some confusion has arisen because the Working Group proposed S_{MSY} as a reference point before the concept of Limit Reference Points (LRP) was introduced (ICES 1993b). At this time it was termed the 'Spawning Target' and was used as a 'Target Reference Point'. In 1998, NASCO formally adopted the precautionary approach, and accepted S_{MSY} as the Conservation Limit (CL) for salmon stocks.

The justification for the use of S_{MSY} as a conservation limit has been developed and outlined in earlier Working Group reports. ICES defines a stock to be outside safe biological limits when it '*suffers increased risk of low recruitment, i.e. average recruitment will be lower than if the stock were at its full reproductive capacity*' (ICES, 2001b). The Working Group maintains that the current use of S_{MSY} as a limit reference point is consistent with the above definition. The Working Group also noted that the limit reference point, $\mathbf{B}_{lim}$, is defined by ICES as '*the limit spawning stock biomass below which recruitment is impaired or the dynamics of the stock are unknown*'. Again, the Working Group considers their application of S_{MSY} to be consistent with this definition. The Working Group noted that it is important to define a biological reference point for salmon that can be objectively defined for all stock and recruitment relationships. This is necessary to ensure a consistent approach across the large number of salmon stocks in the North Atlantic (~2,000 individual stocks). However, in order to be consistent with the advice provided for other fisheries by ICES, the Working Group proposes to make it clear in the report that the conservation limit for Atlantic salmon is synonymous with $\mathbf{B}_{lim}$ but referenced to the spawning stock in numbers of fish (S_{lim}), i.e. rather than the biomass in weight (B), which is not used in the assessment of stocks.

It is also noted that, although the Working Group and ACFM have continued to provide more risk averse catch options, NASCO has in the past used the 50% probability level when setting quotas. By doing so, the S_{MSY} (now S_{lim}) has been used as a 'Target Reference Point' rather than a limit reference point. The latter would require the adoption of a higher probability level. The Working Group considers that further emphasis should be given to the adoption of a higher probability level in the provision of catch advice.

In the provision of advice for other fisheries and stocks, ACFM also refers to a second reference point which is referred to as a precautionary reference point, i.e. for biomass ($\mathbf{B}_{pa}$) and/or fishing mortality ($\mathbf{F}_{pa}$). The equivalent terminology if applied for salmon advice would then be referred to as S_{pa}. To date no work has been carried out by the Working Group to develop S_{pa} for the provision of catch advice. Such a reference point should include the uncertainties in deriving S_{lim} and uncertainties in the estimate of the predicted pre-fishery abundance (PFA).

It is also stressed that previous Working Group reports have not adequately pointed out the consequences of intentionally going above or below S_{lim} and that further modelling and analyses are required to evaluate the consequences of allowing stocks to fall below S_{lim} or S_{pa} in order to improve the advice to managers. This analysis may not be possible without direction from managers regarding their fishery objectives.

2.6 Compilation of Tag Releases and Finclip Data by ICES Member Countries in 2001

2.6.1 Compilation of tag releases and finclip data for 2001

Data on releases of tagged, fin-clipped, and marked salmon in 2001 were provided by the Working Group and are compiled as a separate report. A summary of Atlantic salmon marked in 2001 is given in Table 2.6.1. About 3.88 million salmon were marked in 2001, an increase from the 3.63 million fish marked in 2000. Primary marks are summarized in three classes: microtag (i.e., coded wire tag), external tag/mark, and adipose clips (without other external marks or fin clips). Secondary marks, primarily adipose clips on fish with coded wire tags, are also presented in the Annex. The adipose clip was the most used primary mark (2.97 million), with microtags (0.52 million) the next most used primary mark. Most marks were applied to hatchery-origin juveniles (3.82 million), while 39,790 wild juveniles and 19,081 adults were marked.

Table 2.1.1.1 Nominal catch of SALMON by country (in tonnes round fresh weight), 1960-2001. (2001 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) (12)	UK (N.Irl.) (5,9)	UK (Scotl.)	USA	Other (10)	Total Reported Catch	Unreported catches NASCO Areas	Unreported catches International waters (11)
1960	1636	-	-	-	-	-	60	100		743	1659	1100	33	-	40	283	139	1443	1	-	7237	-	-
1961	1583	-	-	-	-	-	127	127		707	1533	790	20	-	27	232	132	1185	1	-	6464	-	-
1962	1719	-	-	-	-	-	244	125		1459	1935	710	23	-	45	318	356	1738	1	-	8673	-	-
1963	1861	-	-	-	-	-	466	145		1458	1786	480	28	-	23	325	306	1725	1	-	8604	-	-
1964	2069	-	-	-	-	-	1539	135		1617	2147	590	34	-	36	307	377	1907	1	-	10759	-	-
1965	2116	-	-	-	-	-	861	133		1457	2000	590	42	-	40	320	281	1593	1	-	9434	-	-
1966	2369	-	-	-	-	-	1370	104	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	[illegible]	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	1310	-	243	36	32	4	893	217	180	1874	1076	420	18	2	40	395	114	882	0.9	-	7737	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	567	930	313	7	1.9	33	338	94	624	2.4	-	4924	1890	180-350

Table 2.1.1.1 continued

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) (12)	UK (N.Irl.) (5,9)	UK (Scotl.)	USA	Other (10)	Total Reported Catch	Unreported catches NASCO Areas	Unreported catches International waters (11)
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	171	91	600	0.7	-	4118	1962	25-100
1993	373	9	23	70	16	-	-	160	496	541	923	139	8	2.9	56	248	83	547	0.6	-	3696	1644	25-100
1994	355	6	6	49	18	-	-	140	308	804	996	141	10	3.4	44	324	91	649	0	-	3944	1276	25-100
1995	260	3.1	5	48	9	2	83	150	298	790	839	128	9	0.8	37	295	83	588	0	-	3628	1060	-
1996	292	1.7	-	44	14	0.1	92	122	239	687	787	131	7	1.6	33	183	77	427	0	-	3138	1123	-
1997	229	1.3	-	45	8	1	58	106	50	571	630	111	3	1.5	19	142	93	296	0	-	2365	827	-
1998	157	1.3	6	48	9	0	11	130	34	624	740	131	4	2.3	15	123	78	283	0	-	2397	1210	-
1999	152	0.5	0	62	11	0.4	19	119	26	515	811	103	6	2.3	16	150	53	199	0	-	2245	1027	-
2000	153	5.2	8	95	11	0	21	82	2	621	1176	124	-	2.3	33	219	78	274	0	-	2905	1265	-
2001	145	6.4	0	125	11	0	43	87	0	769	1267	114	12	2.2	33	183	53	227	0	-	3078	1170	-
Means																							
1996-2000	197	2	5	59	11	0	40	112	70	604	829	120	5	2	23	163	76	296	0	-	2610	1090	-
1991-2000	320	4	21	61	13	2	124	131	226	619	865	139	8	2	34	206	78	433	0	-	3254	1308	-

1. Includes estimates of some local sales, and, prior to 1984, by-catch.
2. Between 1991 & 1999, there was only a research fishery at Faroes.

In 1997 & 1999 no fishery took place, the commercial fishery resumed in 2000

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 to 2000 do not include catches taken in the recently developed recreational (rod) fishery.
8. Weights prior to 1990 are estimated from 1994 mean weight. Weights from 1990 to 1999 based on mean wt. from R. Asturias. Weights for 2001 based on mean wt. from french 2001 rod catches (1 SW : 2.35 kg ; 2 SW : 4.57 kg).
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.
12. Data for 1993-98 altered from previous reports to take account of catch & release

Table 2.1.1.2 Nominal catch of SALMON in homewaters by country (in tonnes round fresh weight), 1960-2001. (2001 figures include provisional data).
S = Salmon (2SW or MSW fish). G = Grilse (1SW fish). Sm = small. Lg = large; for definitions, see Section 4.1. T = S + G or Lg + Sm

Year	Canada (1)			Finland			France	Iceland Wild	Iceland Ranch	Ireland (2,3)			Norway (4)			Russia (5)	Spain (6)	Sweden (West)	UK (7) (E&W)	UK(N.I.) (2,8)	UK(Scotland)			USA	Total
	Lg	Sm	T	S	G	T	T	T	T	S	G	T	S	G	T	T	T	T	T	T	S	G	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	8286
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	9683
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	7736
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	1310	27	9	36	32	217	180	141	1733	1874	656	420	1076	420	18	40	395	114	501	381	882	0.9	6585
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	5280
1990	486	425	911	41	19	60	15	146	280	-	-	567	545	385	930	313	7	33	338	94	423	201	624	2.4	4520
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	171	91	362	238	600	0.7	3841
1993	214	159	373	53	17	70	16	160	496	-	-	541	611	312	923	139	8	56	248	83	320	227	547	0.6	3661
1994	216	139	355	38	11	49	18	140	308	-	-	804	581	415	996	141	10	44	324	91	400	248	648	0	3929
1995	153	107	260	37	11	48	9	150	298	-	-	790	590	249	839	128	9	37	295	83	364	224	588	0	3534
1996	154	138	292	24	20	44	14	122	239	-	-	687	571	215	787	131	7	33	183	77	267	160	427	0	3043
1997	126	103	229	30	15	45	8	106	50	-	-	570	389	241	630	111	3	19	142	93	182	114	296	0	2302
1998	70	87	157	29	19	48	9	130	34	-	-	624	445	296	740	131	4	15	123	78	162	121	283	0	2376
1999	64	88	152	29	33	62	11	119	26	-	-	515	493	318	811	103	6	16	150	53	142	57	199	0	2223
2000	58	95	150	57	38	95	11	82	2	-	-	621	673	504	1176	124	-	33	219	78	160	114	274	0	2854
2001	63	82	145	105	20	125	11	87	0	-	-	779	850	417	1267	114	12	33	183	53	139	88	227	0	3036
Means																									
1996-2000	94	102	196	34	25	59	11	112	70	-	-	603	514	315	829	120	5	23	163	76	183	113	296	0	2560
1991-2000	175	146	320	40	21	61	13	131	226	-	-	619	545	319	865	139	8	34	206	78	254	179	433	0.3	3129

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. Figures from 1991 to 2000 do not include catches of the recently developed recreational (rod) fishery.
6. Weights prior to 1990 are estimated from 1994 mean weight. Weights from 1990 to 1999 based on mean wt. from R. Asturias. Weights for 2001 based on mean wt. of french 2001 rod catches (1 SW : 2.35 kg ; 2 SW : 4.57 kg).
7. Data for 1993-98 altered from previous reports to take account of catch & release
8. 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 2001 may be provisional.
Methods used for estimating age composition given in footnote

Country	Year	1SW		2SW		3SW		4SW		5SW		MSW (1)		PS		Total	
		No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt
West Greenland	1982	315,532	-	17,810	-	-	-	-	-	-	-	-	-	2,688	-	336,030	1,077
	1983	90,500	-	8,100	-	-	-	-	-	-	-	-	-	1,400	-	100,000	310
(2)	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
	1999	6, 124	18	50	0.4	-	-	-	-	-	-	-	-	84	0.6	6,258	19
	2000	7,715	21	0	0	-	-	-	-	-	-	-	-	140	0.4	7,855	21
	2001	14,795	40	324	2	-	-	-	-	-	-	-	-	293	1.3	15,412	43
Canada	1982	358,000	716	-	-	-	-	-	-	-	-	240,000	1,082	-	-	598,000	1,798
	1983	265,000	513	-	-	-	-	-	-	-	-	201,000	911	-	-	466,000	1,424
	1984	234,000	467	-	-	-	-	-	-	-	-	143,000	645	-	-	377,000	1,112
	1985	333,084	593	-	-	-	-	-	-	-	-	122,621	540	-	-	455,705	1,133
	1986	417,269	780	-	-	-	-	-	-	-	-	162,305	779	-	-	579,574	1,559
	1987	435,799	833	-	-	-	-	-	-	-	-	203,731	951	-	-	639,530	1,784
	1988	372,178	677	-	-	-	-	-	-	-	-	137,637	633	-	-	509,815	1,310
	1989	304,620	549	-	-	-	-	-	-	-	-	135,484	590	-	-	440,104	1,139
	1990	233,690	425	-	-	-	-	-	-	-	-	106,379	486	-	-	340,069	911
	1991	189,324	341	-	-	-	-	-	-	-	-	82,532	370	-	-	271,856	711
	1992	108,901	199	-	-	-	-	-	-	-	-	66,357	323	-	-	175,258	522
	1993	91,239	159	-	-	-	-	-	-	-	-	45,416	214	-	-	136,655	373
	1994	76,973	139	-	-	-	-	-	-	-	-	42,946	216	-	-	119,919	355
	1995	61,940	107	-	-	-	-	-	-	-	-	34,263	153	-	-	96,203	260
	1996	82,490	138	-	-	-	-	-	-	-	-	31,590	154	-	-	114,080	292
	1997	58,988	103	-	-	-	-	-	-	-	-	26,270	126	-	-	85,258	229
	1998	51,251	87	-	-	-	-	-	-	-	-	13,274	70	-	-	64,525	157
	1999	50,901	88	-	-	-	-	-	-	-	-	11,368	64	-	-	62,269	152
	2000	55,263	95	-	-	-	-	-	-	-	-	10,571	58	-	-	65,834	153
	2001	48,760	82	-	-	-	-	-	-	-	-	12,102	63	-	-	60,862	145

Table 2.1.1.3 continued

Country	Year	1SW		2SW		3SW		4SW		5SW		MSW (1)		PS		Total	
		No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt
USA	1982	33	-	1,206	-	5	-	-	-	-	-	-	-	21	-	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	2	-	-	-	-	-	-	-	13	-	557	2.1
	1986	76	-	482	1.8	2	-	-	-	-	-	-	-	3	-	541	1.9
	1987	33	-	229	1	10	-	-	-	-	-	-	-	10	-	282	1.2
	1988	49	-	203	0.8	3	-	-	-	-	-	-	-	4	-	259	0.9
	1989	157	0.3	325	1.3	2	-	-	-	-	-	-	-	3	-	487	1.7
	1990	52	0.1	562	2.2	12	-	-	-	-	-	-	-	16	-	642	2.4
	1991	48	0.1	185	0.7	1	-	-	-	-	-	-	-	4	-	238	0.8
	1992	54	0.1	138	0.6	1	-	-	-	-	-	-	-	-	-	193	0.7
	1993	17	-	133	0.5	0	0	-	-	-	-	-	-	2	-	152	0.6
	1994	12	-	0	0	0	0	-	-	-	-	-	-	-	-	12	0.1
	1995	0	0	0	0	0	0	-	-	-	-	-	-	-	-	0	0
	1996	0	0	0	0	0	0	-	-	-	-	-	-	-	-	0	0
	1997	0	0	0	0	0	0	-	-	-	-	-	-	-	-	0	0
	1998	0	0	0	0	0	0	-	-	-	-	-	-	-	-	0	0
	1999	0	0	0	0	0	0	-	-	-	-	-	-	-	-	0	0
	2000	0	0	0	0	0	0	-	-	-	-	-	-	-	-	0	0
	2001	0	0	0	0	0	0	-	-	-	-	-	-	-	-	0	0
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
	1998/99	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0
	1999/00	225	-	1560	-	205	-	-	-	-	-	-	-	-	-	1,990	8
	2000/01	0	0	0	0	0	0	-	-	-	-	-	-	-	-	0	0
	2001/02	0	0	0	0	0	0	-	-	-	-	-	-	-	-	0	0

Table 2.1.1.3 continued

Country	Year	1SW		2SW		3SW		4SW		5SW		MSW (1)		PS		Total	
		No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt
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
												6,298					
	1991	9,213	17	-	-	-	-	-	-	-	-	6,298	53	-	-	15,511	70
	1992	15,017	28	-	-	-	-	-	-	-	-	6,284	49	-	-	21,301	77
	1993	11,157	17	-	-	-	-	-	-	-	-	8,180	53	-	-	19,337	70
	1994	7,493	11	-	-	-	-	-	-	-	-	6,230	38	-	-	13,723	49
	1995	7,786	11	-	-	-	-	-	-	-	-	5,344	38	-	-	13,130	48
	1996	12,230	20	1,275	5	1,424	12	234	4	19	0.5	-	-	354	3	13,443	44
	1997	10,341	15	2,419	10	1,674	15	141	2	22	0.5	-	-	418	3	13,741	45
	1998	11,792	19	1,608	7	1,660	16	147	2	0	0	-	-	460	3	15,169	48
	1999	18,830	33	1,528	8	1,579	16	129	2	6	0.1	-	-	490	3	20,709	62
	2000	17,499	39	5,152	24	2,379	25	110	2	0	0	-	-	991	6	26,196	95
	2001	12,829	20	6,284	32	5,413	58	104	2	0	0	-	-	2,338	13	26,968	125
Iceland	1991	30,011	-	11,935	-	-	-	-	-	-	-	-	-	-	-	41,946	130
	1992	38,955	-	15,416	-	-	-	-	-	-	-	-	-	-	-	54,371	175
	1993	37,611	-	11,611	-	-	-	-	-	-	-	-	-	-	-	49,222	160
	1994	25,480	62	14,408	78	-	-	-	-	-	-	-	-	-	-	39,888	140
	1995	34,046	93	13,380	57	-	-	-	-	-	-	-	-	-	-	47,426	150
	1996	28,039	69	9,971	53	-	-	-	-	-	-	-	-	-	-	38,010	122
	1997	23,945	62	8,872	44	-	-	-	-	-	-	-	-	-	-	32,817	106
	1998	35,537	90	7,791	40	-	-	-	-	-	-	-	-	-	-	43,328	130
	1999	20,031	52	8,093	44	-	-	-	-	-	-	-	-	-	-	28,124	96
	2000	23,850	58	4,456	24	-	-	-	-	-	-	-	-	-	-	28,306	82
	2001	23,717	58	5,564	29	-	-	-	-	-	-	-	-	-	-	29,281	87
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
	1999	3,573	8	-	-	-	-	-	-	-	-	1,460	8	-	-	5,033	16
	2000	7,103	18	-	-	-	-	-	-	-	-	3,196	15	-	-	10,299	33
	2001	4,634	12	-	-	-	-	-	-	-	-	3,853	21	-	-	8,437	33

Table 2.1.1.3 continued

Country	Year	1SW		2SW		3SW		4SW		5SW		MSW (1)		PS		Total	
		No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt
Norway	1981	221,566	467	-	-	-	-	-	-	-	-	213,943	1,189	-	-	435,509	1,656
	1982	163,120	363	-	-	-	-	-	-	-	-	174,229	985	-	-	337,349	1,348
	1983	278,061	593	-	-	-	-	-	-	-	-	171,361	957	-	-	449,442	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	-	-	-	-	-	-	-	-	232,997	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
	1999	164,905	318	70,825	326	18,669	167	-	-	-	-	-	-	-	-	254,399	811
	2000	250,468	504	99,934	454	24,319	219	-	-	-	-	-	-	-	-	374,721	1,176
	2001	207,934	417	117,759	554	33,047	295	-	-	-	-	-	-	-	-	358,740	1,267
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	-	0	0	-	-	2,187	-	107,477	364
	1990	70,595	-	20,633	-	2,919	-	101	-	0	0	-	-	2,010	-	96,258	313
	1991	40,603	-	12,458	-	3,060	-	650	-	0	0	-	-	1,375	-	58,146	215
	1992	34,021	-	8,880	-	3,547	-	180	-	0	0	-	-	824	-	47,452	167
	1993	28,100	-	11,780	-	4,280	-	377	-	0	0	-	-	1,470	-	46,007	139
	1994	30,877	-	10,879	-	2,183	-	51	-	0	0	-	-	555	-	44,545	141
	1995	27,775	62	9,642	50	1,803	15	6	0	0	0	-	-	385	2	39,611	128
	1996	33,878	79	7,395	42	1,084	9	40	0.5	0	0	-	-	41	0.5	42,586	131
	1997	31,857	72	5,837	28	672	6	38	0.5	0	0	-	-	559	3	39,003	111
	1998	34,870	92	6,815	33	181	2	28	0.3	0	0	-	-	638	3	42,532	131
	1999	24,016	66	5,317	25	499	5	0	0	0	0	-	-	1,131	6	30,963	102
	2000	27,702	75	7,027	34	500	5	3	0.1	0	0	-	-	1,853	9	37,115	124
	2001	26,472	61	7,505	39	1,036	10	30	0.4	0	0	-	-	922	5	35,965	114

Table 2.1.1.3 continued

Country	Year	1SW		2SW		3SW		4SW		5SW		MSW (1)		PS		Total	
		No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt
Ireland	1980	248,333	745	-	-	-	-	-	-	-	-	39,608	202	-	-	287,941	947
	1981	173,667	521	-	-	-	-	-	-	-	-	32,159	164	-	-	205,826	685
	1982	310,000	930	-	-	-	-	-	-	-	-	12,353	63	-	-	322,353	993
	1983	502,000	1,506	-	-	-	-	-	-	-	-	29,411	150	-	-	531,411	1,656
	1984	242,666	728	-	-	-	-	-	-	-	-	19,804	101	-	-	262,470	829
	1985	498,333	1,495	-	-	-	-	-	-	-	-	19,608	100	-	-	517,941	1,595
	1986	498,125	1,594	-	-	-	-	-	-	-	-	28,335	136	-	-	526,450	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	-	-	-	-	-	-	-	-	-	-	-	-	-	-	188,890	567
	1991	-	-	-	-	-	-	-	-	-	-	-	-	-	-	135,474	404
	1992	-	-	-	-	-	-	-	-	-	-	-	-	-	-	235,435	630
	1993	-	-	-	-	-	-	-	-	-	-	-	-	-	-	200,120	541
	1994	-	-	-	-	-	-	-	-	-	-	-	-	-	-	286,266	804
	1995	-	-	-	-	-	-	-	-	-	-	-	-	-	-	288,225	790
	1996	-	-	-	-	-	-	-	-	-	-	-	-	-	-	249,623	687
	1997	-	-	-	-	-	-	-	-	-	-	-	-	-	-	209,214	570
	1998	-	-	-	-	-	-	-	-	-	-	-	-	-	-	237,663	624
	1999	-	-	-	-	-	-	-	-	-	-	-	-	-	-	180,477	515
	2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	228,220	621
	2001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	288,362	779
UK	1985	62,815	-	-	-	-	-	-	-	-	-	32,716	-	-	-	95,531	361
(England & Wales)	1986	68,759	-	-	-	-	-	-	-	-	-	42,035	-	-	-	110,794	430
	1987	56,739	-	-	-	-	-	-	-	-	-	26,700	-	-	-	83,439	302
(3)	1988	76,012	-	-	-	-	-	-	-	-	-	34,151	-	-	-	110,163	395
	1989	54,384	-	-	-	-	-	-	-	-	-	29,284	-	-	-	83,668	296
	1990	45,072	-	-	-	-	-	-	-	-	-	41,604	-	-	-	86,676	338
	1991	36,671	-	-	-	-	-	-	-	-	-	14,978	-	-	-	51,649	200
	1992	34,331	-	-	-	-	-	-	-	-	-	10,255	-	-	-	44,586	171
	1993	56,033	-	-	-	-	-	-	-	-	-	13,144	-	-	-	69,177	248
	1994	67,853	-	-	-	-	-	-	-	-	-	20,268	-	-	-	88,121	324
	1995	57,944	-	-	-	-	-	-	-	-	-	22,534	-	-	-	80,478	295
	1996	30,352	-	-	-	-	-	-	-	-	-	16,344	-	-	-	46,696	183
	1997	30,203	-	-	-	-	-	-	-	-	-	11,171	-	-	-	41,374	142
	1998	30,641	-	-	-	-	-	-	-	-	-	6,276	-	-	-	36,917	123
	1999	28,766	-	-	-	-	-	-	-	-	-	12,328	-	-	-	41,094	150
	2000	48,153	-	-	-	-	-	-	-	-	-	12,800	-	-	-	60,953	214
	2001	38,486	-	-	-	-	-	-	-	-	-	12,829	-	-	-	51,315	183

Table 2.1.1.3 continued

Country	Year	1SW		2SW		3SW		4SW		5SW		MSW (1)		PS		Total	
		No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt
UK (Scotland)	1982	208,061	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	46,872	114	-	-	-	-	-	-	-	-	40,427	182	-	-	87,299	296
	1998	53,447	121	-	-	-	-	-	-	-	-	39,248	162	-	-	92,695	283
	1999	25,183	57	-	-	-	-	-	-	-	-	30,651	142	-	-	55,834	199
	2000	43,879	114	-	-	-	-	-	-	-	-	36,657	160	-	-	80,536	274
	2001	38,432	88	-	-	-	-	-	-	-	-	32,712	139	-	-	71,144	227
France	1987	6,013	18	-	-	-	-	-	-	-	-	1,806	9	-	-	7,819	27
	1988	2,063	7	-	-	-	-	-	-	-	-	4,964	25	-	-	7,027	32
	1989	1,124	3	1,971	9	311	2	-	-	-	-	-	-	-	-	3,406	14
	1990	1,886	5	2,186	9	146	1	-	-	-	-	-	-	-	-	4,218	15
	1991	1,362	3	1,935	9	190	1	-	-	-	-	-	-	-	-	3,487	13
	1992	2,490	7	2,450	12	221	2	-	-	-	-	-	-	-	-	5,161	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	-	-	-	-	-	-	-	-	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
	1999	690	2	1,799	9	32	0.2	-	-	-	-	-	-	-	-	2,521	11
	2000	1,792	4	1,253	6	24	0.2	-	-	-	-	-	-	-	-	3,069	11
	2001	1,544	4	1,464	7	25	0.2									3,033	11

1. MSW includes all sea ages >1, when this cannot be broken down.
   Different methods are used to separate 1SW and MSW salmon in different countries:
   - Scale reading: Faroe Islands, Finland (1996 onwards), France, Russia, USA and West Greenland.
   - Size (split weight/length): Canada (2.7 kg for nets; 63cm for rods), Finland up until 1995 (3 kg),
   Iceland (various splits used at different times and places), Norway (3 kg), UK Scotland (3 kg in some places and 3.7 kg in others),
   All countries except Scotland report no problems with using weight to catergorise catches into sea age classes.
   In Scotland, misclassification may be very high in some years.
   In Norway, catches shown as 3SW refer to salmon of 3SW or greater.
2. Data for 2001 calculated from a sample of 566 fish.
3. Best estimates of the proportions of 1SW and MSW salmon derived for the PFA model (see Section 3.3.3).

Table 2.1.1.4 The weight (tonnes round fresh weight) and proportion (%) of the nominal catch by country taken in coastal, estuarine and riverine fisheries.

		Catch						
		Coast		Estuary		River		Total
Country	Year	Weight	%	Weight	%	Weight	%	Weight
Canada	1999	7	5	38	25	105	70	150
	2000	11	7	22	15	117	78	150
	2001	13	9	20	14	112	77	145
Finland	1995	0	0	0	0	48	100	48
	1996	0	0	0	0	44	100	44
	1997	0	0	0	0	45	100	45
	1998	0	0	0	0	48	100	48
	1999	0	0	0	0	63	100	63
	2000	0	0	0	0	95	100	95
	2001	0	0	0	0	125	100	125
France[1]	1995	-	-	2	20	8	80	10
	1996	-	-	4	31	9	69	13
	1997	-	-	3	38	5	63	8
	1998	1	13	2	25	5	63	8
	1999	0	0	4	35	7	65	11
	2000	0	4	4	35	7	61	11
	2001	0	0	5	42	6	58	11
Iceland	1995	20	13	0	0	130	87	150
	1996	11	9	0	0	111	91	122
	1997	0	0	0	0	106	100	106
	1998	0	0	0	0	130	100	130
	1999	0	0	0	0	119	100	119
	2000	0	0	0	0	82	100	82
	2001	0	0	0	0	87	100	87
Ireland	1995	566	72	140	18	84	11	790
	1996	440	64	134	20	110	16	684
	1997	380	67	100	18	91	16	571
	1998	433	69	92	15	99	16	624
	1999	335	65	83	16	97	19	515
	2000	440	71	79	13	102	16	621
	2001	556	73	111	14	102	13	769
Norway	1995	515	61	0	0	325	39	840
	1996	520	66	0	0	267	34	787
	1997	394	63	0	0	235	37	629
	1998	410	55	0	0	331	45	741
	1999	483	60	0	0	327	40	810
	2000	619	53	0	0	557	47	1176
	2001	696	55	0	0	570	45	1266
Russia	1995	43	33	9	7	77	60	128
	1996	64	49	21	16	46	35	131
	1997	63	57	17	15	32	28	111
	1998	55	42	2	2	74	56	131
	1999	48	47	2	2	52	51	102
	2000	64	52	15	12	45	36	124
	2001	70	61	0	0	44	39	114

Table 2.1.1.4 continued

Country	Year	Catch						
		Coast		Estuary		River		Total
		Weight	%	Weight	%	Weight	%	Weight
Spain	1995	0	0	0	0	9	100	9
	1996	0	0	0	0	7	100	7
	1997	0	0	0	0	4	100	4
	1998	0	0	0	0	4	100	4
	1999	0	0	0	0	6	100	6
	2000	-	-	-	-	-	-	-
	2001	0	0	0	0	12	100	12
Sweden[5]	1995	24	65	0	0	13	35	37
	1996	19	58	0	0	14	42	33
	1997	10	56	0	0	8	44	18
	1998	5	33	0	0	10	67	15
	1999	5	31	0	0	11	69	16
	2000	10	30	0	0	23	70	33
	2001	9	27	0	0	24	73	33
UK	1995	200	68	45	15	49	17	294
England & Wales	1996	83	45	42	23	58	32	183
	1997	81	57	27	19	35	24	143
	1998	65	53	19	16	38	31	122
	1999	101	67	23	15	26	17	150
	2000	157	72	25	12	37	17	219
	2001	129	70	24	13	30	17	183
UK	1999	44	83	9	17	-	-	53
N. Ireland[2]	2000	63	82	14	18	-	-	77
	2001	41	77	12	23	-	-	53
UK	1995	201	34	105	18	282	48	588
Scotland	1996	129	30	80	19	218	51	427
	1997	79	27	33	11	184	62	296
	1998	60	21	28	10	195	69	283
	1999	35	18	23	11	141	71	199
	2000	76	28	41	15	157	57	274
	2001	56	24	25	11	146	64	227
Totals								
North East Atlantic[3]	2001	1557	54	177	6	1147	40	2880
North America[4]	2001	15	10	20	14	112	76	147

[1] an illegal net fishery operated from 1995 to 1998, catch unknown in the first 3 years but thought to be increasing. Fishery ceased in 1999. 2001 catches from the illegal coastal net fishery in Lower Normandy are unknown.

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

[3] data not available from Denmark

[4] includes St Pierre et Miquelon

[5] estuarine catch included in coastal catch in 2001

Table 2.1.2.1 Numbers of fish caught and released in rod fisheries along with the % of the total rod catch (released + retained) for countries in the North Atlantic where records are available, 1991-2001. Figures for 2001 are provisional.

Year	Canada [1]		Iceland		Russia		UK (E&W)		UK (Scotland)		USA	
	Total	% of total rod catch	Total	% of total rod catch	Total	% of total rod catch	Total	% of total rod catch	Total	% of total rod catch	Total	% of total rod catch
1991	28,497	33			3,211	51					239	50
1992	46,450	34			10,120	73					407	67
1993	53,849	41			11,246	82	1,448	10			507	77
1994	45,804	39			12,056	83	3,227	13	6,595	8	249	95
1995	31,211	36			11,904	84	3,189	20	12,133	14	370	100
1996	36,934	33	669	2	10,745	73	3,428	20	10,409	15	542	100
1997	48,387	49	1,558	5	14,823	87	3,132	24	10,906	18	333	100
1998	56,860	52	2,826	7	12,776	81	5,365	31	13,455	18	273	100
1999	49,268	50	3,055	10	11,450	77	5,447	44	14,839	28	211	100
2000	62,106	55	2,918	11	12,914	74	7,470	43	21,068	32	0	-
2001	56,597	55	3,607	12	16,945	76	6,319	43	27,339	39	0	-

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

Table 2.1.3.1 Estimates of unreported catches by various methods in tonnes within national EEZs in the North-East Atlantic, North American and West Greenland Commissions of NASCO, 1987-2001.

Year	North-East Atlantic	North-American	West Greenland	Total
1987	2,554	234	-	2,788
1988	3,087	161	-	3,248
1989	2,103	174	-	2,277
1990	1,779	111	-	1,890
1991	1,555	127	-	1,682
1992	1,825	137	-	1,962
1993	1,471	161	< 12	1,644
1994	1,157	107	< 12	1,276
1995	942	98	20	1,060
1996	947	156	20	1,123
1997	732	90	5	827
1998	1,108	91	11	1,210
1999	887	133	12,5	1,032
2000	1,135	124	10	1,269
2001	1,079	81	10	1,170
Mean 1996-2000	962	119	< 14	1092

Table 2.1.3.2 Estimates of unreported catches by various methods in tonnes by country within national EEZs in the North-East Atlantic, North American and West Greenland Commissions of NASCO, 2001,

2001 Commission Area	Country	Unreported Catch t	Unreported as % of Total North Atlantic Catch (Unreported + Reported)	Unreported as % of Total National Catch (Unreported + Reported)
NEAC	Denmark	4	0.1	38
NEAC	Finland	31	0.7	20
NEAC	Iceland	1.8	0.04	2
NEAC	Ireland	67	1.6	8
NEAC	Norway	662	16.1	35
NEAC	Russia	210	4.9	65
NEAC	Sweden	4	0.1	11
NEAC	UK (E & W)	33	0.8	15
NEAC	UK (N.Ireland)	2.6	0.1	5
NEAC	UK (Scotland)	43	1.0	16
NAC	Canada	81	1.9	36
NAC	USA	0	0.0	0
WGC	West Greenland	10	0.2	19
	Total Unreported Catch	1170	27.5	
	Total Reported Catch of North Atlantic salmon	3078		

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), 1980-2001.

Year	North Atlantic Area										Outwith 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	344,645	110,784	20,362	16,418	14,860	13,166	2,686	114	0	523,035	125,000	3,000	33,057	7,068	1,000	400	169,525	692,560
1999	415,399	126,686	37,000	24,370	18,000	12,194	2,900	234	0	636,783	150,000	5,000	39,577	9,195	1,000	500	205,272	842,055
2000	427,000	128,959	32,000	34,095	17,648	16,400	2,600	250	0	658,952	176,000	5,670	40,000	10,906	-	-	232576	891,528
2001	427,000	158,479	46,014	33,092	23,312	13,230	2,800	250	0	704,177	200,000	5,443	40,000	11,500	-	-	256943	961,120
Mean 1996-2000	364,682	109,749	26,033	22,390	15,712	12,782	2,702	232	0	554,284	121,732	4,974	31,677	8,734	1,000	600	168,397	722,680
% increase over 5 year average	17	44	77	48	48	4	4		0	27								

2001 data for most countries are provisional.

Where production figures were not available 2000 values were used (Norway, UK (N.Ireland), Canada).

Source of production figures for non-Atlantic areas: misc. fishing publications & government reports.

West Coast USA = Washington State
West Coast Canada = British Columbia
Australia = Tasmania

Table 2.2.2.1 Production of ranched salmon in the North Atlantic (tonnes round fresh weight) as harvested at ranching facilities, 1980-2001.

Year	Iceland commercial ranching	Ireland 1	UK(N.Ireland) River Bush 1	Norway various facilities 1	**Total production**
1980	8				8.0
1981	16				16.0
1982	17				17.0
1983	32				32.0
1984	20				20.0
1985	55	17.5	17.0		89.5
1986	59	22.9	22.0		103.9
1987	40	6.4	7.0		53.4
1988	180	11.5	12.0	4.0	207.5
1989	136	16.3	17.0	3.0	172.3
1990	280	5.7	5.0	6.0	296.7
1991	345	3.6	4.0	5.0	357.6
1992	460	9.4	11.0	10.0	490.4
1993	496	9.7	8.0	11.0	524.7
1994	308	15.2	0.4	9.5	333.1
1995	298	16.8	1.2	2.0	318.0
1996	239	18.5	3.0	8.0	268.5
1997	50	4.1	2.8	2.0	58.9
1998	34	11.0	1.0	1.0	45.6
1999	26	4.3	1.4	1.0	32.7
2000	2	3.8	3.5	1.0	11.1
2001	0	9.7	2.8	1.0	13.5
Mean 1996-2000	70.2	8.3	2.3	2.6	83.4

[1] Total yield in homewater fisheries and rivers.

Table 2.3.1.1. Monthly mortality rate estimates for River Bush hatchery smolts from the 1974 to 1976 releases (data from Doubleday et al. 1979) and for the 1999 hatchery smolts (W. Crozier, Unpubl. Data).

Stock	Growth Model	Age Group	Smolt Cohort	Lifetime Survival	Mortality - 2nd Year at Sea: 314 days	Monthly
River Bush Hatchery smolts	Exponential	Age-1	All three	8.5%	3.4%	0.3%
		Age-2,2+	All three	34.3%	1.5%	0.1%
		Age-1	1974	8.4%	3.4%	0.3%
			1975	13.0%	2.8%	0.3%
			1976	8.5%	3.4%	0.3%
		Age-2,2+	1974	26.8%	1.8%	0.2%
			1975	n.e.	n.e.	n.e.
			1976	24.5%	1.9%	0.2%
	Linear	Age-1	All three	7.3%	17.0%	1.8%
		Age-2,2+	All three	31.9%	7.8%	0.8%
		Age-1	1974	6.7%	17.5%	1.8%
			1975	10.9%	14.6%	1.5%
			1976	8.4%	16.2%	1.7%
		Age-2,2+	1974	24.7%	9.5%	0.9%
			1975	n.e.	n.e.	n.e.
			1976	22.4%	10.1%	1.0%

	Growth Model	Growth Data	Smolt Cohort	Lifetime Survival	Mortality - 2nd Year at Sea: 11 months	Monthly
River Bush Age-1 Hatchery	Exponential	Doubleday et al. 1979	1999	2.7%	10.5%	1.0%
		W. Crozier (Unpubl. Data)	1999	2.4%	19.2%	1.9%
	Linear	Doubleday et al. 1979	1999	2.2%	28.0%	2.9%
		W. Crozier (Unpubl. Data)	1999	2.2%	28.0%	2.9%

Table 2.3.1.2. Summary of monthly mortality rate estimates during the second year at sea for various stocks of Atlantic salmon in the North Atlantic.

Stock	Origin	Smolt cohorts			N	Method of estimation	Mortality rate (% per month): Median	Min.	Max.
North America									
LaHave River	Wild	1996	to	1999	4	Inverse-weight	2.8%	2.3%	3.3%
LaHave River	Hatchery	1972	to	1999	28	Inverse-weight	3.3%	2.3%	4.4%
Northwest Miramichi	Wild	1999	to	1999	1	Inverse-weight	2.7%	-	-
River Trinite	Wild	1984	to	1999	16	Inverse-weight	3.4%	2.9%	4.3%
Sandhill River	Wild	1969	to	1971	3	Inverse-weight	1.5%	1.4%	1.7%
Saint John River	Hatchery: age-1 smolts	1991	to	1998	7	Maturity schedule	17.6%	11.5%	20.8%
LaHave River	Wild	1996	to	1996	1	Maturity schedule	12.0%		
River Trinite	Wild	1984	to	1990	7	Maturity scehdule	12.6%	7.9%	14.7%
River Trinite	Wild	1991	to	1999	9	Maturity scehdule	5.1%	1.4%	9.1%
Miramchi River	Wild	1983	to	1997	15	Maturity schedule	12.4%	3.6%	19.2%
NEAC									
River Bush	Hatchery: age-1 smolts	1974	to	1976	3	Inverse-weight	1.7%	1.5%	1.8%
	Hatchery: age-2 smolts	1974	to	1976	3	Inverse-weight	1.0%	0.9%	1.0%
	Hatchery: age-1 smolts	1999	to	1999	1	Inverse-weight	2.9%	-	-
River Scorff	Wild	1995	to	1997	3	Maturity schedule	16.2%	15.6%	16.7%

Table 2.3.2.1. Percentage increase in estimated NEAC PFA resulting from increasing M from 0.01 to levels between 0.015 and 0.050 per month. (Return times for 1SW and MSW salmon are assumed to be 8 months and 17 months respectively)

New M	Percentage increase in estimated PFA	
	1SW	MSW
	(for 8 months)	(for 17 months)
0.015	4%	9%
0.020	8%	19%
0.025	13%	29%
0.030	17%	40%
0.035	22%	53%
0.040	27%	67%
0.045	32%	81%
0.050	38%	97%

Table 2.3.2.2 Effects on estimates of PFA, CL, SER, Harvestable surplus, etc for Southern European MSW salmon stocks for M equal to 0.01 and 0.03 per month.

	Current M	New M	Effect of higher M
adult M	**0.010**	**0.030**	
time (months)	**17.0**	**17.0**	
Est. returns	**600,000**	**600,000**	
Est. PFA	**711,183**	**999,175**	**40%**
CL	**501,445**	**501,445**	**0%**
SER	**594,365**	**835,052**	**40%**
Harvestable surplus	**116,818**	**164,123**	**40%**
40% allocation to fishery	**46,727**	**65,649**	**40%**
Survivors from fishery	**664,456**	**933,526**	**40%**
Returns to HWs	**560,578**	**560,578**	**0%**

Table 2.4.4.1 - The NEAC index rivers.

River	Country	Latitude	Wetted area accessible to salmon (m²)	Number of SR observations	S (eggs/m²) mean (std dev)	R (eggs/m²) mean (std dev)
Nivelle	France	43° north	320995	12	1.94 (0.87)	1.43 (1.06)
Oir	France	48.5° north	48000	14	6.35 (3.83)	3.64 (2.24)
Frome	UK (England)	50.5° north	876420	12	5.78 (3.22)	6.01 (3.63)
Test	UK (England)	51° north	1383063	9	1.05 (0.51)	1.31 (0.46)
Itchen	UK (England)	51° north	694500	10	1.12 (0.65)	1.32 (0.78)
Dee	UK (England)	53° north	6170000	9	2.26 (0.99)	3.64 (0.56)
Burrishoole	Ireland	54° north	155000	12	9.95 (2.47)	24.25 (9.89)
Lune	UK (England)	54.5° north	4230000	7	2.18 (0.49)	3.72 (0.54)
Bush	UK (N. Ireland)	55° north	845500	13	3.12 (1.40)	10.33 (3.67)
Mourne	UK (N. Ireland)	55° north	10360560	13	1.54 (0.87)	5.11 (2.38)
Faughan	UK (N. Ireland)	55° north	882380	11	12.5 (7.2)	43.79 (20.48)
Girnock	UK (Scotland)	57° north	58764	12	4.33 (2.54)	7.03 (2.52)
North Esk	UK (Scotland)	57° north	2100000	6	15.23 (3.18)	20.94 (3.17)
Imsa	Norway	59.5° north	10000	7	24.06 (26.92)	23.67 (14.86)
Ellidaar	Iceland	64° north	199711	9	32.31 (7.97)	89.06 (51.52)

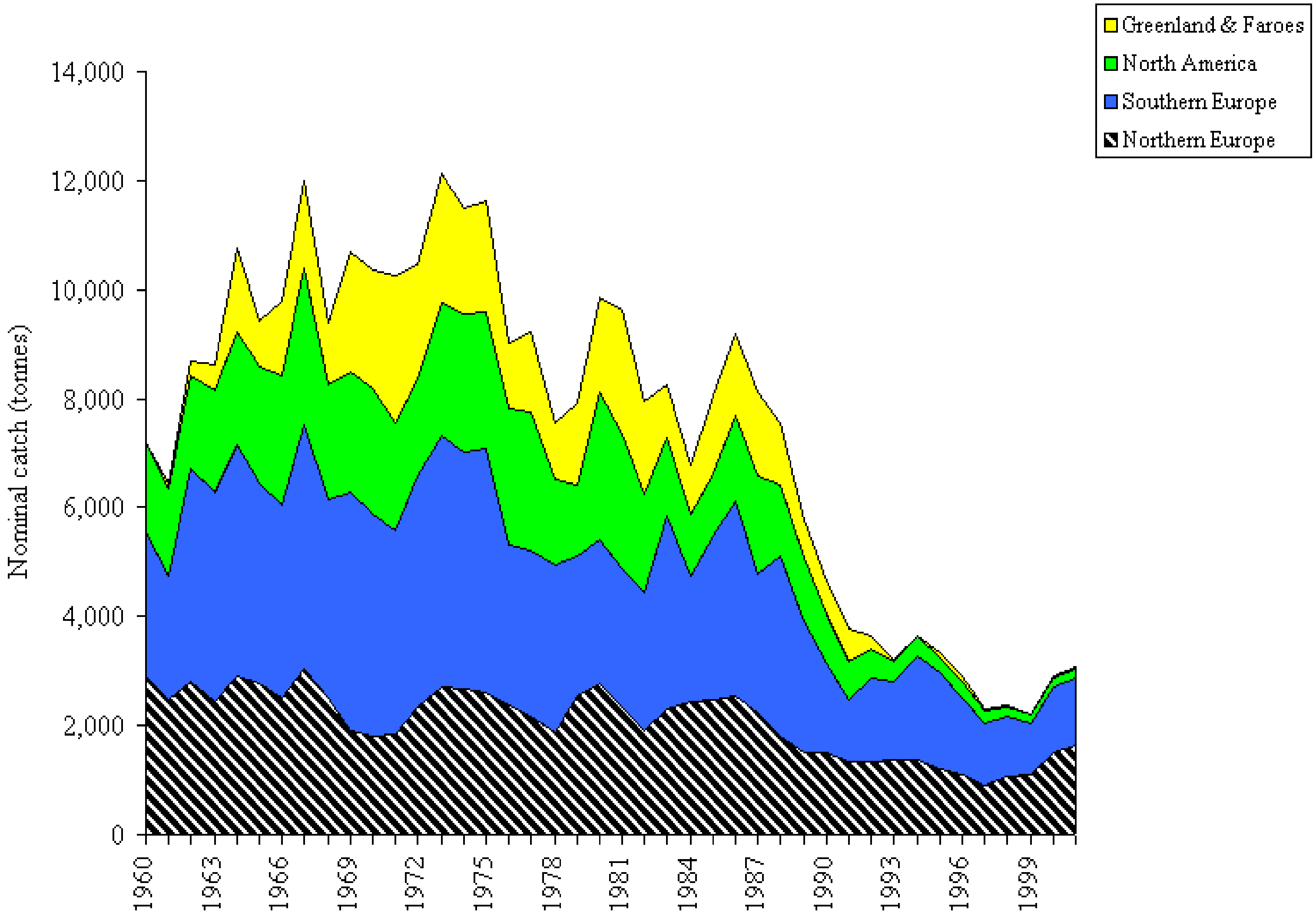
Table 2.4.4.2 - The salmon rivers of Brittany (France).

River	Latitude	Wetted area accessible to salmon (m^2)
COUESNON	48.5° north	542082
LEFF	48.5° north	374651
TRIEUX	48.5° north	909468
JAUDY	48.5° north	242521
LEGUER	48.5° north	684828
YAR	48.5° north	53489
DOURON	48.5° north	85958
DOURDUFF	48.5° north	61253
JARLOT	48.5° north	75370
QUEFFLEUTH	48.5° north	76782
PENZE	48.5° north	110663
HORN	48.5° north	65841
FLECHE	48.5° north	66900
ABER WRAC'H	48.5° north	76782
ABER ILDUT	48.5° north	81723
ABER BENOIT	48.5° north	59842
ELORN	48.5° north	216623
MIGNONNE	48.5° north	73253
CAMFROUT	48.5° north	45019
FAOU	48.5° north	33725
AULNE	48.5° north	985583
GOYEN	48° north	93017
ODET	48° north	769196
AVEN	48° north	142427
BELON	48° north	48548
ELLE	48° north	650642
SCORFF	48° north	696837
BLAVET	48° north	1316773
KERGROIX	48° north	49960

Table 2.6.1. Summary of Atlantic salmon tagged and marked in 2001. 'Hatchery' and 'Wild' refer to smolts or parr; 'Adult' refers to wild and hatchery fish. Data from Belgium and Spain were not available. Fish were not tagged in Finland. PIT tags were not included.

Country	Origin	Primary Tag or Mark			Total
		Microtag	External mark	Adipose clip	
Canada	Hatchery	0	44,334	1,870,421	1,914,755
	Wild	0	13,097	101	13,198
	Adult	0	6,320	0	6,320
	Total	0	63,751	1,870,522	1,934,273
Denmark	Hatchery	3	3	3	9
	Wild	3	3	3	9
	Adult	3	3	3	9
	Total	9	9	9	27
France	Hatchery	0	2,489	297,604	300,093
	Wild	0	0	0	0
	Adult	0	0	0	0
	Total	0	2,489	297,604	300,093
Iceland	Hatchery	139,041	0	0	139,041
	Wild	2,183	0	0	2,183
	Adult	0	217	0	217
	Total	141,224	217	0	141,441
Ireland	Hatchery	267,967	0	0	267,967
	Wild	3,755	0	0	3,755
	Adult	0	0	0	0
	Total	271,722	0	0	271,722
Norway	Hatchery	0	40,418	0	40,418
	Wild	0	3,893	0	3,893
	Adult	0	153	0	153
	Total	0	44,464	0	44,464
Russia	Hatchery	0	1,000	585,300	586,300
	Wild	0	94	0	94
	Adult	0	2,860	0	2,860
	Total	0	3,954	585,300	589,254
Sweden	Hatchery	0	4,920	31,285	36,205
	Wild	0	287	0	287
	Adult	0	0	0	0
	Total	0	5,207	31,285	36,492
UK (England & Wales)	Hatchery	55,445	5,136	136,231	196,812
	Wild	364	1,551	1,715	3,630
	Adult	0	1,187	0	1,187
	Total	55,809	7,874	137,946	201,629
UK (N. Ireland)	Hatchery	32,321	0	46,853	79,174
	Wild	1,350	0	0	1,350
	Adult	0	0	0	0
	Total	33,671	0	46,853	80,524
UK (Scotland)	Hatchery	6,250	0	0	6,250
	Wild	6,751	4,592	0	11,343
	Adult	500	2,434	0	2,934
	Total	13,501	7,026	0	20,527
USA	Hatchery	0	249,744	0	249,744
	Wild	0	1,578	0	1,578
	Adult	0	5,340	0	5,340
	Total	0	256,662	0	256,662
All Countries	Hatchery	501,037	348,054	2,967,707	3,816,798
	Wild	14,416	25,105	1,829	41,350
	Adult	513	18,524	13	19,050
	Total	515,966	391,683	2,969,549	3,877,198

Figure 2.1.1.1 Nominal catches of salmon in four North Atlantic regions 1960-2001



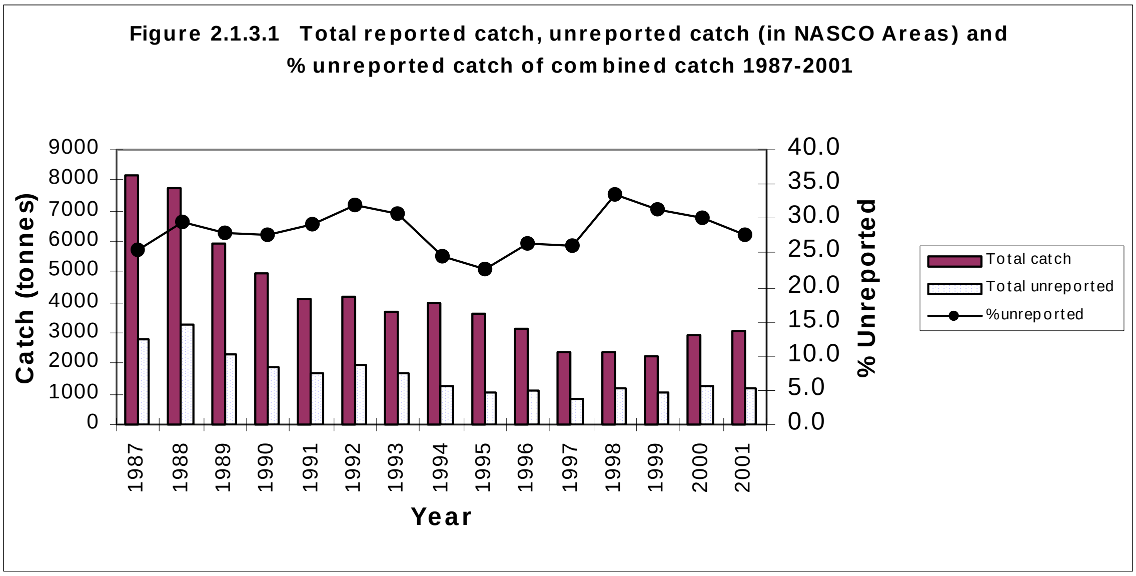


Figure 2.2.1.1. Worldwide farmed Atlantic salmon production, 1980-2000. Data for non-North Atlantic area do not include Chile (and other countries) for 2000.

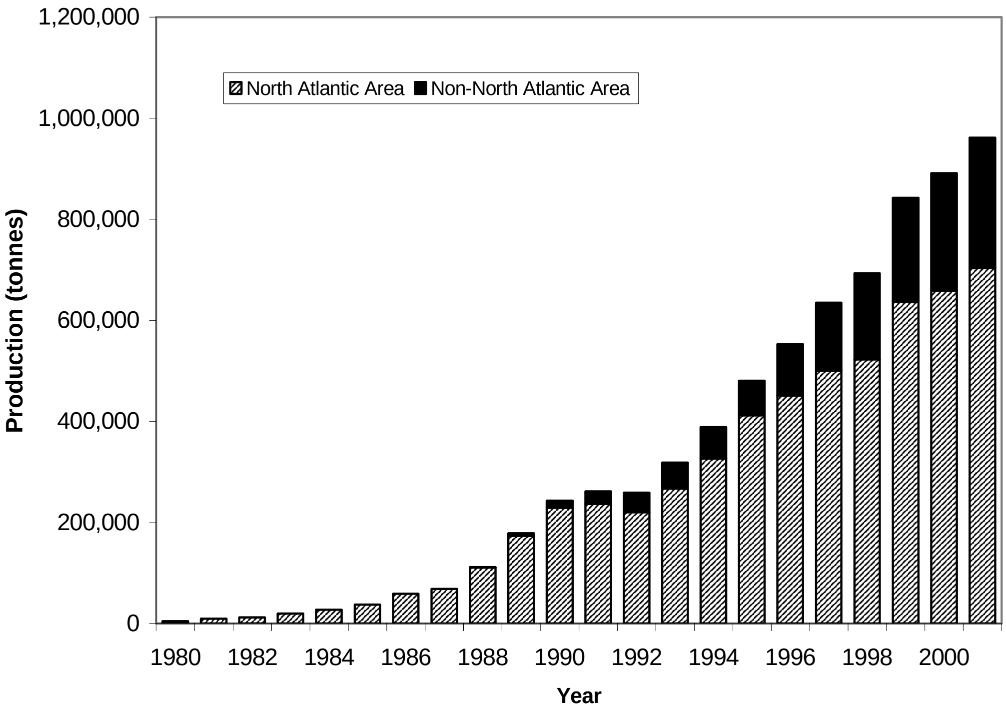


Figure 2.2.2.1. Production of ranched salmon in the North Atlantic, 1980-2001.

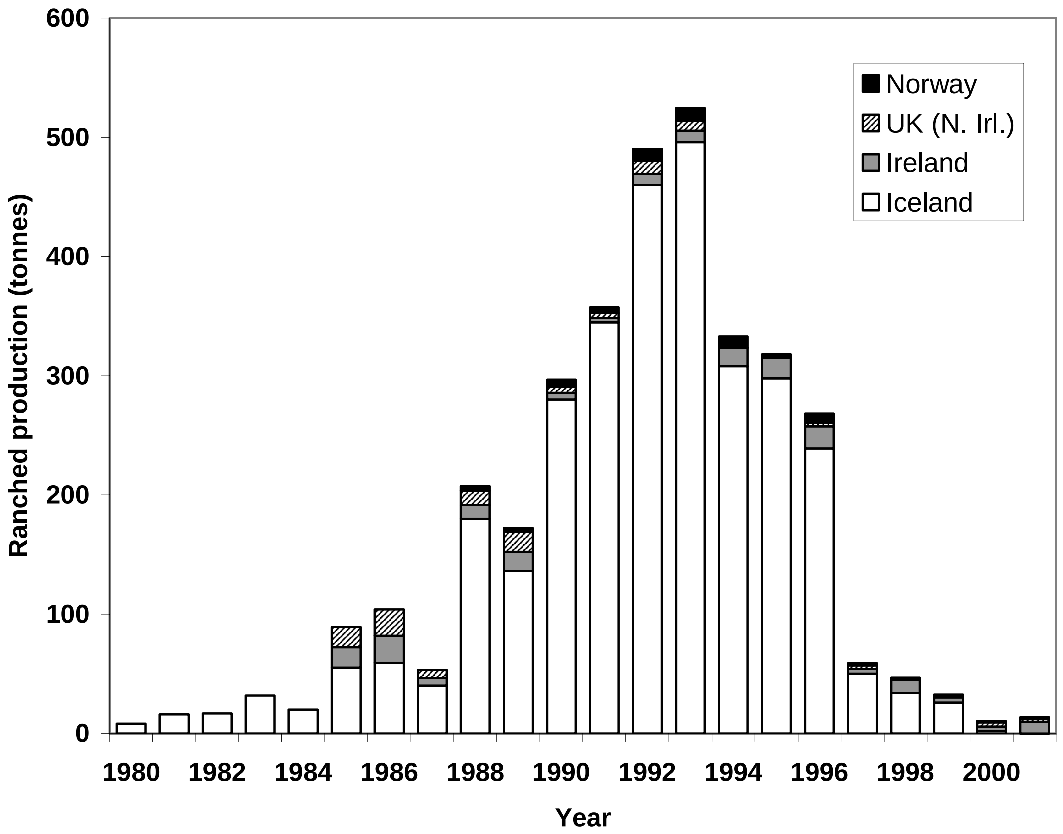


Figure 2.3.1.1 Replacement isopleths defined by the freshwater survival and marine survival axes for two populations of Atlantic salmon with differing average female fecundities. Values of marine survival and freshwater survival above the replacement lines would produce increased abundance whereas values below the replacement lines result in population declines.

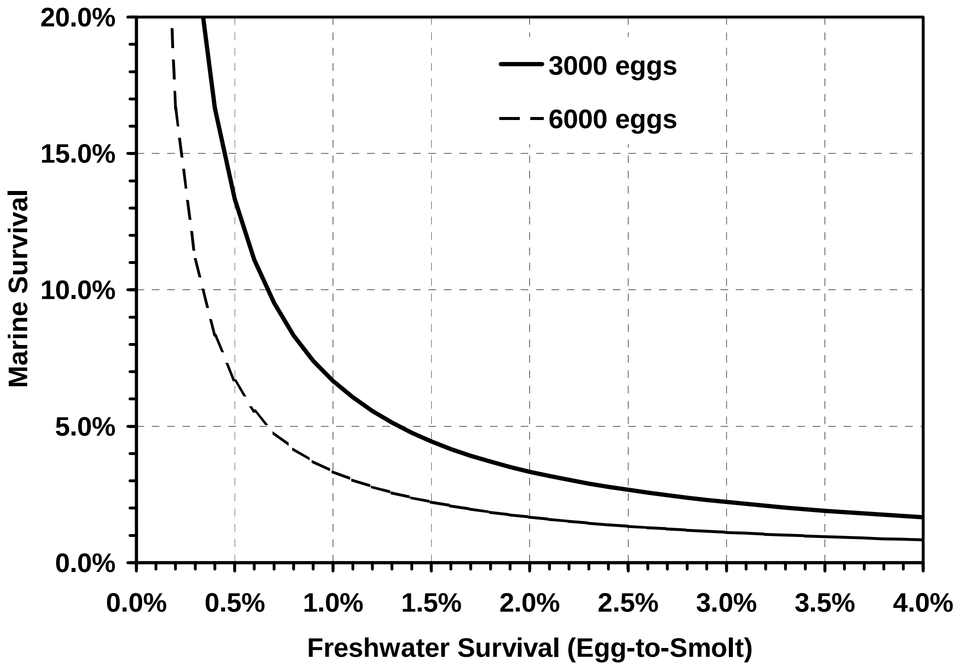


Figure 2.3.1.2. Predicted monthly mortality rate for Atlantic salmon of the Miramichi River in the second year at sea based on the average weight of salmon during the second year at sea and the allometric relationship described by Lorenzen (1996). The average weight during the second year at sea is calculated from the average weight of 1SW salmon sampled in the Miramichi River in smolt year + 1 and the average weight of 2SW salmon sampled in the Miramichi River in smolt year + 2. The parameters of the Lorenzen (1996) equation were: b = -0.305, W_u = 3.69.

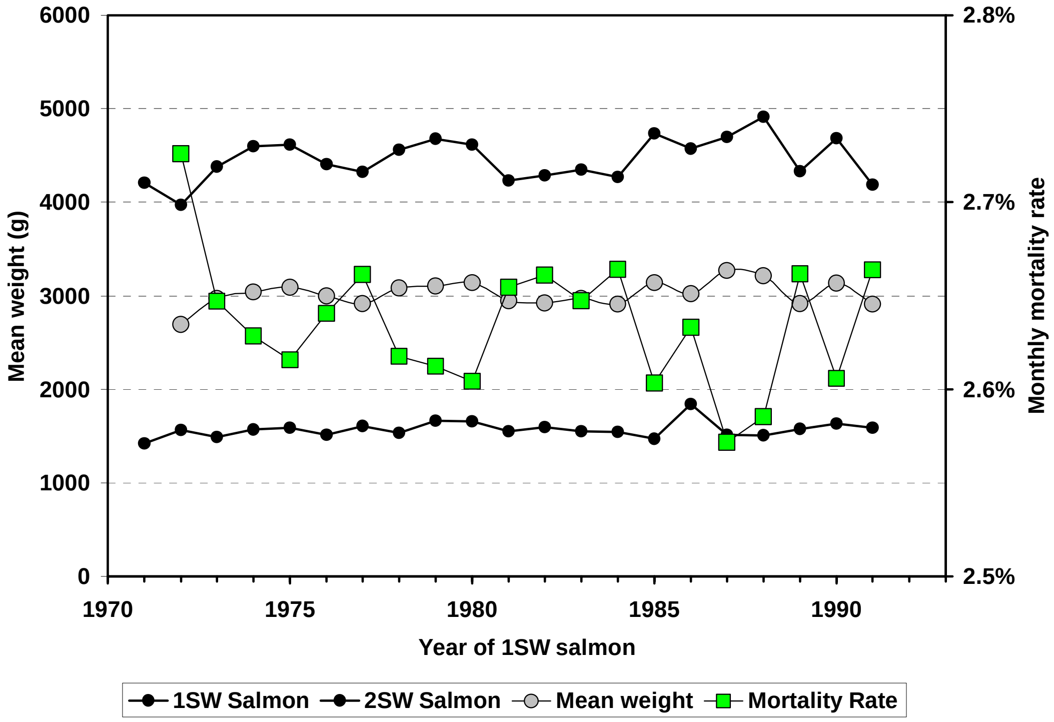
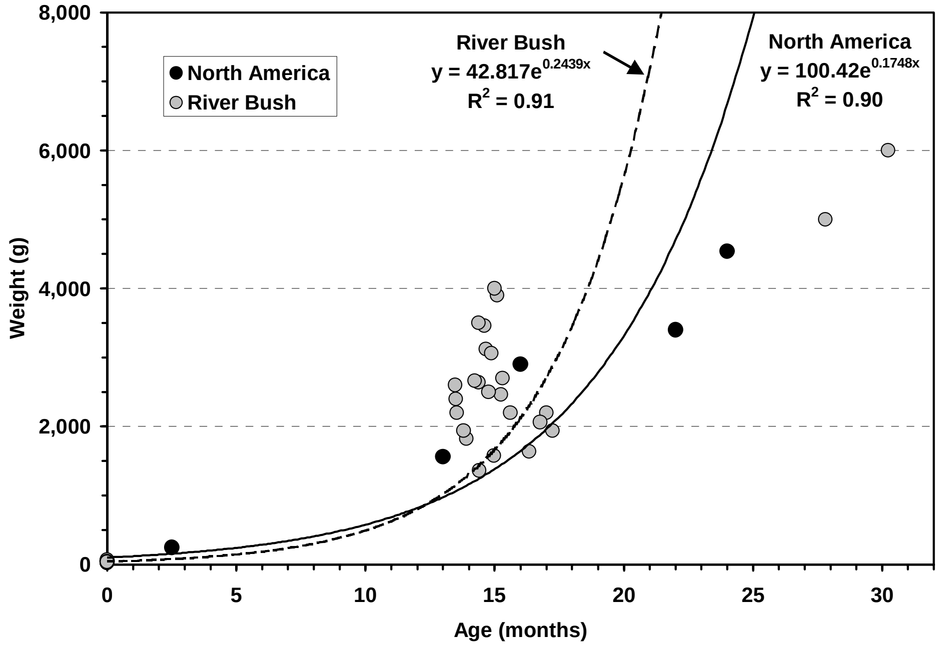


Figure 2.3.1.3. Comparison of weight at sea age (months) data used to model the growth functions of Atlantic salmon from River Bush and Sandhill River (North American stock). Exponential growth functions are in the upper panel, linear growth functions are in the lower panel. Data are from Doubleday et al. (1979).



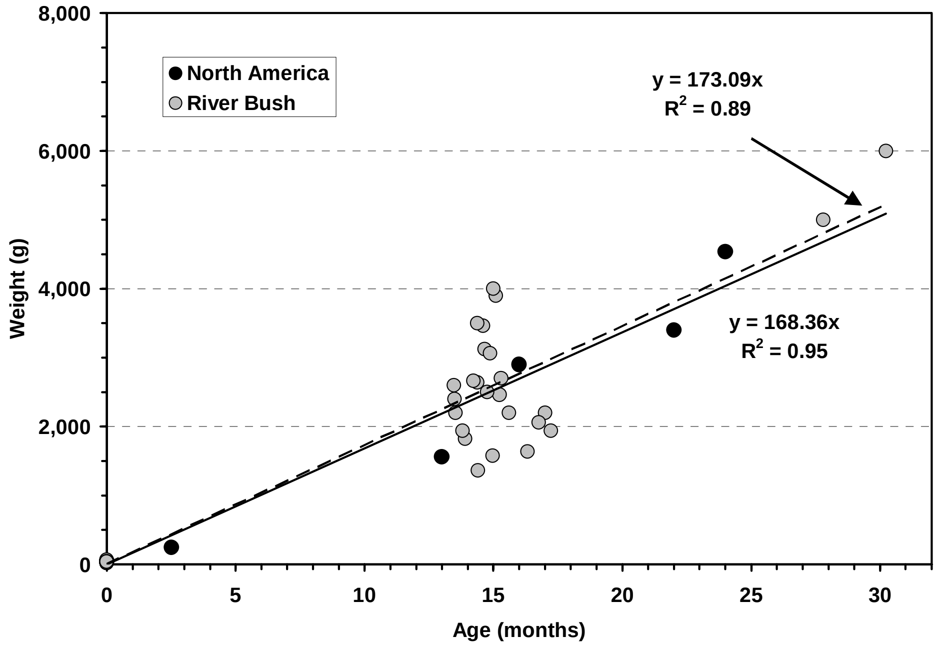


Figure 2.3.1.4. Monthly natural mortality rates (M) in the second year at sea for Canadian Atlantic salmon stocks using the Doubleday et al. (1979) model and linear growth functions.

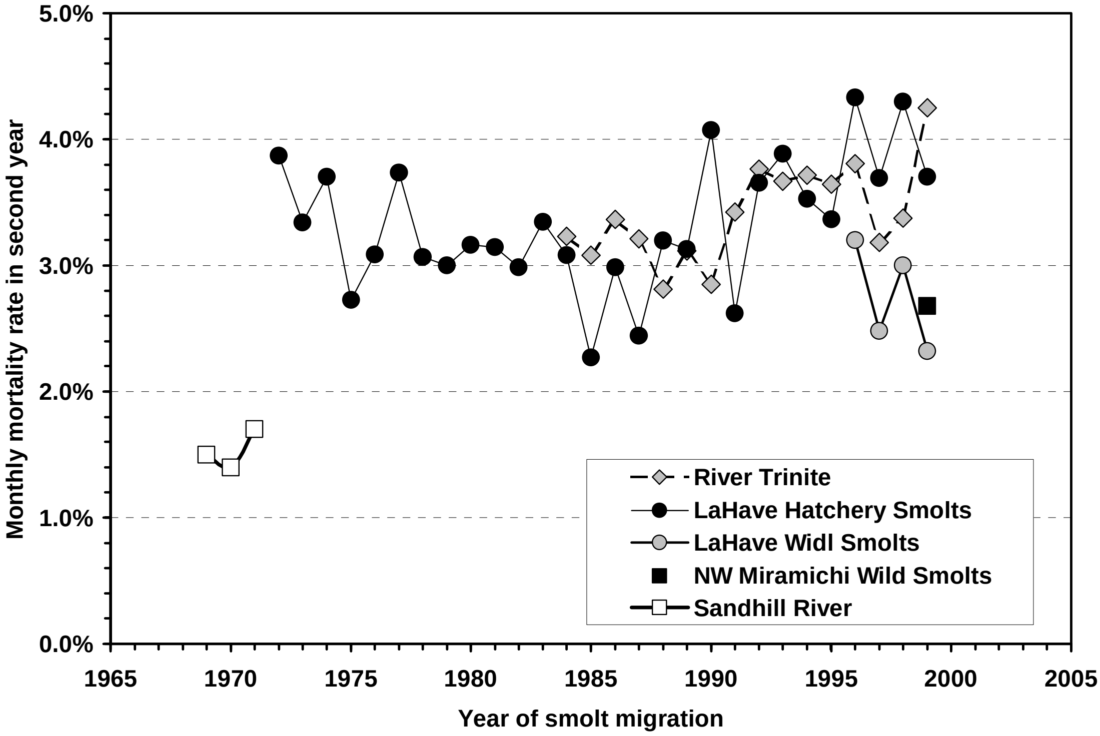


Figure 2.3.1.5. Monthly mortality rate estimates from the maturity schedule method for three stocks in North America. The upper panel is results for River Trinite, the middle panel is for hatchery smolts from the Saint John River, the bottom panel is for the Miramichi River.

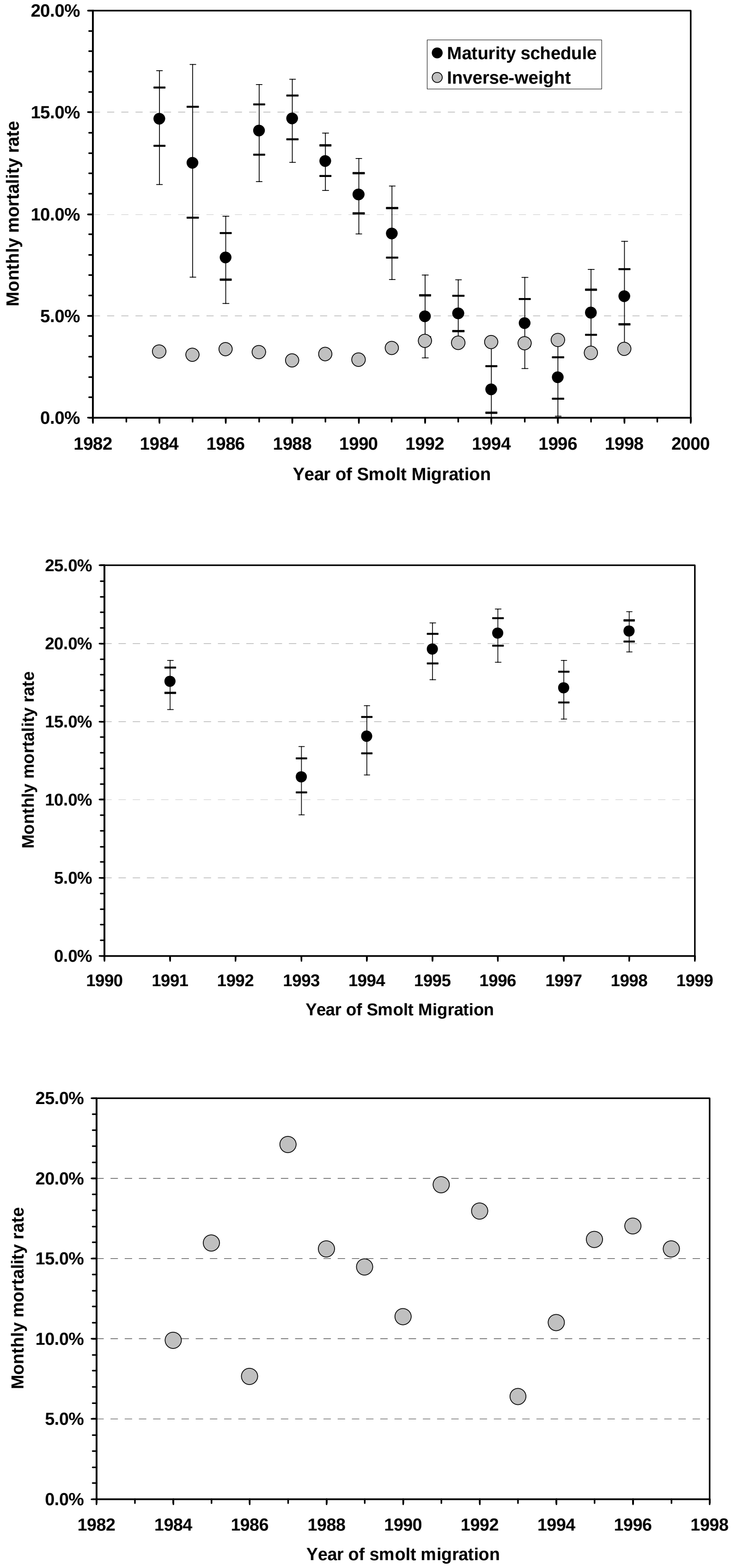


Figure 2.4.4.1 - Box plot of the posterior distribution of the D parameter (see text). The plot displays the 5th, 10th, 25th, 50th, 75th, 90th and 95th percentiles.

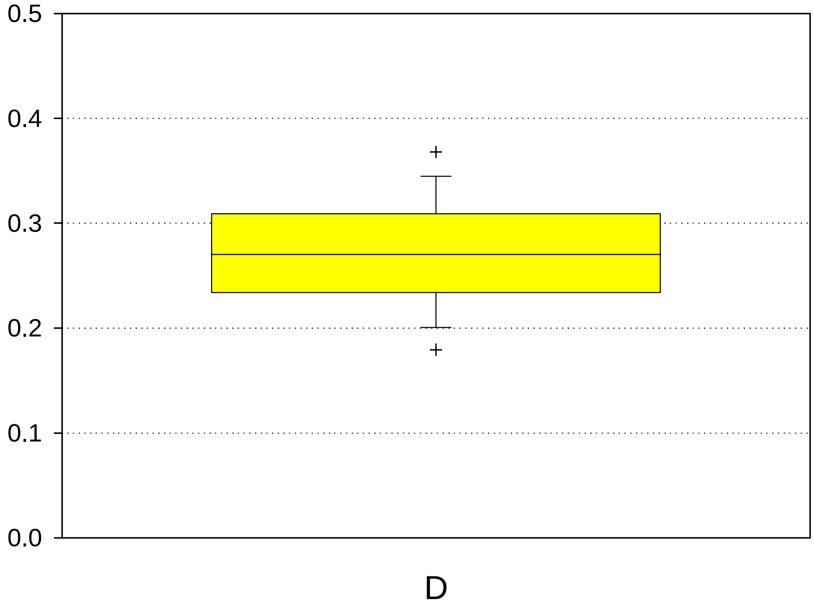


Figure 2.4.4.2 – Box plots of the posterior distributions of S_{opt} expressed in eggs per m² of wetted area accessible to salmon. The index rivers are ordered according to latitude. The items denoted "Post pred XX" in the x-axis are the posterior distributions of S_{opt} for any new river without SR data but located north of the latitude indicated (XX°) i.e a prediction for any river in that latitude. Each box plot displays the 5th, 10th, 25th, 50th, 75th, 90th and 95th percentiles.

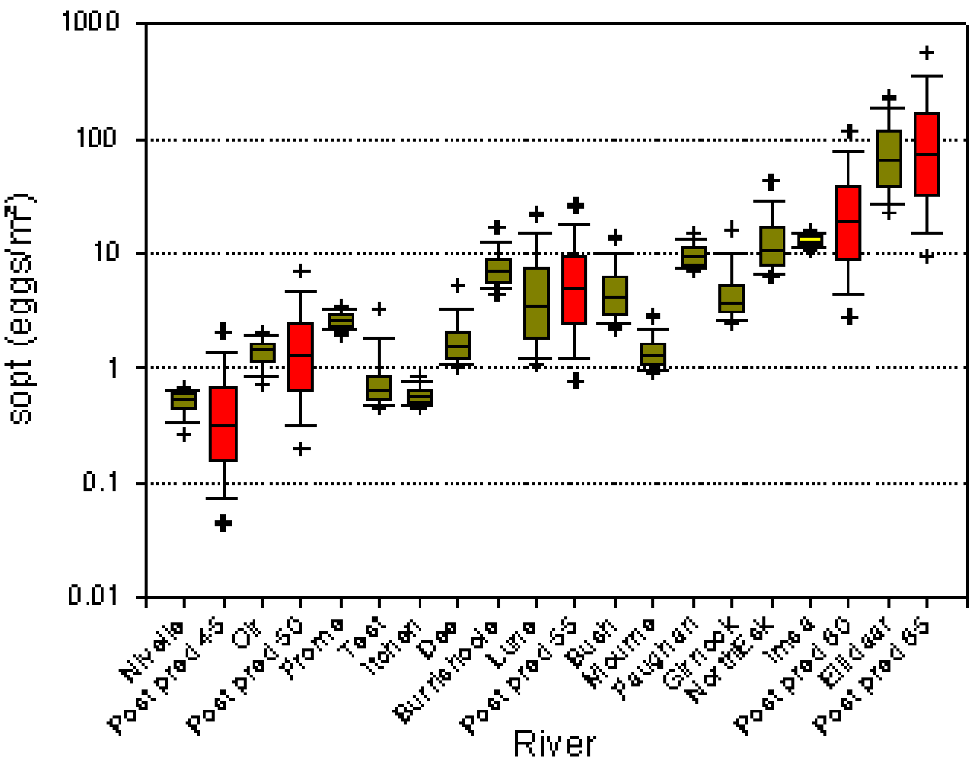
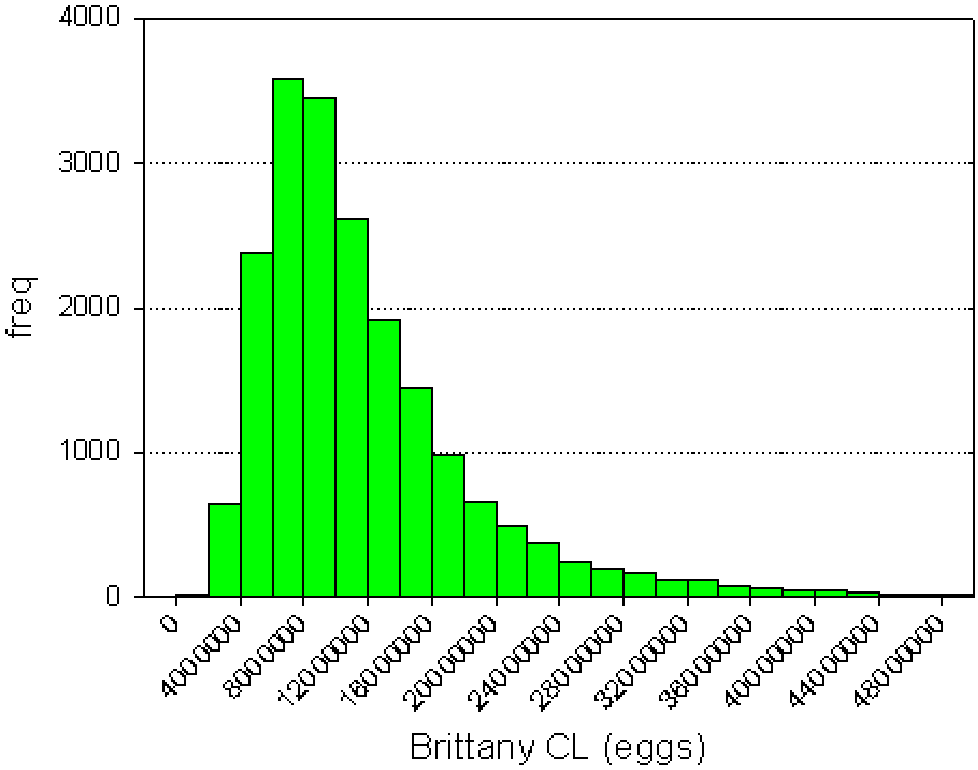


Figure 2.4.4.3 – Histogram of the posterior distribution of the Brittany CL.



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

3.1 Fishing at Faroes in 2000/2001

No fishery for salmon was carried out in 2001 or, to date, in 2002. Consequently, no biological information is available from the Faroese area for this season. No buy-out arrangement has been made since 1999.

3.2 Homewater fisheries in the NEAC area

3.2.1 Significant events in NEAC homewater fisheries in 2001

In Sweden, the opening date of the coastal fisheries was delayed to the 1st April (as opposed to the 1st March) whereas the closing date was extended to the 1st October (as opposed to the 15th September). In addition, the minimum legal length of salmon that could be retained was decreased from 50cm to 45cm.

A carcass tagging and logbook scheme for net-caught and rod-caught salmon was introduced into both Ireland and UK (N. Ireland) for the first time in 2001. This is designed to improve records/returns for rod-caught fish and to facilitate regulation of numbers caught (by quota) should this be necessary.

In UK (Northern Ireland), UK (England & Wales), UK (Scotland) and Ireland effort in the angling fishery was reduced in many areas, for varying periods of the season, due to the restrictions imposed on travelling in the countryside to contain the possible spread of Foot and Mouth Disease.

In UK (Northern Ireland) voluntary restrictions on netting were introduced in the Fisheries Conservancy Board area for 2001. These included a 10-week delay to the opening of the season and an agreement by some netsmen not to fish at all. A voluntary code of practice for angling in the same area in 2001 included catch and release up to 31st May, a daily bag limit of 2 fish from 1st June to the end of the season, and a ban on the sale of rod-caught salmon.

3.2.2 Gear

There were no reports of significant changes in the type of gear units used in the NEAC area countries in the year 2001.

3.2.3 Effort

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

Trends in effort are shown in Figures 3.2.3.1 A and 3.2.3.1 B for the Northern and Southern NEAC countries respectively. There is an overall trend in both areas.

In the Northern NEAC area, net effort data are only available for Norway. In the early part of the time-series, drift net effort accounted for the majority of the effort expended. However, this fishery closed in 1989, reducing the overall effort substantially. The liftnet fishery, which made a minor contribution to overall effort, showed a decreasing trend until it ceased to operate in 1993. The two remaining methods, bagnets and bendnets, show contrasting patterns of effort until the early 1990s when both show downward trends until the end of the time-series.

In the Southern NEAC countries, net effort data are available from UK (England & Wales), UK (Scotland), UK (N. Ireland), Ireland, and France. In all cases, a downward trend, of varying degrees, is evident.

In contrast to net effort, rod effort indices, where available, show both upward and downward trends. In the Northern NEAC area, the available data set from Finland shows an increasing trend. In the Southern NEAC area, a declining trend is evident in UK (England & Wales) and France, whereas an increasing trend is observed in Ireland due to the introduction of a new one-day angling licence in 1993.

3.2.4 Catches

NEAC area catches are presented in Table 3.2.4.1. The total catch in the NEAC area was 2887 t (Table 3.2.4.1)**,** up 6% on the 2000 catch, and representing 94% of the total North Atlantic nominal catch in 2001. Both southern and northern areas reported catches that showed slight increases compared to 2000 (4 and 8 % respectively), and significant increases compared to the 1996-2000 mean (9 and 34 % respectively). These increases in total catches arise from substantial increases of the 2001 nominal catch compared to 2000 in a few countries (Ireland, Iceland, and Finland), while others showed substantial decreases (UK (Scotland)), UK (England and Wales), UK (Northern Ireland)). The nominal catches for individual countries can be found in Table 2.1.1.1.

Figure 3.2.4.1 shows the trends of nominal catches of salmon in the Southern and Northern NEAC areas, from 1971 until 2001. Catches in Southern countries were near to 4500 t in 1972-1975, but in the latter part of the time-series average catches were between 1000 to 1500 t. The decline is characterised by two steep declines, one in 1976 and the other over the years 1989-1991. Catches in Northern countries varied from 1850 to 2700 t from 1971 to 1986 and have undergone a slower decline since then, leading to levels of 1000 to 1500 t during the 1995-2000 period. Thus, catches in the Southern countries, which were predominant in the NEAC area before 1990, are now slightly inferior to those reported in the Northern countries. National catch data are discussed in further detail in section 3.3.3 in relation to trends in abundance.

3.2.5 Catch per unit effort (CPUE)

An overview of the CPUE data for the NEAC area is presented in Figure 3.2.5.1. The CPUE values presented are indices relative to the averages of the time-series. The original, more detailed CPUE data are presented in Tables 3.2.5.1 - 3.2.5.5. The CPUE for rod fisheries have been collected by relating the catch to rod days or angler season, and that of net fisheries was calculated as catch per licence-day, trap month, or crew month.

In the Southern NEAC area, CPUE showed a general increase in UK (N-Ireland) net fisheries, a decrease in UK(Scotland) net fisheries, whereas no trend was observed in UK (England & Wales) net fisheries and in France rod fisheries. In most of the Northern NEAC area, there has been a general increasing trend in the CPUE figures for various fisheries, especially in recent years in Norway (net) and Finland (rod) (Fig. 3.2.5.1).

In UK (England and Wales) CPUE for the net fishery increased in most regions compared to 2000 and the previous 5-year averages (Table 3.2.5.3). The CPUE for the Scottish net fisheries were higher than the previous 5-year averages (Table 3.2.5.4). In UK (N-Ireland), the river Bush rod fishery CPUE showed a clear increase compared to both recent indices (Table 3.2.5.1).

CPUE for the rod fisheries in Finland show a consistent increase in both rivers compared to 2000 and the previous 5-year average (Table 3.2.5.1). In Russia, CPUE for the rod fisheries increased in most White Sea rivers but decreased in the Barents Sea rivers (Table 3.2.5.2). CPUE for the marine fishery in Norway has increased for the past years for bagnets and bendnets and the trend has been mostly consistent across all size groups, although there was a decline between 2000 and 2001 in 1SW group (Table 3.2.5.5).

CPUE is a measure that can be influenced by various factors, and it is assumed that the CPUE of net fisheries is a more stable indicator of the general status of salmon stocks than rod CPUE; the latter may be more affected by varying local factors, e.g. weather conditions, management measures, and angler experience. Both may also be affected by many measures taken to reduce fishing effort, for example, changes in regulations affecting gear. If large changes occur for one or more factors a common pattern may not be evident over larger areas. It is, however, expected that for a relatively stable effort CPUE can reflect changes in the status of stocks and stock size. This can be seen in the increase in CPUE for the Norwegian marine fishery that is also reflected in increased catch (Section 3.3.4) as well as the calculated PFA values (Section 3.6).

3.2.6 Age composition of catches

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

The percentage of 1SW fish in the catches of the Northern countries is 60 % in 2001, which is the lowest value since 1987. It is below the 5-year mean (67%) and the 10-year mean (66%). Since 1987, it has varied from 61 to 72 %. The five countries show relatively similar percentages in 1987-1994, but have undergone substantial divergences since then

(Figure 3.2.6.1). Iceland, Russia and to a lesser extent, Finland, usually have proportions in excess of 70% during the six last years, whereas Norway and Sweden remain below the average of Northern countries.

For the southern European countries, the overall percentage of 1SW fish varied from 49 to 65% since 1987 and is 63% in 2001, above the 5-year and the 10-year means (60%). England and Wales show high values (65 – 83% since 1990, 10-year mean = 75%), as opposed to the low percentages of Scotland (10-year mean = 54%). France has the most variable values (27 to 74%), but its contribution to the southern European countries figures is small. The very low proportion of 1SW fish in 1999 (27%) is due to a drop of their nominal catches combined to a significant increase of the 2SW catches (Table 2.1.1.3.). The proportions shifted to previously observed levels in 2000 and 2001, with an increase in 1SW catches and a reduction in the number of MSW fish taken.

3.2.7 Farmed and ranched salmon in catches

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

3.2.8 National origin of catches

In 2001, a number of tags originating from fish released from other countries (UK (N.Ireland), UK (England & Wales), and Spain) were recovered in the Irish fisheries.

An update of the adult recovery information derived from tagged smolts released in Norway was made available to the Working Group. Between 1996 and 2000 a total of 474,342 smolts, mainly hatchery reared, were tagged and released. A total of 4297 adult recoveries were reported from Norway and 20 from other countries (0.5% of the total number of salmon recovered). This is consistent with previous observations that very few Norwegian salmon are intercepted in other countries.

3.2.9 Summary of homewater fisheries in the NEAC area

In the NEAC area there has been a general reduction in catches since the 1980s. This reflects a decline in fishing effort, as a consequence of management measures, the reduced value of commercially-caught salmon, as well as a reduction in the size of stocks. However, the overall nominal catch in the NEAC area in 2001 (2887 t) represented a 6% increase on the catch for 2000. Catches in both southern and northern areas reported increased slightly compared to 2000 (4 and 8 % respectively), and substantially compared to the 1996-2000 mean (9 and 34 % respectively).

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

CPUE data for various net and rod fisheries indicate a general increase in northern Europe while patterns in southern Europe are less consistent. The Working Group noted that reduction in the number of fisheries operating can benefit those fisheries still in operation and that the lack of consistent trends in CPUE may reflect the imprecise nature of these indices.

No common trends were noted in the sea age composition of the 2001 catches in the NEAC areas, and there was no clear division between countries in Northern and Southern Europe.

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

3.3 Status of stocks in the NEAC area

3.3.1 Survival indices

An overview of the estimates of marine survival for wild and hatchery-reared smolts returning to homewaters (i.e. before homewater exploitation) for the 2000 and 1999 smolt year classes (returning 1SW and 2SW salmon, respectively) is presented in Fig. 3.3.1.1. The survival values presented are standardized (Z-score) indices relative to the averages of the time-series. The original survival indices for different rivers and experimental facilities are presented in Tables 3.3.1.1 and 3.3.1.2.

An overall trend in both Northern and Southern NEAC areas, both wild and hatchery smolts, shows a constant decline in marine survival over the past 10-20 years (Fig. 3.3.1.1). The steepest decline appears to be for the wild smolts in the Southern NEAC area, returning as 1SW salmon. Survival of both wild and hatchery fish returning as 2SW in Northern NEAC area, however, has increased since 1997 (Fig. 3.3.1.1).

In rivers Ellidar (Iceland) and Bush (UK N-Ireland), the survival indices of wild smolts that migrated to the sea in 2000 were much lower than the previous year and the 5- and 10-year averages (Table 3.3.1.1).

In Norway, marine survival indices for the latest smolt year classes were mostly above those of the previous year and the 5- and 10-year averages for hatchery-released fish (Table 3.3.1.2). In Southern NEAC area, about half of the rivers showed an increase and half a decline in marine survival for hatchery-released smolts compared to the previous year and the long-term averages (Table 3.3.1.2). Return rates of hatchery-released fish may not always be a reliable indicator of marine survival of wild fish.

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

3.3.2 Previous developments and improvements to the NEAC PFA Model

The Working Group has previously developed a model to estimate the pre-fishery abundance (PFA) of salmon from countries in the NEAC area. PFA in the NEAC area is defined as the number of 1SW recruits on January 1st in the first sea winter. The method employs a basic run-reconstruction approach similar to that described by Rago *et al.* (1993) and Potter and Dunkley (1993). The model estimates the PFA from the catch in numbers of 1SW and MSW salmon in each country. These are raised to take account of minimum and maximum estimates of non-reported catches and exploitation rates of these two sea-age groups. Finally these values are raised to take account of the natural mortality between January 1st in the first sea winter and the mid-point of the respective national fisheries. A Monte Carlo simulation (1000 runs) using ‘Crystal Ball’ in Excel (Decisioneering, 1996) is used to estimate confidence limits on the PFA values. Full details of the model are provided by Potter *et al.* (1998).

No significant changes were introduced to the model in 2002, although further improvements were made to the data inputs by some countries, and these are summarised in section 3.3.3. In addition, as discussed in section 2.3, the Working Group has determined that a value of 'm' of around 0.03 per month is more appropriate than the previous value of 0.01. This is based upon a review of the inverse weight model; a range from 0.02 to 0.04 has therefore been used in the PFA model.

More fundamental changes have been made to the presentation of the model outputs which are shown in section 3.3.4.

3.3.3 National input to the NEAC PFA model

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

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

In some instances, the above information has been supplied in two or more regional blocks per country. In these instances, the model output is combined to provide one set of output variables per country. Descriptions of how the model input has been derived are presented below for most countries. Details are provided in Table 3.3.3.1a-u.

Finland

Catch

The catch input to the model of Finland represents an estimate based on catch inquiries and the total number of licences issued. The Norwegian catch from the River Teno has been included in the Finnish catch, which results in a set of input data that practically represents a single river system. Catch composition is estimated based on catch samples and corresponding scale analyses.

Level of unreported catch

Unreported catch is estimated by extrapolating the catches of the fishermen that failed to report their catches as reporting is not mandatory.

Exploitation rates

Exploitation rates in the river fisheries are derived from radio-tagging studies in 1992-93 and 1995, when 70-100 adult fish (1SW and MSW) were tagged yearly in the estuary. Most of the important river fisheries were covered by these experiments.

France

Catch

The estimation of salmon catch in France comes from two main sources: (1) mandatory declaration of rod and line catches (with scales from each fish caught) to the Conseil Supérieur de la Pêche (CSP) and (2) professional net fishermen declaration to the Institut Français pour l'exploitation de la Mer (Ifremer) for the River Adour estuary, the latter completed by a sampling of fish biometric characteristics and scales. Since 1985, the 1SW / MSW split is based on scale interpretation of an important propotion of the catch. The figures prior to 1985 are not considered as reliable as the following ones.

Level of unreported catch

Unreported legal catch for the rod and line fishery is estimated by catch inquiries from technical agents of the Conseil Supérieur de la Pêche on each river. The estimation of the professional net fishery catch (Adour Basin) is thought to be reliable and no unreported legal catch is considered.

For most years, the unreported illegal catch is not assessed and considered nil. This unreported illegal catch has been assessed some years by *ad hoc* inquiries in the estuary of a number of rivers of Brittany (2001) and on the coasts (Baie of Mont Saint-Michel in 2000).

The unreported catch is included in the nominal catch. Thus, the rates input to the model for 1SW and MSW are near zero and range from –0.00001 to 0.00001.

Exploitation rates

Exploitation rates come from four index rivers and from values calculated for the rivers of Brittany (which account for more than 60% of the overall catches) on the basis of their juvenile habitat surfaces, converted in a number of adults. The values were modified when changes in the regulation and the distribution of the angling effort occurred, an extension of the season towards the summer and the autumn allowing for a higher exploitation of the grilses.

Data from index River Nivelle is available, but this river is not representative of other French rivers in terms of exploitation rates, because of its very small fishery (less than 6 anglers) and the short section being fished (4 km). In addition, this river has very few MSW in its population, and these are not exploited by the fishery.

Iceland

Area split

The input data for the PFA model is divided into two areas. Rivers in West and South Iceland are combined in one area and rivers North and East in another. This is on the basis of different climate and oceanic conditions affecting the salmon life cycle, e.g. run timing, smolt age, and sea age.

Catch

Age class information is available from individual recordings of catch in logbooks in the rod fishery. The division into sea age classes is based on the bimodal weight distribution. The 1SW females are < 3.5 kg and 2SW greater than 3.5 kg. The 1SW males are less than 4 kg and 2SW greater than 4 kg. Scale analyses have shown that the presence of salmon having spent more than two winters at sea and of previous spawners is uncommon and that the categorisation into 1SW and 2SW age classes by weight is accurate. The net catches are recorded on a daily basis and individual recordings are rarely available. The age split in the net fishery is derived from the weight distribution in the rod fishery from the same river system or from rivers in the same area.

In the River Ranga in South Iceland smolt releases have been increasing since 1990 and have reached a level of 200,000-300,000 smolts for the past few years. Originally the River Ranga had a small salmon stock with a history of 10 to 90 fish caught annually until 1990. The river has very limited habitat for salmon production. The catch in River Ranga in 2001 was over 5,000 fish, which is about 18% of the total reported salmon catch in Iceland. Since these fish are expected to have very low spawning success in the river they are excluded from the PFA catch input data.

Level of unreported catch

The fishing right in Icelandic salmon rivers belongs to landowners that must, by law, form a fishery association that manages the fishing right. The rod fishing rights are leased to the highest bidder. No ocean or estuary fisheries are allowed. The unreported fishery is believed to be low. The level of unreported catch is based on a guess-estimate value of 2%. This estimate needs reconsideration and systematic evaluation.

Exploitation rates

Rates of exploitation are based on a few rivers with fish counters. The longest time-series is from River Ellidaar located in Southwest Iceland and is dominated by 1SW salmon and shows a relatively stable exploitation rate between 40 and 55%. The estimates of exploitation are available for rivers in the North and East Iceland and are 40-65% for 1SW salmon. The exploitation rate of 2SW is from 50 to over 70%. Fish counters in salmon rivers are more numerous than some years ago, and more information of exploitation will become available. That will give information on differences in exploitation in relation to the river size, run size of salmon, and possibly changes in exploitation between years. The only estimate available for a gillnet fishery gives an exploitation value of 39-52% and also indicates a higher exploitation rate on larger fish.

Until a longer time-series of counter estimates becomes available the overall exploitation estimates for the PFA model inputs for Icelandic rivers are estimated to be in the range of 40-60% for 1SW and 50-70% for 2SW salmon.

Ireland

Catch

The catches derive from annual declared catches from the Regional Fisheries Boards. They are split by age on the basis of a reported age distribution from 1980 to 1988. In the absence of any other information the mean proportion of 2SW salmon in the series (7.5%) has been used since 1988 and a mean of 10% has been used prior to 1980. The catch does not include returns from releases of smolts for ranching or enhancement.

Level of unreported catch

The values are guess-estimated from local reports and knowledge achieved during catch sampling and fisheries protection activities.

Exploitation rates

Since 1980 a coded-wire tagging (CWT) programme has been operated in several rivers in Ireland. Up to 300,000 hatchery smolts and up to 5,000 wild smolts are tagged and released annually. There is also a substantial data set on wild salmon from the Burrishoole monitored river providing a further index of wild returns and exploitation rates. Overall, there are estimates of exploitation rates available for 3 wild stocks and 7 hatchery stocks for both 1 and 2SW salmon.

The annual mean of the 1SW wild exploitation index is used as the input data for the lower range of exploitation in the PFA model while the mean of the 1SW hatchery index is used as the upper range.

The annual mean of the 2SW wild and hatchery exploitation index is used as the input data for the upper and lower range of exploitation in the PFA model depending on which is higher or lower in that year.

Norway

Area split

Norway is split into three regions, along a south/north axis on the basis of climatic differences and oceanographical differences among the areas. The areas are: (1) south Norway from the Swedish border to Stadt, (2) mid-Norway from Stadt to Lofoten, and (3) north Norway from Lofoten to the border with Russia.

Catch

Nominal catches of salmon in the three regions were used. In recent years there have been improvements in declaring catches. From 1979 there was a weight split 1SW/MSW (<3kg/>3kg). From 1993 the split was changed to 1SW/2SW/3SW (<3kg/3-7kg/>7kg). Mean weight was provided for most groups and used to estimate numbers. Norwegian catch data for the river Teno has been incorporated into the Finnish assessment.

Unreported catch

No systematic effort is used to estimate unreported catches. Inputs are guess-estimates based on occasional reports from test fishing, surveillance reports, and questionnaires. Currently there is no evidence that the level of unreported catches differs between the three regions.

Exploitation rates

The rates for the national model are guess-estimates. For parts of south Norway they are derived from estimated marine exploitation rates from the river Imsa and the River Drammen. In recent years some exploitation rates for a few rivers in mid-Norway have been taken into consideration. The exploitation rates have been adjusted in relation to reduced fishing effort. At present the same exploitation levels for the three regions has been used.

Only data from 1983 onwards have been used to derive quasi stock and recruitment relationship.

Russia

Area split

The Atlantic salmon rivers of north-west Russia are split into the following four regions: Kola Peninsula, Barents Sea basin; Kola Peninsula, White Sea basin; Archangelsk region; and the Karelia and the Pechora river region. The split is based on four regions with separate catch statistics and different biological characters. For example, the difference in age composition and relative abundance of summer and autumn salmon evident among these four regions has influenced the split.

Catch

The declared catch data, in numbers, is available for the full time period (1971 onwards) for all four regions. Catches were allocated to 1SW or MSW age groups on the basis of commercial and scientific catch sampling programmes.

Level of unreported catch

Unreported catches in legal fisheries are estimated from logbooks and catch statistic data, by comparing catch survey results with reported catch. Illegal catch is guess-estimated and based on local knowledge of fisheries. The major component of the illegal catch comes from in-river fisheries and this contributes the greatest uncertainties. The level of non-reporting has increased considerably in early 1990s due to the economic changes in Russia and temporary reduction of control and enforcement. This is a particular problem on the Pechora River where scientific sampling programmes suggest that the illegal catch on this river is very high. All these factors have been considered in deriving the level of unreported catch for the PFA model.

Exploitation rates

Information on exploitation rates is derived from several fisheries in the Kola Peninsula where counting fences are operated. These are the basis of the inputs to the model, regional sea age differences being adjusted on the basis of local knowledge from estimated stock levels.

UK (England & Wales)

Catches

Nominal catches for England and Wales have been derived from the catch returns submitted by netsmen and anglers. Catches have then been split into 1SW and MSW categories using two different methods. Over the period 1992-2001, monthly age-weight keys derived from salmon caught at an indicator river trap (River Dee), have been used to estimate the age composition of all rod-caught fish where a weight and date of capture have been provided. This has then been scaled up to the total catch (rods and nets combined) on a pro rata basis. In earlier years (1971-91) the age composition of the total catch has been estimated using the mean weight of the fish caught and the mean weight of 1SW and MSW salmon recovered in tagging programmes.

A large proportion of the fish taken in the northeast coast fishery are destined for Scottish rivers and these are therefore deducted from the England and Wales returning stock estimate and added to that for eastern Scotland. This proportion is estimated to have declined from 95% in the early part of the time-series to 75% more recently, reflecting the steady improvement in the status of the stocks in northeast England.

Level of unreported catch

The rate of under-reporting for net fisheries is generally considered to be low in most regions of England and Wales, and this has been supported by the findings of two recent studies which indicate an under-reporting level of 7 to 8%. Opinions collected from Environment Agency regional fisheries personnel in 1998 were in broad agreement, falling in the range 0% to 15%. However, in recent years it is believed that over-reporting of catches has occurred in some fisheries, in response to potential future buy-outs and the perception that compensation will be based on declared catches. A figure of 8% has therefore been used to correct for under-reporting of the national net catch, with the exception of the north east coast where no under-reporting has been assumed for 2001.

For the purpose of setting conservation limits, the Environment Agency have estimated that declared salmon rod catches since 1994 should be increased by 10% to allow for under-reporting. This has been based on a study of annual catch returns following reminders and will be reviewed following the introduction of improved reporting arrangements (second reminder) in 2001. Exceptions apply for a few rivers for which the fishery owners' returns are regarded as being accurate, and for which no scaling factor for under-reporting is considered necessary.

By their nature, illegal catches are very difficult to quantify. However, assessments can be made on the basis of enforcement activities. Consultation with Environment Agency regional fisheries personnel in 1998 suggested that illegal catches in coastal waters and within rivers and estuaries ranged from 5% to 18 % of the total declared catch. A figure of 12% has been used to estimate the total illegal catch for England and Wales. It is recognised that this estimate is crude and that it is not possible to detect year-on-year changes in this value.

Exploitation rates

National exploitation rates have been estimated by deriving a time-series of 'standard fishing units' from the numbers of licences issued. The catching power of each type of gear was converted to the same units on the basis of historic CPUE data. The 'fishing mortality per standard fishing unit' (f_{unit}) was estimated by assuming total exploitation rates for 1998, based on estimates for a number of rivers. Total f was then estimated for each year by multiplying f_{unit} by the number of units, and this was then converted back to a percentage.

UK (Northern Ireland)

Area split

The data used are derived from two fishery management areas, the Foyle and the rest of the country. There is some evidence that stock status in the two areas may differ and thus it makes sense to treat them separately for modelling purposes. Catch statistics are published separately for each fishery area, and differing fishing regulations apply.

Catch

There are good declared catch data for commercial nets, due to long-standing netsmen and dealer licensing schemes, but no consistent recording of rod catches is carried out. This is the major omission in the data time-series. No overall N. Irish rod catch estimates are available, thus the declared catches used in the model to date are for commercial net fisheries only.

Estimates of sea age composition of the catch for most of the time-series are based on 1SW/MSW data from adults returning to the R. Bush. These are probably unrepresentative, as they derive from only one river and are based on total annual returns, which include pre- and post-fishery periods. 1SW/MSW splits would be available from declared catches, as logbooks provide for such a split. However, the accuracy of this weight-based split (around 3.5 kg) has not been tested. Since 2000, 1SW/MSW splits have been based on biological sampling of the fishery. This has resulted in a reduction in MSW proportion applied.

Level of unreported catch

Estimates of unreported catch in legal fisheries are based on observations of catches by Departmental staff engaged in tag recovery programmes. Staff often observe daily catches being landed at individual netting sites.

Estimates of unreported catch as a result of illegal fishing are based on intelligence reports from fishery officers and other persons with local knowledge. These are guess-estimates only, with no verification possible.

Annual adjustments in unreported catches have been used since tagging programmes started in the mid-1980's. Prior to that a constant underreporting figure is used, as no annual data are available.

Exploitation rates

Estimates of exploitation rates are based on the R. Bush microtagging programme (hatchery fish since 1983 and wild fish since 1986). Exploitation from this monitored river is used as an input figure for all N. Irish fisheries. However, the representativeness of exploitation on this stock is not known, especially for river stocks in the Foyle area. Fixed exploitation levels are used in the early time-series, based on data from the first few years of tagging, under the assumption that exploitation was high and relatively constant during the 1970's and early 1980's (not verified).

Exploitation data for 1SW fish are the more reliable, as they are based on tagged wild smolts. MSW data are less reliable as they are based on mixed wild/ranched fish data and numbers of tags returned fell below acceptable limits in many years.

Possible improvements

The biggest improvement in catch data for N. Ireland would be the inclusion of rod catches. This is likely to be possible, following introduction of a carcass tagging scheme throughout Ireland in 2001.

Exploitation rate estimates for the early time-series (pre-tagging) could possibly be checked by crude examination of catch and counter time-series for the Foyle fishery area, together with scaling for effort (no. of licences issued). This would test the assumption about constancy in this period. Availability of tagging data from the R. Finn (a MSW river) should provide better data on MSW exploitation rates in the fisheries. This is expected from around 2003 onwards. R. Bush exploitation data will continue to be used as the source of information on 1SW salmon.

UK (Scotland)

Area split

The country is divided into two, along an east/west axis, the split being influenced by the contrasts in climate, river size, run-timing, and historical size of fisheries that occur. For the purposes of publishing catch information, the country is divided into 11 regional areas. For the purposes of the PFA model the East, North East, Moray Firth, and North regions comprise the east grouping, and the remaining regions comprise the west grouping.

Catch

Nominal catches for Scotland were entered according to the area split defined above. Age class information is available to the extent that catches are reported as 1SW or MSW salmon. Catch sampling programmes have shown that there is a variable (by region, year, and fishery) proportion of 1SW salmon misreported as MSW salmon. Farmed salmon are typically present at levels of less than 1% in the nominal catch and therefore no adjustment is made prior to input to the PFA model.

Level of unreported catch

The current values used in the national model are based on guess-estimates made by local managers in some eastern areas of the country. The different series of unreported values used in this analysis for the east and west areas are based on a subjective view on the relative incidence of unreported catches in the east and west areas. Unreported catches in the west area are argued to be greater than in the east area on two counts. Firstly, human population densities are lower in the west and therefore there is likely to be less surveillance over the reporting, or otherwise, of salmon catches. Secondly, west coast rivers are more numerous and, in general, smaller than east coast rivers, leading to a greater number of locations where unreported catches may be taken. The ranges input to the model are a subjective measure of uncertainty in these parameters.

Exploitation rates

Rates for the national model are guess-estimates derived in a manner similar to that for UK (England and Wales) using reported effort and estimated standard fishing units. Examination of the net effort indices show that effort was greater in the east area than in the west area at the beginning of the time-series being considered, and that the relative rate of decline is also greater in the east area than in the west area. The values input to the PFA model take into account these considerations.

3.3.4 Status of national stocks as derived from the PFA model

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

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

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

- Estimated total returns and spawners (±SD) (derived from the National Conservation Limit model).
- Estimated total catch (including non-reported) of 1SW and MSW salmon.
- Estimated pre-fishery abundance (PFA) of maturing 1SW and non-maturing 1SW salmon (labelled as 1SW and MSW).

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

- National stock-recruitment relationship (PFA against lagged egg deposition), with S_{lim} fitted by the method proposed by Potter and Nicholson (2001).

Finland: Finnish salmon essentially comprise a single river stock, the River Teno (Tana); the data inputs have been modified this year and now include both Finnish and Norwegian catch for this river. The assessment suggests that the numbers of returns and spawners have fluctuated widely since 1971. The early part of the time-series (1971 to 1978) is characterised by a steep rise, followed by a sharp decline. Numbers of returns and spawners remained low until 1982, but have shown a steady increase since this time, with a more marked rate of increase after 1998. The highest number of returns in the time-series was observed in 2000.

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

Iceland: The assessment suggests that there has been an overall decline in total returns of salmon to Iceland, from around 120,000 in the 1970s to about 50,000 in 2001, the lowest value in the time-series. Estimated returns showed an upward trend in the early part of the time-series (1971-78), followed by a sharp decline (1979-84) and a brief recovery to early levels in the late 1980s. There has been a clear downward trend since 1988. There has also been a marked decline in MSW salmon relative to 1SW fish.

Ireland: Estimates of PFA and spawning stocks for Ireland show significant fluctuations over time and three distinct periods are indicated with highest abundance in the 1970's, lower abundance in the 1980's, and the lowest abundance occurring in the 1990's. The early part of the time-series (1971 to 1981) is characterised by a steep rise to the maximum value in the entire time-series, followed by a sharp and prolonged decline. A subsequent recovery period is noted from 1981 to 1989, although the values never rose to the levels observed in the earlier part of the time-series. A second period of decline occurred from 1989 to 1999 and although this ended in 1992, all of the subsequent values up to present have been lower than in the preceding 20-year period. The status of the stocks must therefore be considered to be low with no significant recovery in the last decade.

Norway: The data for the Norwegian part of the River Tana (Teno) have now been included in the Finnish PFA estimates. The estimated returns and PFA appear to have been stable in the early part of the time-series (1971-86), but subsequently declined until the late 1990s. In the past four years, there has been an improvement in stocks. Exploitation rate has decreased, but nevertheless remains relatively high over the last 30 years.

Russia: Total returns to Russia are estimated to have been very variable in the period 1971 to 1987 but have subsequently shown a gradual increase. The PFA estimate shows similar variability in the early part of the time-series, but has been relatively stable since 1986. There has been a marked reduction in the exploitation rate in the last decade.

Sweden: Stocks in Sweden have fluctuated widely throughout the time-series and following a substantial decline in the mid-1990s, there has been an increase in the last three years. A feature of the latter half of the time-series is the increasing proportion of the stock that is comprised of MSW salmon. The exploitation rate has remained high over the last 30 years.

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

UK (Northern Ireland): Stocks are estimated to have declined slowly during the 1970's and early 1980's, however increased again into the 1990's. There has been a marked down-turn since 1998, the highest in the time-series, with estimates for the last three years being among the lowest over the period. The catch is dominated by 1SW fish, but there are uncertainties in the relative status of 1SW and MSW fish, as the data on catch composition by sea age are uncertain for most of the historical time-series.

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

3.3.5 Sensitivity analysis of the PFA model

A sensitivity analysis for the spreadsheet model which generates pre-fishery abundance (PFA) estimates in the NEAC area was described in ICES 2001/ACFM:15.
The sensitivity of the overall assessment of PFA for the NEAC Area and for the Northern and Southern European stock complexes depends on the values of the various parameters provided for different countries, and these will also be weighted by the national catches. It is thus not immediately apparent to which parameter values the assessment will be most sensitive. Table 3.3.5.1 provides an evaluation of the effects (% change) on the assessment of PFA of maturing and non-maturing 1SW salmon from Northern and Southern Europe of making the following changes to individual national or regional parameter values:

- adding 0.1 (10%) to non-reporting rate (‘R’)
- adding 0.1 (10%) to exploitation rate (‘U’)
- adding 2 months to time of return to homewaters (‘t’)
- multiplying ‘R’ by 1.2
- multiplying ‘U’ by 1.2
- multiplying ‘t’ by 1.2

[Adding 0.1 to parameters tends to weight the effects on low values, whereas multiplying them by 1.2 weights these effects on larger values.] The evaluation is based upon the data inputs used for the PFA assessment for 2001. It should be noted that this analysis does not test the reliability of the parameters but indicates the effects on the PFA estimates when modest changes are made to individual values.

At this level of disaggregation the model is fairly sensitive to some parameter values. Changes (as described above) to the parameter values listed in the text table below have a greater than 5% effect on the respective PFA estimates (Table 3.3.5.1). The analysis also indicates that increasing 'm' from 0.03 to 0.04 per month for all the national data sets would increase the PFA estimates for maturing 1SW salmon by about 8% and for non-maturing 1SW salmon by about 19%.

The sensitivity analysis indicates that particular attention should be paid to ensuring that the parameter values listed below are accurate:

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

3.3.6 Grouping of national stocks

Each year, NASCO asks for a description of events in the salmon fisheries and the status of salmon stocks, and for management advice for the major salmon fisheries. As there are over 1,600 salmon stocks in the NEAC area, it is necessary to group stocks when providing this advice. ICES has previously provided information on the status of stocks by river or by country, and used the following groups of countries to combine the PFA estimates for managers (e.g. ICES 2001/ACFM:15):

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

These groupings represent a convenient geographical split delimited by the North Sea. It also roughly separates the two groups of European stocks (southern and northern) that have previously been considered to make the greatest contribution to the West Greenland and Faroes fisheries respectively.

No detailed analysis of the basis for these stock groupings has previously been undertaken. However, Friedland *et al* (1998) have noted similarities between the marine survival trends for the River Figgio (south-west Norway) and North Esk (north-east Scotland) which are relatively close to each other, but on either side of, the current divide between the Northern and Southern areas. It has therefore been suggested that it might be appropriate to have a third, intermediate stock grouping, possibly comprising river stocks in southern Scandinavia and northern UK (ICES, 2000). However, the Working Group also noted that wherever boundaries are defined, it is likely that river stocks adjacent to, but on either side of, the chosen dividing line will show greater similarities than those further apart. Where such similarities are observed it does not therefore imply that the dividing line is inappropriate unless clearer discontinuities can be demonstrated elsewhere.

When providing information on the status of stocks and fisheries in the NEAC area, ICES currently provides catches (and similar data) by country, although some data are grouped in alternative ways depending upon their availability. The Working Group considered that although there might be merit in providing such data for stocks grouped according to biological criteria, the difficulties of collecting data in a similar format in different jurisdictions was likely to outweigh the benefits of using such groups. It was also noted that compilations of data on stocks within each jurisdiction are of importance to national managers, and some countries already make greater use of the national reports on their stocks that are provided to ICES. The Working Group therefore agreed on the following criteria for determining stock groups for describing the status of stocks:

- all river stocks should be included in one of the groups;
- no river stocks should be included in more than one group;
- the groups should be clear to managers;
- both geographical and biological groupings may be used.

The Working Group therefore concluded that ICES should continue to provide such information on national stock groups, although information should also be compiled on biological groups (e.g. sea-ages) and smaller regions as required. It was also agreed that it was helpful to present stock trends for the Northern and Southern stock groups.

NASCO also requests ICES to provide catch options or alternative management advice for the distant water fisheries at West Greenland and Faroes which both exploit salmon from a large numbers of river stocks (ICES, 2001). The Working Group agreed the following criteria for defining stock groups for the provision of management advice:

- groups should be defined for each fisheries for which advice is required;
- all river stocks that make a significant contribution to the fishery should be included;
- stocks that make no significant contribution to any fishery can be excluded;
- stocks can contribute to more than one group; and
- groups should ideally have some geographical integrity.

The Working Group concluded that the 'significance' of the contribution of a river stock to the fishery should be based upon the level of exploitation on that stock. It was also concluded that weighting the contributions that stocks make to a group (e.g. on the basis of their contribution to the target fishery) would complicate the assessment process and would be very difficult to present to managers and stakeholders.

In order to determine the stock groups for the provision of management advice for the Faroes and West Greenland fisheries, comparable indices of exploitation were estimated for national salmon stocks. These were based upon the 10-year average of national PFA estimates and the relative contribution of national stocks to the fisheries from tag recoveries (i.e. the recovery rate per 1,000 tags released). These are shown in Table 3.3.6.1 and Figure 3.3.6.1 for 1SW (CF1) and MSW (CF2) salmon in the Faroes fishery and MSW (CG2) salmon in the West Greenland fishery. There is no apparent pattern in the levels of exploitation in the Faroes fishery, for either 1SW or MSW salmon. However, there is a clear pattern for MSW salmon at West Greenland, with very low indices of exploitation for Russia, Norway, Sweden, and Iceland, but increasing indices for more southerly European countries.

On this basis it was proposed that advice for the Faroes fishery (both 1SW and MSW) should be based upon all NEAC area stocks, but that advice for the West Greenland fishery should be based upon Southern European MSW salmon stocks only (comprising UK, Ireland, and France).

3.3.7 Summary of status of the stocks

The marine survival of wild and hatchery-reared smolts in both Northern and Southern NEAC areas show a constant decline over the past 10-20 years. The steepest decline is that in the wild smolts in Southern NEAC area, returning as 1SW salmon. Survival of both wild and hatchery fish returning as 2SW in Northern NEAC area, however, has increased during the most recent years.

In general, the total returns of salmon and spawning stocks in the Northern NEAC area, as derived from the NEAC PFA model, have fluctuated for past 30 years but show an increase in the recent years. In contrast, salmon stocks in Iceland show a decline since the late 1980's, especially for MSW salmon.

Salmon stocks in the Southern NEAC area show a consistent decline over the past 20-30 years. This relates especially to the MSW component of the salmon stocks.

The consistent trends in marine survival of smolts and the estimated returns and spawners as derived from the PFA model suggest that returns are strongly influenced by factors in the marine environment.

3.4 Development of age-specific conservation limits

3.4.1 Progress with setting river-specific conservation limits

While NASCO's remit in distant water fisheries requires an international approach (e.g. via summation of conservation requirements for southern and northern NEAC stock complexes (Table 3.4.3.1)), the use of conservation limits at national, regional, and local levels is also highly important. At these levels, data on compliance with conservation limits for individual rivers or groups of rivers provides important data on status of stocks. These data are in some cases already being used to manage fisheries at regional and local levels, and this is expected to increase as more river-specific conservation limits are set. The use of river-specific conservation limits is now generally accepted as providing the most viable means of providing management advice for salmon at all levels from river through to stock complexes. Delivery of conservation limits at all these levels can be enhanced through international cooperation and sharing of data and techniques.

Availability of stock and recruitment data sets

In all, there are around 15-25 stock and recruitment datasets in the NEAC area, ranging from long time-series to rivers where stock-recruitment (S/R) relationships are in the process of being (or could be) developed. These include a mixture of smaller rivers and tributaries of large river systems. Given the time and resource difficulties with collecting meaningful S/R data, it is unlikely that many further datasets will be developed in the near future. However, as these rivers are spread throughout the NEAC area and cover a wide array of river types and productivity levels, even incomplete S/R datasets may provide useful information for helping to identify BRPs for transport of conservation limits to rivers with little or no data.

National use of river-specific conservation limits

As noted in Section 3.4.3, three countries (France, Sweden, and UK (England & Wales)) are already using river-specific conservation limits to derive national conservation limits. These are supplemented by Ireland and UK (N. Ireland), where river-specific conservation limits have been produced; however, as these are still viewed as preliminary they have not yet been used for inclusion in the ICES catch advice process. In the case of Ireland, conservation requirements based on fishery districts have been incorporated into the homewater catch advice process for the first time for 2002. Several countries in the NEAC area have still to develop even interim conservation limits for their rivers, although most are actively working towards this. While it is noted that NASCO has specifically asked for the development of age-specific conservation limits, there has been little new progress with dividing river-specific conservation limits between sea-age groups.

Establishment of an EU concerted action

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

These and related issues are being dealt with by the EU funded SALMODEL Concerted Action "*A co-ordinated approach towards the development of a scientific basis for management of wild Atlantic salmon in the North-East Atlantic*" (Contract No**:** QLK5-CT1999-01546; www.salmodel.net). Reports on progress in several of these areas have been presented to the Working Group in 2002 (Working Papers, 28, 29, and 36). A brief summary of progress taken from the second year report of the project is given below:

Developing common methods of setting conservation limits

The central theme of developing common methods of setting conservation limits has been approached in SALMODEL by means of Bayesian hierarchical techniques. This development is reported fully in section 2.4.4. Briefly, when S/R data are considered as representative of an assemblage of rivers, we can ask the question, what can be inferred about the nature of the S/R relationship for any new river based on data from the sampled rivers? There are two main sources of uncertainty; S/R data are available for only a limited number of rivers, and with a limited number of observations within each river.

A Bayesian hierarchical analysis (BHA) provides a framework for integrating these two levels of uncertainty, producing a posterior distribution of parameters such as S_{lim} for a river with no S/R data. This approach was applied to 15 S/R datasets from throughout the NEAC area, with latitude as a covariate and wetted area as a measure of production area (to scale for river size). Distributions of S_{lim} revealed significant variations among rivers even within a relatively narrow latitudinal range, consequently there is great uncertainty in S_{lim} for a river with no S/R data. This is not surprising, given the inherent variability of the recruitment process and the likelihood that variables other than the latitude and wetted area may influence recruitment processes among rivers.

However, extension of the analysis in a test case to examine the utility of this method for estimating CLs on a regional or national level indicated that aggregation of groups of rivers that had single river CLs set by this method produced a posterior distribution of CLs more precise than that of individual river components. The Working Group considered this method should be further investigated for setting regional/national CLs, as it may provide a means of replacing the interim pseudo-stock-recruitment approach.

Transporting s/r relationships to rivers where no s/r data exist

The process of setting river-specific conservation limits critically depends not only on being able to identify BRPs (say from stock/recruitment relationships) but also on appropriate methods to transport these to other rivers where no S/R data exist. There are a variety of transport methods in use in the NEAC area, all based on measuring some attributes of area of available productive habitat. These range from remote sensing (e.g. aerial photographs), through map-based measurements (e.g. catchment area/ gradient/wetted area) to in-river surveys of productive habitat area. In practical terms, remote sensing alone is unlikely to provide satisfactory solutions for meaningful transport, while logistical/resource difficulties mean that in-river surveys of all rivers will be impossible. A trend is emerging in several countries for map-based surveys (incorporated into GIS-supported production models), with in-river surveys used to provide ground truthing and calibration. It has been concluded that presently an intermediate habitat variable (on a hierarchy of possible measurement levels), such as wetted area, might be the only viable approach for estimating production areas throughout large areas of the NEAC range. Higher-grade information would of course be used where appropriate. SALMODEL has noted the requirement for wetted area data from the BHA approach described above and will produce information on recommended methodologies for wetted area measurement, together with an estimate of the resources/timescales required.

Non-stationarity in s/r relationships

A significant issue that is being addressed by SALMODEL is the possible limitation in the use of S/R data imposed by non-stationarity in S/R data sets. Clearly, BRPs derived from S/R datasets may be subject to change if production characteristics of the stock or productive potential of the habitat are temporally variable. SALMODEL has evaluated S/R datasets throughout the NEAC area and concluded that non-stationarity is present in all these data, but particularly strong in certain datasets. As this may affect the validity of transported BRPs, it was concluded that the BHA approach would be based on data from the last 15 years, to minimise these effects. This work also highlighted the present use of BRPs derived from S/R datasets of varying length, which may result in conservation limits being set with respect to historical "pristine" conditions or current "degraded" conditions variously across the NEAC. A dialog with managers to determine whether pristine, degraded or long-term average S/R data should be used is warranted.

The effect of sea trout on setting CLs

The implication of sympatric trout for the setting and use of conservation limits has also been investigated. Because of potential interaction at different life stages, the presence of sea trout could, for example, reduce the production of salmon smolts, which may result in lower-than-expected salmon production and setting of conservation limits too high for the prevailing mixed species ecosystem. A further effect relates to various CL compliance estimation methods such as angler exploitation coupled to counter data, where differing effort and catchability of salmon and sea trout fisheries may make it difficult to estimate and separate salmon from sea trout egg deposition. Studies carried out on available datasets concluded that sea trout dominated the rod catch (and by inference egg deposition) in more than 30% of rivers in Ireland, Sweden, and UK (England & Wales);. However, in countries with the largest salmon stocks (Norway and UK (Scotland)) salmon tend to dominate the catches. Sea trout are shown to be relatively more important in small catchments and in smaller streams/tributaries in all sizes of catchment, but as these areas make a relatively small contribution to total catchment rearing area, sea trout probably do not need to be taken into account in setting salmon CLs on most areas. At the broad-scale survey level used in SALMODEL, there was no evidence of strong competitive interactions between juvenile salmon and sea trout, which contrasts results from specific published scientific experiments, suggesting that further work is required.

The genetic implications of CL limits

Legitimate concerns have been expressed about the suitability of using single conservation limits for management of larger river systems known to have genetically differentiated sub-populations at the sub-catchment level. Modelling was carried out to examine rates of loss of genetic variation in simulated salmon populations of various sizes and having various migration/straying rates under various harvest scenarios. Results indicated that numerically weak or isolated populations are at greater risk from loss of genetic variation due to over-harvest, while populations having a higher probability of receiving spawners from "source" populations were more robust in a situation where a single CL does not recognise differences among populations. Further work is being carried out to determine relationships between the theoretical effective genetic population size (N_e) and observed population size, together with possible evolutionary and shorter-term production consequences of loss of N_e.

Risk in setting CLs

SALMODEL has also examined implications of setting reference levels at different levels and for different stock components, especially the implications for stocks in smaller rivers. Simulation modelling indicates that:

- In order to maintain a pre-determined probability of achieving the spawner objective in individual rivers the aggregated sum must be increased as the number of rivers in the complex increases;
- In the aggregated complex the performance of the small rivers is much more uncertain than for large rivers;
- Combining CLs of rivers of different productivity without accounting for these in the expected recruitment will result in under-escapement in lower productivity systems and over-escapement in high productivity systems;
- If straying occurs among rivers in a complex, the aggregated sum of the CLs must be increased.

These results confirm that management of mixed stock fisheries involves additional risk to individual river status. SALMODEL is considering how to incorporate these findings into the catch advice process for fisheries in the NEAC area (eg. via probability of achieving spawning requirement for components of stock aggregations under various harvest scenarios). A logical extension of this would suggest that each stock component should be managed with respect to its CL, if this could be defined, right down to river reach or spawning bed. However, practical management advice should centre on the aggregation level we can set CLs for (such as individual river stocks), noting that even these will in many cases be harvested as part of stock aggregations. Thus, mixed stock fisheries can comprise not just aggregations of single river stocks but also aggregations of sub-stocks from larger complex rivers.

While SALMODEL is mainly developing and examining issues related to the use of s/r data in setting BRPs and in how these may be used for other rivers, alternative approaches are also being considered. For example, an approach being developed in UK (Scotland) centres on the use of extensive historical rod catch data to set within-season temporal catch targets in river fisheries, based on observations on the catch:stock relationship and on coherence among catches in different rivers within the same time periods. If catches in a temporal segment across rivers were not meeting targets set with respect to the status previously defined as adequate, then further investigation and management action would be triggered.

3.4.2 Changes to the National Conservation Limits model

As indicated above, relatively few river-specific conservation limits have been developed for salmon stocks in the NEAC area. An interim approach has therefore been developed for estimating national conservation limits for countries that cannot provide an estimate based upon river-specific estimates. The approach is based on establishing quasi-stock-recruitment relationships for national salmon stocks in the North East Atlantic Commission (NEAC) area (Potter *et al*., 1998).

In brief, the model provides a means for relating the estimates of numbers 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, using the proportion of female fish in each age class and the average number of eggs produced per female. The egg deposition in year ‘n’ is assumed to contribute to the recruitment in years ‘n+3’ to ‘n+8’ in proportion to the numbers of smolts produced of ages 1 to 6 years, and these proportions are therefore used to estimate the ‘lagged egg deposition’ contributing to the recruitment of maturing and non-maturing 1SW fish in year ‘n+8’. The plots of lagged eggs (stock) against the 1SW adults in the sea (recruits) have been presented as ‘pseudo-stock-recruitment’ relationships.

ICES and NASCO currently define the conservation limit for salmon as the stock size that will result in the maximum sustainable yield in the long term (i.e. S_{lim}). However, it is not straightforward to estimate this point on the national stock-recruitment relationships because the replacement line is not known (the replacement line is the line on which ‘stock’ equals ‘recruits’). This is the case for the pseudo-stock-recruitment relationships established by the national model because the stock is expressed as eggs, while the recruits are expressed as adult salmon. The Working Group had previously used three non-parametric methods (ICES (1993/Assess:10)) to provide options for setting the conservation limits. These identified the egg deposition below which recruitment started to decline. If this was not evident over the range of data available, S_{lim} could be set at the minimum stock size previously observed.

In 2001 the Working Group adopted a new method for setting biological reference points from “noisy” (uncertain) stock-recruitment relationships, such as provided by the national pseudo-stock-recruitment datasets (ICES CM2001/ACFM:15). This model assumes that there is a critical stock level below which recruitment decreases linearly towards zero stock and recruitment, and above which recruitment is constant. The position of the critical stock level is determined by searching for the value that minimises the residual sum of squares. This point is a proxy for S_{lim} and is therefore defined as the conservation limit for salmon stocks. This provides a more objective method for estimating these reference points than the non-parametric methods previously used.

Potter and Nicholson (2001) described a modified version of this method, which updates the method first used by ICES in 2001, by allowing uncertainty around these estimates to be described. This has been provided in spreadsheet form to the Working Group in 2002 (Fig. 3.4.2.1).

Briefly, stock and recruitment data are input to the columns on the left side of the sheet (these data do not have to be in the same units). The model also allows two probability levels to be inserted to generate upper confidence limits only (it is assumed that only more conservative CLs will be required if uncertainty is incorporated). The output from the model is shown in three embedded figures:

Panel 1 shows the stock-recruitment relationship with the fitted model;

Panel 2 shows the time-series of stock estimates;

Panel 3 shows a plot of the residual sum of squares for values of Sc (the stock level at the inflection point).

The estimated CLs are tabulated (the precision of these estimates is limited to 1% of the minimum-maximum stock range).

The Working Group concluded this approach was more appropriate for future evaluation of the national conservation limits as it allows uncertainty around these CLs to be estimated and this information can be employed in providing precautionary management advice. Hence, this approach was applied to the 2001 national stock-recruitment relationship assessment.

3.4.3 National Conservation Limits

The national model has been run for the countries for which no river-specific conservation limits have been developed (i.e. all countries except France, UK (England & Wales), and Sweden). The outputs are illustrated in Section 3.3.4. For Iceland, Russia, Norway, UK (Northern Ireland), and UK(Scotland) the input data for the PFA analysis (1971-2001) have been provided separately for more than one region; the lagged spawner analysis has therefore been conducted for each region separately and the estimated conservation limits summed for the country. The conservation limits derived from the national model and river-specific estimates are shown in Table 3.4.3.1. The Working Group has previously noted that outputs from the national model are only designed to provide a provisional guide to the status of stocks in the NEAC area. It will also be noted that the conservation limit estimates may alter from year to year as the input of new data affects the 'pseudo-stock-recruitment relationship'. This further emphasises the fact that this approach only provides a basis for qualitative catch advice.

The estimated national conservation limits have been summed for Northern and Southern Europe (Table 3.4.3.1) and are given on Figures 3.5.1.4 and 3.5.1.6 for comparison with the estimated spawning escapement. The conservation limits have also been used to estimate the spawner escapement reserves (SERs) (i.e. the CL increased to take account of natural mortality between the recruitment date (1st Jan) and return to home waters) for maturing and non-maturing 1SW salmon from the Northern and Southern Europe stock complexes. The SERs are shown as horizontal lines in Figures 3.5.1.3 and 3.5.1.5. The Working Group also considers the current SER levels may be less appropriate for evaluating the historic status of stocks (e.g. pre-1985), that in many cases have been estimated with less precision.

3.5 Catch Options or Alternative Management Advice

3.5.1 Trends in the PFA for NEAC stocks

Tables 3.5.1.1 to 3.5.1.6 show combined results from the PFA assessment for the Northern and Southern European groups and the whole NEAC area. The PFA of maturing and non-maturing 1SW salmon and the numbers of 1SW and MSW spawners for these areas are shown in Figures 3.5.1.1 to 3.5.1.6.

The 95% confidence limits (dotted lines for PFA and vertical bars for the spawning escapement) shown in Figures 3.5.1.1 to 3.5.1.6 indicate the high level of uncertainty in this assessment procedure. However, the Working Group recognised that the model provided an interpretation of our current understanding of national fisheries and stocks based upon simple parameters. Errors or inconsistencies in the output largely reflect uncertainties in our best estimates of these parameters. Furthermore, there are risks that progressive errors could occur if, for example, the rate that exploitation has been reduced over a period of years is underestimated. The results therefore need to be treated with caution.

Figure 3.5.1.1 shows that there has been a general decline in recruitment of 1SW and MSW salmon in the whole NEAC area over the past 30 years, and both age groups are currently at the lowest levels observed. Numbers of 1SW and MSW spawners have also declined (Figure 3.5.1.2) over the past 30 years, although the decline has been less severe, indicating that reductions in exploitation have, to some extent, compensated for the decline in stocks. The general trends depicted are similar to those derived from the model run last year. However, the absolute number of recruits and spawners throughout the series differs from last year's estimates as a result of improved national inputs to the model and as a result of changing m to 0.03. These comments refer also to the trends shown in Figures 3.5.1.3 to 3.5.1.6.

Figure 3.5.1.3 shows that recruitment of maturing 1SW salmon (potential grilse) in Northern Europe was generally high (around 1.1 million) in the 1970s and 1980s, although the numbers have fluctuated quite widely, but there was a steady decline in these stocks from the mid-1980s to the mid-1990s. In the past four years there has been an upturn in the recruitment trend to levels of around one million, although the 2001 stock is down on 2000. In contrast, there is an increasing trend in the number of 1SW spawners throughout the time-series, with escapement in 2000 and 2001 being the highest estimated (Figure 3.5.1.4), indicating that exploitation has been declining.

Numbers of non-maturing 1SW recruits (potential MSW returns) for Northern Europe are also estimated to have fluctuated around 1.1 million between 1970 and 1985, but subsequently fell to about half this level in the late 1990s; there has been a slight upturn in the past four years. The numbers of MSW spawners, however, show no trend over the time-series although numbers appear to have been increased in the last three years. It therefore appears that the decline in recruitment has been balanced by the reductions in exploitation both in homewater fisheries and at Faroes. These trends in recruitment for the Northern European stocks are broadly consistent with the limited data available on the marine survival of monitored stocks in the Northern area (Section 3.3.1).

In the Southern European stock complex (Figure 3.5.1.5), the numbers of maturing 1SW recruits are estimated to have fallen substantially since the 1970s. Recruitment was at its lowest during the 1990s and there was a further drop in the estimated recruitment in 1999, with values in the last three years being the lowest in the time-series. This pattern is consistent with the data obtained from a number of monitored stocks. Survival of wild smolts to return as 1SW fish fell to very low levels in the Southern European area for which data were available (Section 3.3.1). This suggests that the marked reduction in 1SW returns in 1999 is likely to have been due in large part to a widespread decline in marine survival. Reductions have also been observed in freshwater production, and marine survival could be affected by factors operating in freshwater.

The PFA estimates suggest that the number of non-maturing 1SW recruits in Southern Europe has declined fairly steadily over the past 30 years (Figure 3.5.1.5); these stocks have also reached their lowest levels at the end of the time-series. This is broadly consistent with the general pattern of decline in marine survival of 2SW returns in most monitored stocks in the area (Section 3.3.1). In more recent years, reductions in exploitation do not appear to have kept pace with the stock declines, and the spawning escapement has thus also fallen over the period (Figure 3.5.1.6).

3.5.2 Forecasting the PFA for NEAC stocks

The Working Group considered the development of a model to forecast the pre-fishery abundance of non-maturing (potential MSW) salmon from the Southern European stock group (comprising Ireland, France, and all parts of UK). Stocks in this group are the main European contributors to the West Greenland fishery (See Section 3.3.6). The objective was to use the model fitted to data from 1977-2000 to predict *PFA* in the subsequent years 2001-2002.

A model of the form:

$$PFA = Stock \times e^{\beta_0 + \beta_1 Habitat + noise} \qquad (\textit{Model 1})$$

has previously been used to forecast PFA of North American 2SW salmon (ICES, 2001). This model was modified for the NEAC analysis to allow for attenuation of abundance at different levels of spawning or a trend in the efficiency of converting *Spawners* into *PFA*.

For the NEAC forecast the model was therefore generalised to:

$$PFA = Spawners^{\lambda} \times e^{\beta_0 + \beta_1 Habitat + \beta_2 Year + noise} \qquad (\textit{Model 2})$$

The additional parameter, λ, allows for a non-proportional relationship between *PFA* and *Spawners* for a fixed *Habitat*; a non-zero value of β_2 implies that there is a trend in the efficiency of conversion of *Spawners* into *PFA*.

Both *Model 1 and 2* were fitted in terms of log(*PFA/Spawners).* For Model 2, this implies:

$$\log(PFA/Spawners) = \lambda' \log(Spawners) + \beta_0 + \beta_1 Habitat + \beta_2 Year + noise \; (\textit{Model 3})$$

where $\lambda' = \lambda - 1$.

The data to be used in the model (Table 3.5.2.1) consisted of:

- *PFA*: the pre-fishery abundance of MSW salmon from Southern Europe for the period 1977-2000 was taken from the output of NEAC PFA model as reported in Section 3.3.4.
- *Stock*: the index used in the model is the 'lagged egg' numbers for the period 1977-2002 derived from the national PFA and CL analysis (Section 3.3.2);
- *Habitat*: the same habitat index was used as in the North American PFA prediction model. This thermal habitat is defined as a relative index of the area suitable for salmon at sea and was derived from sea surface temperature (SST) data obtained from the National Meterological Centre of the National Ocean and Atmospheric Administration and previously published catch rates for salmon from research vessels fishing in the north-west Atlantic (as used in Section 5.6.2).

Pair-wise plots of the data are given in Figure 3.5.2.1, with the observations to be used for prediction plotted using solid circles. While there is evidence of a strong temporal trend in both PFA and Eggs Nos., and a weak relationship between PFA and eggs, there is no clear relationship of either PFA and or Egg Nos. with Habitat.

The data suggest that the noise term is, at least approximately, normally distributed with constant variance. However, to provide a more general method, bootstrapping of the model residuals was used for variable selection and construction of prediction confidence intervals (Davison and Hinkley, 1997).

To provide some guidance as to which of the variables in *Model 2* might provide better predictions, Figure 3.5.1.2 shows the aggregate prediction error for a series of models. The model Null(*PFA*) is a null model using only the mean log(*PFA*) for prediction. Similarly, Null(*PFA/Eggs*) is a null model using only the mean log(*PFA/Eggs*). Subsequent models are named in terms of the variables included in *Model 3* (e.g. the model labelled *Habitat* is equivalent to *Model 1*).

This plot shows a marked decrease in the aggregate prediction error at *Year* and again at *Year + Eggs*. This is in agreement with the traditional analysis of variance given in Table 3.5.2.2.

The chosen final model was:

$$\log(PFA / Spawners) = -1.165\log(Spawners) + 20.49 - 0.0475(Year - 1900)$$

with residual variance 0.206^2 on a log scale (equivalent to a residual standard deviation of about 20% on a *PFA* scale). The fitted model is equivalent to:

$$PFA = Spawners^{-0.165} \times e^{20.49 - 0.0475(Year - 1900)}$$

The overwhelming driver of *PFA* appears to be a simple downwards linear trend in log(*PFA/Eggs*), a trend shared by log(*Eggs*), although *PFA* appears to depend on both time and the number of *Eggs*. However, the high correlation between *Year* and *Egg Nos*. makes interpretation difficult.

The forecasts using this model and the bootstrapped 95% confidence intervals are given in Table 3.5.2.3 and shown together with the trend in *PFA* in Figure 3.5.2.3. The probability distribution of the 2002 forecast is shown in Table 3.5.2.4. The model forecasts that, in 2002, the Southern European MSW stock will fall to around 552,000. This is about one third of the estimated PFA in the mid-1970s, and lower PFA levels have only been estimated for three years (1996 to 1998). Although the model is not strongly driven by *Egg Nos.* this decline is consistent with the continuing decline in estimated egg deposition.

3.5.3 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 its concerns about harvesting salmon in mixed stock fisheries, particularly for fisheries exploiting individual river stocks and sub-river populations that are at unsatisfactorily low levels. Annual adjustments in quotas or effort regulations based on changes in the mean status of the stocks is unlikely to provide adequate protection to the individual river stocks that are most heavily exploited by the fishery or are in the weakest condition.

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

Despite resolution of some uncertainties about the most appropriate stock groupings (section 3.3.6), because of the preliminary nature of the conservation limit estimates, the Working Group is unable to provide quantitative catch options for most stock complexes at this stage. In the absence of predictive estimates of PFA and more reliable estimates of conservation limits, it is unlikely that quantitative catch advice will be developed in the immediate future. An exception this year is the provision for the first time of a quantitative prediction of PFA for southern European MSW stocks (Section 3.5.2). The Working Group feels that the following qualitative catch advice is appropriate based upon the PFA data and estimated SERs shown in Figures 3.5.1.3 and 3.5.1.5.

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

For all fisheries, the Working Group considers that management of single stock fisheries should be based upon local assessments of the status of stocks. Conservation would be best achieved by fisheries in estuaries and rivers targeting stocks which have been shown to be above biologically-based escapement requirements.

[NB In the evaluation of the status of stocks, PFA or recruitment values should be assessed against the spawner escapement reserve values, while the spawner numbers should be compared with the conservation limits.]

Northern European 1SW stocks: The PFA of 1SW salmon from the Northern European stock complex has been above the spawning escapement reserve throughout the time-series (Fig. 3.5.1.3), with some evidence of an upturn in the past few years. However, the spawning escapement was below the conservation limit until 1987 (Fig. 3.5.1.4). This upward trend was continued with a slight reduction in 1SW spawners relative to 2000. The Working Group considers that overall exploitation of the stock complex at the current rate is acceptable, although this should not increase as the status of individual stocks varies considerably. It should be noted, however, that the inclusion of farmed fish in the Norwegian data will result in the exploitable surplus being overestimated. Since very few of these salmon have been caught outside homewater fisheries in Europe, even when fisheries were operating in the Norwegian Sea, management of maturing 1SW salmon should be based upon local assessments of the status of river or sub-river stocks.

Northern European MSW stocks: The PFA of non-maturing 1SW salmon from Northern Europe has been declining since the mid-1980s, and the exploitable surplus has fallen from around 1 million recruits in the 1970s to about half this level in recent years (Fig. 3.5.1.3). The Working Group considers the Northern European MSW stock complex to be within safe biological limits, as spawners are above CL and trending in a positive direction (Fig. 3.5.1.4), although it is recognised that the status of individual stocks will vary considerably. In addition, the inclusion of farmed fish in the Norwegian data will result in the exploitable surplus being overestimated. The Working Group therefore considers that caution should still be exercised in the management of these stocks, particularly in mixed stock fisheries, and exploitation should not be permitted to increase until a clear pattern of status above SER is established.

Southern European 1SW stocks: Recruitment of maturing 1SW salmon in the Southern European stock complex has shown a strong decreasing trend throughout most of the time-series (Fig. 3.5.1.5). Moreover the spawning escapement for the whole stock complex has fallen below the conservation limit in four of the past five years, with no evidence from the 2001 data of a reverse in this trend (Fig. 3.5.1.6). Despite a small surplus above SER of around 300,000 fish during the last two years, exploitation in those years was clearly high enough to prevent conservation requirements being met. The Working Group therefore considers that reductions in exploitation rates are required for as many stocks as possible and that mixed stock fisheries present particular threats to conservation.

Southern European MSW stocks: The PFA of non-maturing 1SW salmon from Southern Europe has been declining steadily since the 1970s (Fig. 3.5.1.5), and the preliminary quantitative prediction of PFA for this stock complex indicates that PFA will remain close to present low levels for each of the next two years (575,000 and 552,000 fish) (Fig. 3.5.2.3). There is evidence from the prediction that PFA will decrease in the near future and the spawning escapement has not been significantly above conservation limit for the last six years (Fig. 3.5.1.6). The stock group is therefore thought to remain very close to safe biological limits, and the Working Group therefore considers that precautionary reductions in exploitation rates are required for as many stocks as possible, in order to ensure that conservation requirements are met for each river stock with high probability. The Working Group also notes that mixed stock fisheries present particular threats to conservation.

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

3.6 Evaluation of the effects on stocks and homewater fisheries of significant management measures introduced since 1991

The Working Group noted significant reductions in the number of gear units deployed in most countries in the NEAC area since 1991 (Table 3.6.1). This is considered to reflect both measures aimed at reducing levels of exploitation and the declining commercial viability of some fisheries. NEAC countries have also introduced a number of other measures. In addition to regulated gear reductions, these measures include: restrictions on fishing seasons, buy-out arrangements, voluntary restrictions, and increasing use of catch and release.

The Working Group noted that both fishing effort and reported catches were believed to have increased in some NEAC net fisheries due to the anticipation of quota management systems based on historical catches or a presumption that buyouts and/or set-asides might be implemented in the future. It was not possible to quantify these increases.

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

NEAC northern area

The buy-out of gillnets in the Hvita river system in Iceland is estimated to have improved the rod catch in tributaries of the river by 28 to 35%. The increase in rod catches also suggested that the rod fishery may be taking 39 to 52% of the previous net catch. In Russia, commercial catches in the 1990s are estimated to be 3.5 times smaller than in the 1980s, largely as a result of management changes aimed at reducing the fishing effort and a cessation of the salmon fishery on the Pechora River, in particular.

NEAC southern area

In UK (England and Wales), the North East coast fishery is the largest net fishery and has taken, on average, 68% of the national declared net catch over the period 1970-92. A phase-out of this fishery was introduced in 1993, and the number of licences issued has subsequently fallen from 142 in 1992 to 70 in 2001 (51%). The exploitation rate in 1992 was estimated to be in the region of 50%. Assuming the remaining fishermen are representative and that there have been no major changes in the fishery, the average exploitation rate (1997-2001) would have fallen to around 30% (i.e. a 40% reduction). This is greater than the reduction in the average drift net catch (1997-2001), which has fallen by 22% compared with the 5 years (1988-92) prior to the start of the phase-out. A number of other smaller coastal mixed stock fisheries have also been phased out since 1991.

National measures were introduced in UK (England and Wales) in 1999 to protect spring salmon. In 2001, these are estimated to have saved around 3,100 salmon from capture by net fisheries and around 1,100 by rod fisheries before June 1. These estimates are based on the catch and the average proportion of fish taken in this period in the 5 years prior to the measures being introduced; the latter estimate has been adjusted for catch and release.

In Scotland, members of the Salmon Net Fishing Association, to which the majority of active netsmen are affiliated, continued a voluntary agreement, introduced in 2000, to delay fishing until the beginning of April in order to protect early running MSW salmon. Similar delays to the start of the season were also introduced in Sweden.

In Ireland, the introduction of measures in the commercial fishery in 1997 effectively reduced effort in the commercial fishery by about 20% (5 to 4 days). Further restrictions on night-time fishing further reduced the effort by up to 50% in some areas where all day fishing was previously carried out. Fishing effort on spring salmon stocks was also reduced with the later opening of the season for some gears. A more detailed appraisal of these methods on Irish stocks and fisheries was presented in last year’s Working Group report (ICES 2001/ACFM:15). This had concluded that the measures contributed to a reduction in both the overall catch and the exploitation rate on Irish stocks. Exploitation rate estimates in net fisheries for tagged wild and hatchery stocks for 2001 were below recent long-term averages; this was felt to reflect the recent management changes.

In northern France, TACs have been operated in several regions for some years. In Brittany (which provides more than 60% of the total catch) a MSW specific TAC, introduced in 2000, continued to apply and resulted in the temporary closure of some rod fisheries in 2001. One and two month delays to the start of the angling season were also introduced on three other rivers, in an effort to reduce exploitation of spring salmon. However, catch data suggest that this resulted in catches well above average when the season commenced, suggesting that the measures merely delayed exploitation. In addition, a six-week closure of the net fishery took place in the Adour estuary in June and July 2001; this is estimated to have saved around 6,500 1SW salmon.

The above estimates and the overall reduction in gear units suggest that the impact of fisheries on NEAC stocks has been significantly reduced since 1991.

3.7 By-catch and distribution of post-smolts in the Norwegian Sea

3.7.1 Estimate of by-catches of post-smolts in pelagic fisheries in the Norwegian Sea

Atlantic salmon post-smolts have been observed to have a similar distribution in time and space as the mackerel (ICES 2000/ACFM:13), and both species seem to follow the warm and saline Atlantic current on their northward migration. The salmon post-smolts are mainly observed close to the sea surface (Figure 3.7.1.1). Although salmon post-smolts probably remain close to the near-surface layers, mackerel also frequently occur in the upper layers (0-50 m layer) of the water column, as reported during aerial surveys of mackerel schools in the Norwegian Sea in July 1997 – 2001 (ICES 2002/G:06).

The potential risk of salmon post-smolts being taken in commercial fisheries for pelagic fish, has been discussed for some time, but so far little substantial data to estimate this has been available. Efforts were made to collect data on by-catch of salmon in the Faroese herring fishery in June of 1998 and 1999 (Jacobsen 2000 however, no post-smolts by-catches were reported.

In June 2001 catches of post-smolts made during a special post-smolt survey west of the Voering Plateau in the Norwegian Sea by the Institute of Marine Research, Norway, also contained a mackerel. This survey was carried out at approximately the same time as the commercial mackerel fishery starts in the nearby areas. The simultaneous occurrence of salmon and post-smolts in areas where a commercial fleet is known to operate, provided an opportunity to examine the possible magnitude of the by-catches of post-smolts of salmon in the commercial fishery.

The commercial mackerel fishery

The mackerel fishery in the International zone (IIa) in the Norwegian Sea during the summer months is mostly carried out by a trawler fleet, while the fleet operating in Norwegian (div. IIb and IIIa-c) and the Faroes (div. V) EEZs predominantly consists of purse seiners. In 1997 the fleet fishing in the Norwegian Sea (IIa) comprised 9 middle sized and 38 large trawlers (ICES 1999/ACFM:06). No information was available in later years.

The commercial trawls used in the Norwegian Sea are operated with the head rope in various depths down to 50 m and supplied with extra flotation on the trawl-wings if operated close to the surface. Towing speed surpasses 5 knots (Holm, pers obs. 1999).

The fishery for mackerel follows the northward migration of the mackerel stocks, and in 1997 - 2000 took place in an area delineated approximately by 62°N; 11° W and 66°N; 4°E in the 2nd quarter, and 62°N; 10°W and 70°N; 7E in the 3rd quarter respectively. (Figure 3.7.1.2). The catch in the Norwegian Sea in the 2nd quarter was smaller than in the 3rd quarter in this area.

Research fishery for salmon post-smolts.

A trawl survey specially designed to catch salmon posts-smolts alive was carried out in June 2001 using a surface trawl equipped with a Fish Lifter (Holst and MacDonald 2000). The surface trawl and trawling method is described in Holm *et al.* (2000).

The survey took place between 13 and 17 June 2001 between 64.3 – 67.9°N and 1 – 3°E (west of the Voering Plateau). In total 14 hauls with a mean tow-duration of 1.8 h. were conducted (Figure 3.7.1.3).

A total of 198 post-smolts and 5 salmon were captured (Holm *et al.* 2002). Simultaneously, a total of 7,959 kg mackerel was taken (Table 3.7.1.1). This corresponds to a catch of 0.025 post-smolts per kg mackerel caught. The number of post-smolts taken in the different hauls varied considerably, from 0 to 93, resulting in a range of CPUEs (number caught per trawl-hour) from 0 to 93. The total weight of mackerel captured in the different hauls varied between 0 and 1,400 kg giving a variation in CPUE (kg per trawl-hour) of 0 – 1,100. There was no correlation between the number of post-smolts caught per trawl hour and weight of mackerel caught by trawl hour.

Based on the ratio of the number of post-smolts and weight of mackerel captured, a first approach was made to estimate post-smolt by-catches by scaling up these data with an estimate of the commercial mackerel trawl catch in the in the Norwegian Sea (IIa and Vb) and the catch in areas West of Ireland and Great Britain (IVa , VI and VII).

Post-smolt distribution

Our knowledge of the distribution marine distribution of Atlantic salmon is still insufficient, but recent investigations have shed light on at least parts of the migration of the salmon to their feeding areas. Smolts migrate from Irish and British rivers from May to June (O'Maoileidigh, pers. com.). In June high densities of post-smolts of southern origin (1 – 2 years at leaving the rivers) have been found in the Faroes- Shetland channel (Shelton *et al.* 1997; ; Holm *et al.*1999; Holst *et al*. 2000), in June west of the Voering Plateau (Holm et al. 2001; 2002) and in July- August spread over most of the Norwegian Sea as far as 74° N (Holm *et al.* 1999; 2000). It is probable, therefore, that many migrate northward with the Atlantic current to the Norwegian Sea while an unknown proportion are migrating to feeding areas around Greenland (Section 5.2).

Mackerel catches in 2000

Table 3.7.1.2 summarises the total commercial mackerel catch in quarter 2 and 3 (which covers the time period when an interception between the two species is most likely). Reported total catch was 85,678 tonnes in the Norwegian Sea (Division II and Vb) and 17,248 tonnes in quarter 2 in the area west of Ireland and British Isles (Division IVa,VI and VII) according to ICES 2002/ ACFM:06. The data for 2001 are not yet available, but it is assumed that they are in the same order of magnitude. From the areas west of Ireland and the British Isles the proportion of the trawl captures of the total catch (including also handline and purse seine catches) is unknown. However, only trawls are directly comparable to the research method, and therefore only the estimated trawl caught mackerel catches are used for calculations.

3.7.2 Update on the distribution of post-smolts in the Norwegian Sea

In 2001, seven pelagic surveys were carried out by the IMR, Norway, during May to August. Two dedicated salmon cruises were carried out in selected fjords in SW Norway, while the others, one of which was a dedicated salmon survey, were carried out in the Norwegian Sea and adjacent areas. Figure 3.7.2.1 presents the distribution of the 2001 horizontal haul trawls. A total of 605 post-smolts and 21 salmon were captured, 60 % of which were taken in the coastal and fjord areas. The general distribution of the captures was similar to previous years (Figure 3.7.2.2). The special salmon cruise to the Norwegian Sea confirmed that west of the Voering Plateau is a high-density aggregation area for post-smolts in June, where the fish are associated with the warm saline waters of a branch of the Atlantic current. A clear relationship between surface trawling (head-rope at 0 m) and prevalence of hauls containing post-smolts was found (Figure 3.7.1.1).

3.8 Data deficiencies and research needs in the NEAC area

1. To improve the input of environmental variables in the predictive models, research on temporal and spatial distribution of salmon post-smolt of different origin in the ocean should be continued and expanded. Two approaches are recommended: (a) A coordinated tagging program of salmon smolts throughout the distribution range followed by intensive sampling in local and distant waters. (b) tagging smolts with Data Storage Tags.

2. To improve the estimates of by-catch of post-smolts in the mackerel fishery, a continuing effort to develop and expand the surveys in the actual areas is required. Furthermore, the commercial catches of mackerel in the Norwegian Sea (ICES Divisions IIa and Vb), Northern North Sea (IVa), and west of Ireland and Scotland (VIa,b; VIIb,c,j,k) should be provided by ICES Divisions and per standard week during the period May-August (week 18-33).

3. Research on post-smolts in the early marine phase should be continued and expanded. This should include studies on interactions with parasites and assessments of the impact of sea lice on post-smolts.

4. Further progress should be made in establishing PFA methodologies.

5. An ICES Study Group should be formed to develop alternative models and management systems for providing management advice for homewater fisheries.

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

Year	England & Wales					UK (Scotland)		UK (N. Ireland)			Norway			
	Gillnet licences	Sweepnet	Hand-held net	Fixed engine	Rod & Line[1]	Fixed engine[2]	Net and coble[3]	Driftnet	Draftnet	Bagnets and boxes	Bagnet	Bendnet	Liftnet	Driftnet (No. nets)
1971	437	230	294	79	-	3,069	802	142	305	18	4,608	2,421	26	8,976
1972	308	224	315	76	-	3,437	810	130	307	18	4,215	2,367	24	13,448
1973	291	230	335	70	-	3,241	884	130	303	20	4,047	2,996	32	18,616
1974	280	240	329	69	-	3,182	777	129	307	18	3,382	3,342	29	14,078
1975	269	243	341	69	-	2,978	768	127	314	20	3,150	3,549	25	15,968
1976	275	247	355	70	-	2,854	756	126	287	18	2,569	3,890	22	17,794
1977	273	251	365	71	-	2,742	677	126	293	19	2,680	4,047	26	30,201
1978	249	244	376	70	-	2,572	691	126	284	18	1,980	3,976	12	23,301
1979	241	225	322	68	-	2,698	747	126	274	20	1,835	5,001	17	23,989
1980	233	238	339	69	-	2,892	670	125	258	20	2,118	4,922	20	25,652
1981	232	219	336	72	-	2,704	647	123	239	19	2,060	5,546	19	24,081
1982	232	221	319	72	-	2,377	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	-	0
1994	177	158	257	53	37,278	753	245	119	68	18	2,630	2,825	-	0
1995	163	156	249	47	34,941	737	226	122	68	16	2,542	2,715	-	0
1996	151	132	232	42	35,281	614	203	117	66	12	2,280	2,860	-	0
1997	139	131	231	35	32,781	671	196	116	63	12	2,002	1,075	-	0
1998	130	129	196	35	32,525	537	151	117	70	12	1,865	1,027	-	0
1999	120	109	178	30	29,132	355	109	113	52	11	1,649	989	-	0
2000	110	103	158	32	30,139	382	122	109	57	10	1,557	982	-	0
2001	113	99	143	33	23,099	251	81	107	50	6	1,976	1,081	-	0
Mean 1996-2000	130	121	199	35	31,972	512	156	114	62	11	1,871	1,387		
% change [4]	-13.1	-18.0	-28.1	-5.2	-27.8	-51.0	-48.1	-6.5	-18.8	-47.4	5.6	-22.0		
Mean 1991-2000	158	141	229	46	33,154	696	212	117	71	15	2,201	2,223		0
% change [4]	-28.4	-30.0	-37.6	-28.3	-30.3	-63.9	-61.8	-8.7	-29.6	-58.9	-10.2	-51.4		

1 Total number of rods days fished, data for 2001 is provisional.

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

3 Number of gear units expressed as trap months.

4 (2001/mean - 1) * 100

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

	Ireland				Finland				France		
					The Teno River			R. Näätämö			
	Driftnets No.	Draftnets	Other nets Commercial	Rod	Recreational fishery Tourist anglers		Local rod and net fishery	Recreational fishery	Rod and line licences	Com. nets in freshwater[4]	Licences in estuary[4,5]
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	457	161	23,875	29,461	10,198	755	705	2,111	53	55
1994	732	494	176	24,988	26,517	8,985	751	671	1,680	17	59
1995	768	512	164	27,056	24,951	8,141	687	716	1,881	17	59
1996	778	523	170	29,759	17,625	5,743	672	814	1,806	21	69
1997	852	531	172	31,873	16,255	5,036	616	588	2,974	10	59
1998	874	513	174	31,565	18,700	5,759	621	673	2,358	16	63
1999	874	499	162	32,493	22,935	6,857	616	850	2,232	15	61
2000	871	490	158	33,527	28,385	8,275	633	624	2,745	16	35
2001	838	507	160	33,527	33,501	9,367	863	590	3,111	12	32
Mean 1996-2000	850	511	167	31843	20780	6334	632	710	2423	16	57
% change[6]	-1.4	-0.8	-4.3	5.3	61.2	47.9	36.6	-16.9	28.4	-23.1	-44.3
Mean 1991-2000	782	506	170	27058	23450	7634	683	723	2271	30	60
% change[6]	7.2	0.2	-6.0	23.9	42.9	22.7	26.3	-18.4	37.0	-60.0	-46.8

[1] Common licence for salmon and seatrout introduced in 1986 leading to a short-term increase in the number of licences issued.

[2] Since 1987 fishermen have been obliged to declare their catches.

[3] This figure is an estimate from a sample of anglers, the sea trout and salmon angling licenses being common since 2000·

[4] The number of licences, 1999 included, indicates only the number of fishermen (or boats allowed to fish for salmon. It overestimates the actual number of fishermen fishing for salmon up to 2 c

[5] Adour estuary only southwest of France.

[6] (2000/mean - 1) * 100

Table 3.2.4.1 Nominal catch of SALMON in NEAC Area (in tonnes round fresh weight), 1960-2001 (2001 figures are provisional).

Year	Southern countries	Northern countries	Faroes (1)	Other catches in international waters	Total Reported Catch	Unreported catches NEAC Area	Unreported catches International waters (2)
1960	2641	2899	-	-	5540	-	-
1961	2276	2477	-	-	4753	-	-
1962	3894	2815	-	-	6709	-	-
1963	3842	2434	-	-	6276	-	-
1964	4242	2908	-	-	7150	-	-
1965	3693	2763	-	-	6456	-	-
1966	3549	2503	-	-	6052	-	-
1967	4492	3034	-	-	7526	-	-
1968	3623	2523	5	403	6554	-	-
1969	4383	1898	7	893	7181	-	-
1970	4048	1834	12	922	6816	-	-
1971	3736	1846	-	471	6053	-	-
1972	4257	2340	9	486	7092	-	-
1973	4604	2727	28	533	7892	-	-
1974	4352	2675	20	373	7420	-	-
1975	4500	2616	28	475	7619	-	-
1976	2931	2383	40	289	5643	-	-
1977	3025	2184	40	192	5441	-	-
1978	3102	1864	37	138	5141	-	-
1979	2572	2549	119	193	5433	-	-
1980	2640	2794	536	277	6247	-	-
1981	2557	2352	1025	313	6247	-	-
1982	2533	1938	606	437	5514	-	-
1983	3532	2341	678	466	7017	-	-
1984	2308	2461	628	101	5498	-	-
1985	3002	2531	566	-	6099	-	-
1986	3595	2588	530	-	6713	-	-
1987	2564	2266	576	-	5406	2554	-
1988	3315	1969	243	-	5527	3087	-
1989	2433	1626	364	-	4423	2103	-
1990	1645	1775	315	-	3735	1779	180-350
1991	1145	1677	95	-	2917	1555	25-100
1992	1523	1805	23	-	3351	1825	25-100
1993	1443	1853	23	-	3319	1471	25-100
1994	1896	1684	6	-	3586	1157	25-100
1995	1774	1503	5	-	3282	942	-
1996	1395	1358	-	-	2753	947	-
1997	1113	962	-	-	2075	732	-
1998	1121	1099	6	-	2226	1108	-
1999	934	1138	0	-	2072	887	-
2000	1203	1517	8	-	2728	1135	-
2001	1255	1632	0	-	2887	1079	
Means							
1996-2000	1153	1215	5	-	2371	962	-
1991-2000	1355	1460	21	-	2831	1176	-

1. Since 1991, there has only been a research fishery at Faroes.

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

	Finland (Teno River)		Finland (Naatamo River)		France	UK(N.Ire.)(R.Bush)
	Catch per angler season	Catch per angler day	Catch per angler season	Catch per angler day	Catch per angler season	Catch per rod day
Year	kg	kg	kg	kg	Number	Number
1974		2.8				
1975		2.7				
1976		-				
1977		1.4				
1978		1.1				
1979		0.9				
1980		1.1				
1981	3.2	1.2				
1982	3.4	1.1				
1983	3.4	1.2				0.248
1984	2.2	0.8	0.5	0.2		0.083
1985	2.7	0.9	n/a	n/a		0.283
1986	2.1	0.7	n/a	n/a		0.274
1987	2.3	0.8	n/a	n/a	0.39	0.194
1988	1.9	0.7	0.5	0.2	0.73	0.165
1989	2.2	0.8	1.0	0.4	0.55	0.135
1990	2.8	1.1	0.7	0.3	0.71	0.247
1991	3.4	1.2	1.3	0.5	0.60	0.396
1992	4.5	1.5	1.4	0.3	0.94	0.258
1993	3.9	1.3	0.4	0.2	0.88	0.341
1994	2.4	0.8	0.6	0.2	2.31	0.205
1995	2.7	0.9	0.5	0.1	1.15	0.206
1996	3.0	1.0	0.7	0.2	1.57	0.267
1997	3.4	1.0	1.1	0.2	0.43 [1]	0.338
1998	3.0	0.9	1.3	0.3	0.67	0.569
1999	3.7	1.1	0.8	0.2	0.76	0.273
2000	5.0	1.5	0.9	0.2	0.79	0.259
2001	5.9	1.7	1.0	0.3	0.65	0.444
Mean 1996-00	3.6	1.1	1.0	0.2	0.84	0.341

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

Table 3.2.5.2 CPUE for salmon rod fisheries in the Barent Sea and White Sea basin in Russia.

	Barents Sea Basin, catch per angler day				White Sea Basin, catch per angler day			
Year	Rynda	Kharlovka	Varzina	Iokanga	Ponoy	Varzuga	Kitsa	Umba
1991					2.794	1.870		1.330
1992	2.370	1.454	1.070	0.135	3.489	2.261	1.209	1.366
1993	1.177	1.464	0.488	0.650	2.881	1.278	1.425	2.720
1994	0.710	0.847	0.548	0.325	2.332	1.596	1.588	1.436
1995	0.486	0.782	1.220	0.718	3.459	2.524	1.784	1.196
1996	0.703	0.845	1.502	1.398	3.503	1.444	1.761	0.930
1997	1.197	0.709	0.613	1.411	5.330	2.364	2.482	1.457
1998	1.010	0.551	0.441	0.868	4.544	2.284	2.784	0.979
1999	0.947	0.642	0.427	1.193	3.300	1.710	1.657	0.756
2000	1.348	0.769	0.565	2.283	3.494	1.526	3.018	1.245
2001	1.160	1.272	0.888	0.730	4.200	1.860	1.814	1.039
Mean 1996-00	1.041	0.703	0.710	1.431	4.034	1.866	2.340	1.073

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

		Region (aggregated data, various methods)					
Year	North East drift nets	North East	Southern	South West	Midlands[1]	Wales	North West
1988		5.49	10.15			-	-
1989		4.39	16.80			0.90	0.82
1990		5.53	8.56			0.78	0.63
1991		3.20	6.40			0.62	0.51
1992		3.83	5.00			0.69	0.40
1993	8.23	6.43	No fishing			0.68	0.63
1994	9.02	7.53	-			1.02	0.71
1995	11.18	7.84	-			1.00	0.79
1996	4.93	3.74	-			0.73	0.59
1997	6.84	5.30	-	0.42		0.77	0.35
1998	6.49	5.12	-	0.56	0.25	0.69	0.32
1999	8.77	7.28	-	0.48	0.36	0.83	0.37
2000	12.21	10.50	-	0.69	0.43	0.40	0.64
2001	10.06	8.70	-	0.62	0.42	0.47	0.56
Mean 1996-00	7.85	6.39	-	0.54	0.35	0.68	0.45

[1]Seine nets and lave nets only

Table 3.2.5.4 CPUE data for Scottish net fisheries.
Catch in numbers of fish per unit effort.

Year	Fixed engine	Net and coble CPUE
	Catch/trap month [1]	Catch/crew month
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	60.51	110.93
1997	33.95	56.27
1998	36.75	65.54
1999	24.30	69.70
2000	54.20	105.10
2001	57.80	86.80
Mean 1996-00	41.94	81.51

[1] - Excludes catch and effort for Solway Region

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

	Bagnet			Bendnet		
Year	< 3kg	3-7 kg	>7 kg	< 3kg	3-7 kg	>7 kg
1998	0.88	0.66	0.12	0.80	0.56	0.13
1999	1.16	0.72	0.16	0.75	0.67	0.17
2000	2.01	0.90	0.17	1.24	0.87	0.17
2001	1.52	1.03	0.22	1.03	1.39	0.36

Table 3.2.6.1 Percentage of 1SW salmon in catches from countries in the North East Atlantic Commission, 1987-2001.

Year	Iceland	Finland	Norway	Russia	Sweden	**Northern countries**	UK (Scot)	UK (E&W) (2)	France	**Southern countries**
1987		66	61	71		**63**	61	68	77	**63**
1988		63	64	53		**62**	57	69	29	**60**
1989	69	66	73	73	41	**72**	63	65	33	**63**
1990	66	64	68	73	70	**69**	48	52	45	**49**
1991	72	59	65	70	71	**66**	53	71	39	**58**
1992	72	70	62	72	68	**65**	55	77	48	**59**
1993	76	58	61	61	62	**63**	57	81	74	**64**
1994	64	55	68	69	64	**67**	54	77	55	**61**
1995	72	59	58	70	78	**62**	53	72	60	**59**
1996	74	79	53	80	63	**61**	54	65	51	**56**
1997	73	69	64	82	54	**68**	54	73	51	**60**
1998	82	75	66	82	59	**70**	58	83	71	**65**
1999	71	83	65	78	71	**68**	45	70	27	**55**
2000	84	67	67	75	69	**69**	54	79	58	**65**
2001	81	48	58	74	55	**60**	54	75	51	**63**
Means										
1996-2000	77	75	63	79	63	**67**	53	74	52	**60**
1991-2000	74	67	63	74	66	**66**	54	75	54	**60**

1. Figures for 1989 and 1990 are estimates of the proportion of 1SW derived for the PFA model (see Section 3.3.3).
2. Best estimates of the proportions of 1SW and MSW salmon derived for the PFA model (see Section 3.3.3).

Table 3.3.1.1 Estimated survival of wild smolts (%) to return to homewaters (prior to coastal fisheries) for various monitored rivers in the NE Atlantic area.

Smolt	Iceland[1]					Ireland		UK (N.Ireland)[8]	Norway[2]		UK (Scotland)[2]			France	
migration	Ellidaar	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	20.8														
1980						17.9	0.5								
1981						7.6	3.0		17.3	4.0	13.7	6.9	0.3		
1982						20.9	2.7		5.3	1.2	12.6	5.4	0.2		
1983		2.0				10.0	1.5		13.5	1.3	-	-	-		
1984						26.2	1.6		12.1	1.8	10.0	4.1	0.1		
1985	9.4					18.9	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	16.6	0.6	35.1	17.3	5.6	13.9	3.4	0.1	2.6	
1988	12.7			0.6	0.9	14.6	0.6	36.2	13.3	1.1	-	-	-	2.4	
1989	8.1	1.1	2.0	0.2	0.7	6.7	0.6	25.0	8.7	2.2	7.8	4.9	0.1	3.5	
1990	5.4	1.0	1.0	1.2	1.3	5.0	0.5	34.7	3.0	1.3	7.3	3.1	0.2	1.8	
1991	8.8	4.2	0.6	1.1	0.5	7.3	1.0	27.8	8.7	1.2	11.2	4.5	-	9.2	
1992	9.6	2.4	0.8	1.4	0.5	7.3	-	29.0	6.7	0.9	-	-	-	8.9	6.9 [7]
1993	9.8	-	-	1.0	1.1	10.8	1.6	-	15.6		-	-	-	8.3 [7]	10.3 [7]
1994	9.0	-	-	1.4	0.6	9.8	1.1	27.1	-	-	17.2	2.3	0.1	7.2 [7]	7.5 [7]
1995	9.4	1.6	1.2	0.3	0.9	8.4	0.1	n/a	1.8	1.5	11.5	5.1	0.1	2.3	-
1996	4.6	1.4	0.3	1.2	0.7	6.3	0.9	31.0	3.5	0.9	10.7	3.5	0.2	4.4	-
1997	5.3	0.7	0.5	2.4	0.5	12.7	0.6	19.8	1.5	0.3	10.3	6.3	0.1	3.4	4.8
1998	5.3	1.0	1.0	1.3	-	5.5	0.8	13.4	7.2	1.1	-	-	-	2.6	-
1999	7.7	1.3	0.9	-	-	4.6		16.5	3.3	2.0	-	-	-	-	-
2000	3.8	0.8		-		5.8		10.1	11.3		11.2			-	-
Mean															
(5-year)	6.5	1.1	0.8	1.3	0.7	7.5	0.6	20.2	4.8	1.2	10.8	5.0	0.1	3.2	4.8
(10-year)	7.5	1.7	0.8	1.3	0.8	7.8	0.8	24.9	5.7	1.2	11.4	4.1	0.1	5.3	7.4

[1] Microtags.

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

[3] Microtags, corrected for tagging mortality.

[4] Assumes 50% exploitation in rod fishery.

[5] Minimum estimates.

[6] From 0+ stage in autumn.

[7] Incomplete returns.

[8] Assumes 30% exploitation in trap fishery.

Table 3.3.1.2 Estimated survival of hatchery smolts (%) to adult return to homewaters, (prior to coastal fisheries) for monitored rivers and experimental facilities in the NE Atlantic area.

Smolt year	Iceland[1]		UK (N.		Norway[2]				Sweden[2]	
	R.		R. Bush		R. Imsa		R.		R. Lagan	
	1SW	2SW	1+ smolts	2+ smolts	1SW	2SW	1SW	2SW	1SW	2SW
1981					10.1	1.3				
1982					4.2	0.6				
1983	0.0	0.2	1.9	8.1	1.6	0.1				
1984	0.5	0.2	13.3	-	3.8	0.4	3.5	3.0	11.8	1.1
1985	0.4	0.1	15.4	17.5	5.8	1.3	3.4	1.9	11.8	0.9
1986	0.4	0.7	2.0	9.7	4.7	0.8	6.1	2.2	7.9	2.5
1987	2.7	0.7	6.5	19.4	9.8	1.0	1.7	0.7	8.4	2.4
1988	0.7	0.2	4.9	6.0	9.5	0.7	0.5	0.3	4.3	0.6
1989	0.7	0.4	8.1	23.2	3.0	0.9	1.9	1.3	5.0	1.3
1990	1.9	0.5	5.6	5.6	2.8	1.5	0.3	0.4	5.2	3.1
1991	1.8	0.2	5.4	8.8	3.2	0.7	0.1	0.1	3.6	1.1
1992	1.3	0.2	6.0	7.8	3.8	0.7	0.4	0.6	1.5	0.4
1993	0.5	0.2	1.1	5.8	6.5	0.5	3.0	1.0	2.6	0.9
1994	1.0	0.2	1.6	-	6.2	0.6	1.2	0.9	4.0	1.2
1995	0.8	0.1	3.1	2.4	0.4	0.0	0.7	0.3	3.9	0.6
1996	0.1	0.0	2.0	2.3	2.1	0.2	0.3	0.2	3.5	0.5
1997	0.9	0.0	no release	4.1	1.0	0.0	0.5	0.2	0.6	0.5
1998	no release	no release	2.3	4.5	0.6	0.1	1.9	0.7	1.6	0.9
1999	no release		2.7	5.8	6.2	0.6	2.0	1.8	2.1	
2000			2.8	4.4	5.1		1.3			
Mean										
(5-year)	0.6	0.0	2.5	3.9	2.1	0.2	1.1	0.6	2.3	0.6
(10-year)	1.0	0.2	3.3	5.2	3.3	0.5	1.0	0.6	2.9	1.0

[1]Microtagged.

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

Table 3.3.1.2 Cont'd. Estimated survival of hatchery smolts (%) to 1SW adult return to homewaters, (prior to coastal fisheries) for monitored rivers and experimental facilities in Ireland.

Smolt year	R. Shannon	R. Screebe	R. Burrishoole[1]	R. Delphi	R. Bunowen	R. Lee	R. Corrib Cong. 2	R. Corrib Galway 2	R. Erne
1980	8.6		4.7			10.8	0.9		
1981	2.8		9.1			2.0	1.2		
1982	4.1		9.9			16.3	2.7	16.1	
1983	3.9		3.3			2.0	1.7	4.1	
1984	4.9	10.4	26.9			0.1	5.2	13.2	9.3
1985	4.8	12.3	32.1			17.7	1.4	14.4	9.9
1986	9.1	0.4	9.8			16.3	-	7.6	10.1
1987	4.7	8.3	16.1			8.6	-	2.2	6.9
1988	4.9	9.2	17.1			5.5	4.2	-	2.6
1989	5.0	1.6	10.1			1.7	6.0	4.9	1.2
1990	1.3	0.0	10.9			2.5	0.2	2.3	1.3
1991	4.1	0.2	13.9	10.8		0.8	3.5	4.0	1.3
1992	4.3	1.3	7.5	10.0	5.2	-	0.9	0.6	-
1993	2.9	2.2	11.9	14.3	6.4	-	1.0	-	-
1994	5.1	1.9	13.7	5.6	8.1	-	-	5.3	-
1995	3.6	4.1	7.8	3.3	3.5	-	2.4	-	-
1996	2.9	1.8	5.7	9.9	3.3	-	-	-	-
1997	6.0	0.4	13.3	16.3	5.7	6.9	-	-	8.3
1998	3.1	1.3	4.9	7.1	2.6	4.6	3.3	2.9	2.5
1999	0.7	2.5	6.7	10.7	1.4	-	-	3.2	3.5
2000	1.0	3.8	10.5	13.6	3.4	3.2	6.0	-	3.1
Mean									
(5-year)	3.3	2.0	7.7	9.5	3.3	5.8	2.9	3.1	4.8
(10-year)	3.4	1.6	9.6	9.8	4.5	3.7	1.9	3.1	3.4

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

[2] Different release sites

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

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	8,422	8,538	30	40	30	40	40	60	40	70
1972	13,160	13,341	30	40	30	40	40	60	40	70
1973	16,710	16,940	30	40	30	40	40	60	40	70
1974	16,194	17,265	30	40	30	40	40	60	40	70
1975	23,012	24,537	30	40	30	40	40	60	40	70
1976	20,112	21,444	30	40	30	40	40	60	40	70
1977	13,403	14,288	30	40	30	40	40	60	40	70
1978	9,504	8,633	30	40	30	40	40	60	40	70
1979	11,404	6,581	30	40	30	40	40	60	30	60
1980	9,817	7,746	20	30	20	30	40	60	30	60
1981	7,045	9,493	20	30	20	30	40	60	30	60
1982	5,844	12,164	20	30	20	30	40	60	30	60
1983	9,072	14,016	20	30	20	30	40	60	30	60
1984	13,604	13,124	20	30	20	30	40	60	30	60
1985	15,589	12,349	20	30	20	30	40	60	30	60
1986	16,190	8,566	20	30	20	30	40	60	30	60
1987	21,110	10,973	20	30	20	30	40	60	30	60
1988	12,657	7,464	20	30	20	30	40	60	30	60
1989	23,905	12,262	20	30	20	30	50	70	40	70
1990	21,618	12,005	20	30	20	30	50	70	40	70
1991	22,623	15,465	20	30	20	30	50	70	40	70
1992	35,780	14,973	20	30	20	30	50	70	40	70
1993	21,556	15,805	20	30	20	30	50	70	40	70
1994	16,804	13,972	20	30	20	30	50	70	40	70
1995	15,321	10,515	20	30	20	30	50	70	40	70
1996	24,812	5,989	20	30	20	30	40	60	30	60
1997	20,038	8,247	20	30	20	30	40	60	30	60
1998	25,369	7,347	20	30	20	30	40	60	30	60
1999	45,092	7,764	20	30	20	30	50	70	40	60
2000	45,288	16,623	20	30	20	30	50	70	40	60
2001	25,762	23,698	20	30	20	30	50	70	40	60
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0

M(min)= 0.020 Return time (m)= 1SW(min) 7 MSW(min) 16
M(max)= 0.040 1SW(max) 9 MSW(max) 18

Table 3.3.3.1b Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - FRANCE

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
	Non-reporting included in exploitation rates									
1971	1,740	4,060	0	0	0	0	2	5	25	50
1972	3,480	8,120	0	0	0	0	2	5	25	50
1973	2,130	4,970	0	0	0	0	2	5	25	50
1974	990	2,310	0	0	0	0	2	5	25	50
1975	1,980	4,620	0	0	0	0	2	5	25	50
1976	1,820	3,380	0	0	0	0	2	5	25	50
1977	1,400	2,600	0	0	0	0	2	5	25	50
1978	1,435	2,665	0	0	0	0	2	5	25	50
1979	1,645	3,055	0	0	0	0	2	5	25	50
1980	3,430	6,370	0	0	0	0	2	5	25	50
1981	2,720	4,080	0	0	0	0	2	5	20	50
1982	1,680	2,520	0	0	0	0	2	5	20	50
1983	1,800	2,700	0	0	0	0	2	5	20	50
1984	2,960	4,440	0	0	0	0	2	5	20	50
1985	1,100	3,330	0	0	0	0	2	5	20	50
1986	3,400	3,400	0	0	0	0	2	12	20	50
1987	6,000	1,800	0	0	0	0	2	12	20	50
1988	2,100	5,000	0	0	0	0	2	12	20	50
1989	1,100	2,300	0	0	0	0	2	12	20	50
1990	1,900	2,300	0	0	0	0	2	12	20	50
1991	1,400	2,100	0	0	0	0	2	12	20	50
1992	2,500	2,700	0	0	0	0	2	12	20	50
1993	3,600	1,300	0	0	0	0	2	12	20	50
1994	2,800	2,300	0	0	0	0	2	12	20	40
1995	1,669	1,095	0	0	0	0	5	20	20	40
1996	2,063	1,942	0	0	0	0	5	20	20	40
1997	1,060	1,001	0	0	0	0	5	20	20	40
1998	2,065	846	0	0	0	0	5	20	20	40
1999	690	1,831	0	0	0	0	5	20	20	40
2000	1,792	1,277	0	0	0	0	5	20	20	40
2001	1,544	1,489	0	0	0	0	5	20	20	40
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0

M(min)=	0.020	Return time (m)=	1SW(min)	7	MSW(min)	16
M(max)=	0.040		1SW(max)	9	MSW(max)	18

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

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	30618	16749	1	3	1	3	40	60	50	70
1972	24832	25733	1	3	1	3	40	60	50	70
1973	26624	23183	1	3	1	3	40	60	50	70
1974	18975	20017	1	3	1	3	40	60	50	70
1975	29428	21266	1	3	1	3	40	60	50	70
1976	23233	18379	1	3	1	3	40	60	50	70
1977	23802	17919	1	3	1	3	40	60	50	70
1978	31199	23182	1	3	1	3	40	60	50	70
1979	28790	14840	1	3	1	3	40	60	50	70
1980	13073	20855	1	3	1	3	40	60	50	70
1981	16890	13919	1	3	1	3	40	60	50	70
1982	17331	9826	1	3	1	3	40	60	50	70
1983	21923	16423	1	3	1	3	40	60	50	70
1984	13476	13923	1	3	1	3	40	60	50	70
1985	21822	10097	1	3	1	3	40	60	50	70
1986	35891	8423	1	3	1	3	40	60	50	70
1987	22302	7480	1	3	1	3	40	60	50	70
1988	40028	8523	1	3	1	3	40	60	50	70
1989	22377	7607	1	3	1	3	40	60	50	70
1990	20584	7548	1	3	1	3	40	60	50	70
1991	22711	7519	1	3	1	3	40	60	50	70
1992	26006	8479	1	3	1	3	40	60	50	70
1993	25479	4155	1	3	1	3	40	60	50	70
1994	20985	6736	1	3	1	3	40	60	50	70
1995	25371	6777	1	3	1	3	40	60	50	70
1996	21913	4364	1	3	1	3	40	60	50	70
1997	16007	4910	1	3	1	3	40	60	50	70
1998	21900	3037	1	3	1	3	40	60	50	70
1999	17448	5757	1	3	1	3	40	60	50	70
2000	15502	1519	1	3	1	3	40	60	50	70
2001	13586	2707	1	3	1	3	40	60	50	70
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0

M(min)=	0.020	Return time (m)=	1SW(min)	7	MSW(min)	16
M(max)=	0.040		1SW(max)	9	MSW(max)	18

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

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	4610	6625	1	3	1	3	40	60	50	70
1972	4223	10337	1	3	1	3	40	60	50	70
1973	5060	9672	1	3	1	3	40	60	50	70
1974	5047	9176	1	3	1	3	40	60	50	70
1975	6152	10136	1	3	1	3	40	60	50	70
1976	6184	8350	1	3	1	3	40	60	50	70
1977	8597	11631	1	3	1	3	40	60	50	70
1978	8739	14998	1	3	1	3	40	60	50	70
1979	8363	9897	1	3	1	3	40	60	50	70
1980	1268	13784	1	3	1	3	40	60	50	70
1981	6528	4827	1	3	1	3	40	60	50	70
1982	3007	5539	1	3	1	3	40	60	50	70
1983	4437	4224	1	3	1	3	40	60	50	70
1984	1611	5447	1	3	1	3	40	60	50	70
1985	11116	3511	1	3	1	3	40	60	50	70
1986	13827	9569	1	3	1	3	40	60	50	70
1987	8145	9908	1	3	1	3	40	60	50	70
1988	11775	6381	1	3	1	3	40	60	50	70
1989	6342	5414	1	3	1	3	40	60	50	70
1990	4752	5709	1	3	1	3	40	60	50	70
1991	6900	3965	1	3	1	3	40	60	50	70
1992	12996	5903	1	3	1	3	40	60	50	70
1993	10689	6672	1	3	1	3	40	60	50	70
1994	3414	5656	1	3	1	3	40	60	50	70
1995	8776	3511	1	3	1	3	40	60	50	70
1996	4681	4605	1	3	1	3	40	60	50	70
1997	6406	2594	1	3	1	3	40	60	50	70
1998	10905	3780	1	3	1	3	40	60	50	70
1999	5326	4030	1	3	1	3	40	60	50	70
2000	5595	2324	1	3	1	3	40	60	50	70
2001	4976	2587	1	3	1	3	40	60	50	70
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0

M(min)=	0.020	Return time (m)=	1SW(min)	7	MSW(min)	16
M(max)=	0.040		1SW(max)	9	MSW(max)	18

table 3.3.3.1e Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - All IRELAND.

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	410,949	46,709	30.00	45.00	30.00	45.00	56.48	75.30	35.00	60.00
1972	438,707	50,050	30.00	45.00	30.00	45.00	56.48	75.30	35.00	60.00
1973	477,454	54,173	30.00	45.00	30.00	45.00	56.48	75.30	35.00	60.00
1974	545,115	61,335	30.00	45.00	30.00	45.00	56.48	75.30	35.00	60.00
1975	601,219	68,587	30.00	45.00	30.00	45.00	56.48	75.30	35.00	60.00
1976	409,020	47,605	30.00	45.00	30.00	45.00	56.48	75.30	35.00	60.00
1977	354,185	41,551	30.00	45.00	30.00	45.00	56.48	75.30	35.00	60.00
1978	310,167	36,025	30.00	45.00	30.00	45.00	56.48	75.30	35.00	60.00
1979	286,173	32,562	30.00	45.00	30.00	45.00	56.48	75.30	35.00	60.00
1980	218,566	36,027	30.00	45.00	30.00	45.00	56.48	75.30	35.00	60.00
1981	136,478	25,936	30.00	45.00	30.00	45.00	42.32	56.43	35.00	60.00
1982	270,004	11,763	30.00	45.00	30.00	45.00	57.49	76.65	28.34	81.47
1983	438,823	26,541	30.00	45.00	30.00	45.00	56.24	74.99	10.34	45.41
1984	227,898	20,959	30.00	45.00	30.00	45.00	50.21	66.95	37.02	50.00
1985	433,834	19,059	30.00	45.00	30.00	45.00	61.67	82.22	31.18	39.45
1986	445,335	27,230	30.00	45.00	30.00	45.00	59.28	79.04	36.95	54.30
1987	311,223	25,267	20.00	40.00	20.00	40.00	55.85	74.47	27.50	36.86
1988	394,213	22,220	20.00	40.00	20.00	40.00	53.27	71.03	31.85	94.21
1989	299,210	25,569	20.00	40.00	20.00	40.00	58.88	78.51	38.35	78.00
1990	171,265	15,481	20.00	40.00	20.00	40.00	55.24	73.66	53.85	76.69
1991	121,820	10,456	20.00	40.00	20.00	40.00	51.56	68.75	30.47	61.54
1992	184,259	15,620	20.00	40.00	20.00	40.00	62.95	83.94	46.91	55.26
1993	139,623	12,301	15.00	35.00	15.00	35.00	49.85	66.47	23.59	56.43
1994	227,192	19,949	15.00	35.00	15.00	35.00	54.69	72.93	38.06	62.08
1995	225,766	19,915	15.00	35.00	15.00	35.00	66.90	89.20	40.65	46.62
1996	195,771	17,365	15.00	35.00	15.00	35.00	53.75	71.66	51.93	58.2828
1997	165,319	14,285	10.00	20.00	10.00	20.00	58.23	77.64	18.51	48.88
1998	190,226	17,135	10.00	20.00	10.00	20.00	51.29	68.39	60.47	63.25
1999	156,730	14,635	10.00	20.00	10.00	20.00	66.31	88.41	42.70	52.29
2000	197,042	16,625	10.00	10.00	10.00	10.00	63.56	84.75	26.51	37.51
2001	254,695	21,581	5	10	5	10	64	85	27	38
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0

M(min)= 0.020 Return time (m)= 1SW(min) 7 MSW(min) 16
M(max)= 0.040 1SW(max) 9 MSW(max) 18

Table 3.3.3.1f Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - NORWAY-Total pre-1983

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	212,691	129,618	40	60	40	60	70	90	70	90
1972	248,705	178,591	40	60	40	60	70	90	70	90
1973	243,685	204,556	40	60	40	60	70	90	70	90
1974	232,609	191,988	40	60	40	60	70	90	70	90
1975	233,720	164,641	40	60	40	60	70	90	70	90
1976	219,705	170,758	40	60	40	60	70	90	70	90
1977	226,835	170,296	40	60	40	60	70	90	70	90
1978	185,328	111,848	40	60	40	60	70	90	70	90
1979	333,578	197,717	40	60	40	60	70	90	70	90
1980	233,103	232,347	40	60	40	60	70	90	70	90
1981	230,572	204,381	40	60	40	60	70	90	70	90
1982	178,754	166,244	40	60	40	60	70	90	70	90
1983	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0

M(min)=	0.020	Return time (m)=	1SW(min)	7	MSW(min)	16
M(max)=	0.040		1SW(max)	9	MSW(max)	18

Table 3.3.3.1g Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - NORWAY-N (1983 onwards)

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0
1983	104,040	49,413	40	60	40	60	70	90	70	90
1984	150,372	58,858	40	60	40	60	70	90	70	90
1985	118,841	58,956	40	60	40	60	70	90	70	90
1986	84,150	63,418	40	60	40	60	70	90	70	90
1987	72,370	34,232	40	60	40	60	70	90	70	90
1988	53,880	32,140	40	60	40	60	70	90	70	90
1989	42,010	13,934	40	60	40	60	60	80	60	80
1990	38,216	17,321	40	60	40	60	60	80	60	80
1991	42,888	21,789	40	60	40	60	60	80	60	80
1992	34,593	19,265	40	60	40	60	60	80	60	80
1993	51,440	39,014	30	50	30	50	60	80	60	80
1994	37,489	33,411	30	50	30	50	60	80	60	80
1995	36,283	26,037	30	50	30	50	60	80	60	80
1996	40,792	36,636	30	50	30	50	60	80	60	80
1997	39,930	30,115	25	45	25	45	60	80	60	80
1998	46,645	34,806	25	45	25	45	60	80	60	80
1999	46,394	46,744	25	45	25	45	60	80	60	80
2000	61,854	51,569	25	45	25	45	60	80	60	80
2001	46,806	59,026	25	45	25	45	60	80	60	80
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0

M(min)=	0.020	Return time (m)=	1SW(min)	7	MSW(min)	16
M(max)=	0.040		1SW(max)	9	MSW(max)	18

Table3.3.3.1h Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - NORWAY-Middle (1983 onwards)

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0
1983	121,221	74,648	40	60	40	60	65	85	65	85
1984	94,373	67,639	40	60	40	60	65	85	65	85
1985	114,613	56,641	40	60	40	60	65	85	65	85
1986	106,921	77,225	40	60	40	60	65	85	65	85
1987	83,669	62,216	40	60	40	60	65	85	65	85
1988	80,111	45,609	40	60	40	60	65	85	65	85
1989	94,897	30,862	40	60	40	60	55	75	55	75
1990	78,888	40,174	40	60	40	60	55	75	55	75
1991	67,370	30,087	40	60	40	60	55	75	55	75
1992	51,463	33,092	40	60	40	60	55	75	55	75
1993	58,326	28,184	30	50	30	50	55	75	55	75
1994	113,427	33,520	30	50	30	50	55	75	55	75
1995	57,813	42,696	30	50	30	50	55	75	55	75
1996	28,925	31,613	30	50	30	50	55	75	55	75
1997	43,127	20,565	25	45	25	45	50	70	50	70
1998	63,497	26,817	25	45	25	45	50	70	50	70
1999	60,689	28,792	25	45	25	45	50	70	50	70
2000	109,278	42,452	25	45	25	45	50	70	50	70
2001	88,096	52,031	25	45	25	45	50	70	50	70
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0

M(min)=	0.020	Return time (m)=	1SW(min)	7	MSW(min)	16
M(max)=	0.040		1SW(max)	9	MSW(max)	18

Table 3.3.3.1i Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - NORWAY-South (1983 onwards)

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0
1979	11,597	7,054	40	60	40	60	65	85	65	85
1980	4,965	7,770	40	60	40	60	65	85	65	85
1981	6,173	7,948	40	60	40	60	65	85	65	85
1982	8,734	8,382	40	60	40	60	65	85	65	85
1983	40,511	37,105	40	60	40	60	65	85	65	85
1984	34,248	38,614	40	60	40	60	65	85	65	85
1985	47,877	36,968	40	60	40	60	65	85	65	85
1986	51,839	41,890	40	60	40	60	65	85	65	85
1987	48,690	39,641	40	60	40	60	65	85	65	85
1988	53,775	37,145	40	60	40	60	65	85	65	85
1989	43,128	25,279	40	60	40	60	55	75	55	75
1990	44,259	25,907	40	60	40	60	55	75	55	75
1991	30,771	19,054	40	60	40	60	55	75	55	75
1992	32,488	24,124	40	60	40	60	55	75	55	75
1993	34,503	22,835	30	50	30	50	55	75	55	75
1994	42,551	20,903	30	50	30	50	55	75	55	75
1995	32,685	24,725	30	50	30	50	55	75	55	75
1996	27,739	26,029	30	50	30	50	55	75	55	75
1997	31,381	14,922	25	45	25	45	50	70	50	70
1998	38,299	16,966	25	45	25	45	50	70	50	70
1999	31,256	9,881	25	45	25	45	50	70	50	70
2000	54,671	22,208	25	45	25	45	50	70	50	70
2001	59,425	29,896	25	45	25	45	50	70	50	70
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0

M(min)=	0.020	Return time (m)=	1SW(min)	7	MSW(min)	16
M(max)=	0.040		1SW(max)	9	MSW(max)	18

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

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	134	16,592	5	15	5	15	40	80	40	80
1972	116	14,434	5	15	5	15	40	80	40	80
1973	169	20924	5	15	5	15	40	80	40	80
1974	170	21137	5	15	5	15	40	80	40	80
1975	140	17398	5	15	5	15	40	80	40	80
1976	111	13781	5	15	5	15	40	80	40	80
1977	78	9722	5	15	5	15	40	80	40	80
1978	82	10134	5	15	5	15	40	80	40	80
1979	112	13903	5	15	5	15	40	80	40	80
1980	156	19397	5	15	5	15	40	80	40	80
1981	68	8394	5	15	5	15	40	80	40	80
1982	71	8797	5	15	5	15	40	80	40	80
1983	48	11938	5	15	5	15	40	80	40	80
1984	21	10680	5	15	5	15	40	80	40	80
1985	454	11183	5	15	5	15	40	80	40	80
1986	12	12291	5	15	5	15	40	80	40	80
1987	647	8734	5	15	5	15	40	80	40	80
1988	224	9978	5	15	5	15	40	80	40	80
1989	989	10245	5	15	5	15	40	80	40	80
1990	1418	8429	10	20	10	20	40	80	40	80
1991	421	8725	15	25	15	25	40	80	40	80
1992	1031	3949	20	30	20	30	40	80	40	80
1993	196	4251	25	35	25	35	40	80	40	80
1994	334	5631	30	40	30	40	40	80	40	80
1995	386	5214	40	50	40	50	40	80	40	80
1996	231	3753	50	60	50	60	40	80	40	80
1997	721	3351	50	60	50	60	40	80	40	80
1998	585	4208	50	60	50	60	40	80	40	80
1999	299	3101	50	60	50	60	40	80	40	80
2000	514	3382	50	60	50	60	40	80	40	80
2001	363	2348	50	60	50	60	40	80	40	80
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0

M(min)=	0.020	Return time (m)	1SW(min)	7	MSW(min)	19
M(max)=	0.040		1SW(max)	8	MSW(max)	21

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

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	4892	5979	10	20	10	20	40	50	40	50
1972	7978	9750	10	20	10	20	40	50	40	50
1973	9376	11460	10	20	10	20	35	45	35	45
1974	12794	15638	10	20	10	20	35	45	35	45
1975	13872	13872	10	20	10	20	40	50	40	50
1976	11493	14048	10	20	10	20	50	60	50	60
1977	7257	8253	10	20	10	20	45	55	45	55
1978	7106	7113	10	20	10	20	50	60	50	60
1979	6707	3141	10	20	10	20	35	45	35	45
1980	6621	5216	10	20	10	20	35	45	35	45
1981	4547	5973	10	20	10	20	35	45	35	45
1982	5159	4798	10	20	10	20	30	40	30	40
1983	8504	9943	10	20	10	20	30	40	30	40
1984	9453	12601	10	20	10	20	30	40	30	40
1985	6774	7877	10	20	10	20	30	40	30	40
1986	10147	5352	10	20	10	20	35	45	35	45
1987	8560	5149	10	20	10	20	35	45	35	45
1988	6644	3655	10	20	10	20	30	40	30	40
1989	13424	6787	10	20	10	20	35	45	35	45
1990	16038	8234	10	20	10	20	35	45	35	45
1991	4550	7568	10	20	10	20	25	35	25	35
1992	11394	7109	10	20	10	20	25	35	25	35
1993	8642	5690	10	20	10	20	25	35	25	35
1994	6101	4632	10	20	10	20	25	35	25	35
1995	6318	3693	10	20	10	20	25	35	25	35
1996	6815	1701	15	25	15	25	20	30	20	30
1997	3564	867	20	30	20	30	10	20	10	20
1998	1854	280	30	40	30	40	10	15	10	15
1999	1510	424	35	45	35	45	5	10	5	10
2000	805	323	45	55	45	55	4	8	4	8
2001	591	241	55	65	55	65	2	5	2	5
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0

M(min)=	0.020	Return time (m)	1SW(min)	6	MSW(min)	17
M(max)=	0.040		1SW(max)	8	MSW(max	20

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

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	67845	29077	1	5	1	5	40	60	50	70
1972	45837	19644	1	5	1	5	40	60	50	70
1973	68684	29436	1	5	1	5	40	60	50	70
1974	63892	27382	1	5	1	5	40	60	50	70
1975	109038	46730	1	5	1	5	40	60	50	70
1976	76281	41075	1	5	1	5	40	60	50	70
1977	47943	32392	1	5	1	5	40	60	50	70
1978	49291	17307	1	5	1	5	40	60	50	70
1979	69511	21369	1	5	1	5	40	60	50	70
1980	46037	23241	1	5	1	5	40	60	50	70
1981	40172	12747	1	5	1	5	40	60	50	70
1982	32619	14840	1	5	1	5	40	60	50	70
1983	54217	20840	1	5	1	5	40	60	50	70
1984	56786	16893	1	5	1	5	40	60	50	70
1985	87274	16876	1	5	1	5	40	60	50	70
1986	72102	17681	1	5	1	5	40	60	50	70
1987	79639	12501	1	5	1	5	40	60	40	60
1988	44813	18777	1	5	1	5	40	50	40	50
1989	53293	11448	5	10	5	10	40	50	40	50
1990	44409	11152	10	15	10	15	40	50	40	50
1991	31978	6263	15	20	15	20	30	40	30	40
1992	23827	3680	20	25	20	25	20	30	20	30
1993	20987	5552	20	30	20	30	20	30	20	30
1994	25178	3680	25	35	25	35	20	30	10	20
1995	19381	2847	30	40	30	40	20	30	10	20
1996	27097	2710	30	40	30	40	20	30	10	20
1997	27695	2085	30	40	30	40	20	30	10	20
1998	32693	1963	30	40	30	40	20	30	10	20
1999	22330	2841	30	40	30	40	20	30	10	20
2000	26376	4396	30	40	30	40	20	30	10	20
2001	21697	4622	30	40	30	40	20	30	10	20
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0

M(min)=	0.020	Return time (m)	1SW(min)	7	MSW(min)	18
M(max)=	0.040		1SW(max)	10	MSW(max)	21

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

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	605	17,728	10	30	10	30	50	80	50	80
1972	825	24,175	10	30	10	30	50	80	50	80
1973	1,705	49,962	10	30	10	30	50	80	50	80
1974	1,320	38,680	10	30	10	30	50	80	50	80
1975	1,298	38,046	10	30	10	30	50	80	50	80
1976	991	34,394	10	30	10	30	50	80	50	80
1977	589	20,464	10	30	10	30	50	80	50	80
1978	759	26,341	10	30	10	30	50	80	50	80
1979	421	14,614	10	30	10	30	50	80	50	80
1980	1,123	39,001	10	30	10	30	50	80	50	80
1981	126	20,874	10	30	10	30	50	80	50	80
1982	54	13,546	10	30	10	30	50	80	50	80
1983	598	16,002	10	30	10	30	50	80	50	80
1984	1,833	15,967	10	30	10	30	50	80	50	80
1985	2,763	29,738	10	30	10	30	50	80	50	80
1986	66	32,734	10	30	10	30	50	80	50	80
1987	21	21,179	10	30	10	30	50	80	50	80
1988	3,184	12,816	10	30	10	30	50	80	50	80
			Input data for analisis of total adult returns to Home Waters				Input data for spawners abundance analysis			
Year	Estimated numbers of adult returns to fresh water		Soltwater Unrep. as % of adult returns to FW 1SW		Soltwater Unrep. as % of adult returns to FW MSW		Freshwater Unrep. as % of adult returns to FW 1SW		Freshwater Unrep. as % of adult returns to FW MSW	
	1SW	MSW	min	max	min	max	min	max	min	max
1989	24,596	27,404	5	15	5	15	50	80	50	80
1990	50	49,950	5	15	5	15	50	80	50	80
1991	7,975	47,025	5	15	5	15	50	80	50	80
1992	550	54,450	5	15	5	15	50	80	50	80
1993	68	67,932	5	15	5	15	50	80	50	80
1994	3,900	48,100	5	15	5	15	50	80	50	80
1995	9,280	70,720	5	15	5	15	50	80	50	80
1996	8,664	48,336	5	15	5	15	50	80	50	80
1997	1,440	38,560	5	15	5	15	50	80	50	80
1998	780	59,220	5	15	5	15	50	80	50	80
1999	2,120	37,880	5	15	5	15	50	80	50	80
2000	84	83,916	5	15	5	15	50	80	50	80
2001	31,636	12,364	5	15	5	15	50	80	50	80
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0

M(min)=	0.020	Return time (m)=	1SW(min)	7	MSW(min)	19
M(max)=	0.040		1SW(max)	8	MSW(max)	21

Table 3.3.3.1n Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - SWEDEN

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	6,330	420	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	55	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	3,573	1,460	5	25	5	25	55	90	55	90
2000	7,103	3,196	5	25	5	25	55	90	55	90
2001	4,634	3,853	5	25	5	25	55	90	55	90
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0

M(min)=	0.020	Return time (m)=	1SW(min)	7	MSW(min)	16
M(max)=	0.040		1SW(max)	9	MSW(max)	18

Table 3.3.3.1o Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - UK(England and Wales).

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	28915	23611	25	45	25	45	35	55	30	50
1972	24613	34364	25	45	25	45	33	53	29	49
1973	28989	26097	25	45	25	45	33	53	29	49
1974	35431	18776	25	45	25	45	33	53	29	49
1975	36465	25819	25	45	25	45	33	53	29	49
1976	25422	14113	25	45	25	45	34	54	30	50
1977	27836	17260	25	45	25	45	36	56	30	50
1978	31397	14228	25	45	25	45	36	56	30	50
1979	29030	6803	25	45	25	45	34	54	29	49
1980	26997	22019	25	45	25	45	35	55	30	50
1981	28414	31115	25	45	25	45	35	55	30	50
1982	24139	12003	25	45	25	45	36	56	30	50
1983	35903	13861	25	45	25	45	36	56	30	50
1984	31923	11355	25	45	25	45	38	58	30	50
1985	30759	16020	25	45	25	45	38	58	31	51
1986	35695	21822	25	45	25	45	38	58	30	50
1987	36339	17101	25	45	25	45	37	57	30	50
1988	47242	21225	25	45	25	45	37	57	30	50
1989	32559	17532	20	40	20	40	38	58	30	50
1990	23635	21817	20	40	20	40	38	58	31	51
1991	22408	9152	20	40	20	40	36	56	30	50
1992	22233	6641	20	40	20	40	36	56	30	50
1993	29963	7028	30	60	30	60	33	53	28	48
1994	40610	12130	30	60	30	60	33	53	28	48
1995	29211	11360	15	25	15	25	32	52	25	45
1996	21294	11466	15	25	15	25	29	49	25	45
1997	18201	6732	15	25	15	25	27	47	22	42
1998	19271	3947	15	25	15	25	25	45	20	40
1999	14678	6291	15	25	15	25	22	42	11	31
2000	22466	5972	15	25	15	25	20	40	10	30
2001	18172	6057	0	0	0	0	20	40	7	27
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0

M(min)= 0.020 Return time (m)= 1SW(min) 7 MSW(min) 17
M(max)= 0.040 1SW(max) 9 MSW(max) 19

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

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	79,715	4,196	10	33	10	33	75	85	45	55
1972	66,054	3,477	10	33	10	33	75	85	45	55
1973	58,705	3,090	10	33	10	33	75	85	45	55
1974	74,148	3,903	10	33	10	33	75	85	45	55
1975	52,159	2,745	10	33	10	33	75	85	45	55
1976	36,984	1,947	10	33	10	33	75	85	45	55
1977	37,295	1,963	10	33	10	33	75	85	45	55
1978	45,515	2,396	10	33	10	33	75	85	45	55
1979	35,153	1,850	10	33	10	33	75	85	45	55
1980	46,762	2,461	10	33	10	33	75	85	45	55
1981	33,042	1,739	10	33	10	33	75	85	45	55
1982	57,149	3,008	10	33	10	33	75	85	45	55
1983	79,089	4,163	10	33	10	33	75	85	45	55
1984	28,055	1,477	10	33	10	33	75	85	45	55
1985	38,495	2,026	10	33	10	33	75	85	45	55
1986	44,036	2,318	10	33	10	33	75	85	45	55
1987	17,559	924	10	33	10	33	62	76	41	51
1988	44,920	2,364	10	33	10	33	58	71	32	40
1989	61,585	3,241	10	37	10	37	80	98	54	66
1990	40,732	2,144	10	17	10	17	56	68	34	42
1991	22,176	1,167	10	17	10	17	58	71	39	47
1992	40,144	2,113	10	23	10	23	50	62	30	36
1993	36,127	1,901	10	17	10	17	37	45	11	13
1994	36,921	1,943	10	28	10	28	63	77	36	44
1995	34,116	1,796	10	17	10	17	60	74	38	46
1996	29,017	1,527	10	20	10	20	47	67	24	44
1997	41,765	2,198	5	15	5	15	50	70	24	44
1998	37,953	1,998	5	15	5	15	20	30	15	30
1999	22,126	1,165	5	15	5	15	58	68	25	40
2000	31,038	1,634	5	15	5	15	53	63	25	40
2001	21,827	1,149	0	10	0	10	45	55	25	35
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0

M(min)= 0.020 Return time (m)= 1SW(min) 7 MSW(min) 16
M(max)= 0.040 1SW(max) 9 MSW(max) 18

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

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	36,270	1,909	10	33	10	33	75	85	45	55
1972	35,293	1,858	10	33	10	33	75	85	45	55
1973	29,858	1,571	10	33	10	33	75	85	45	55
1974	22,787	1,199	10	33	10	33	75	85	45	55
1975	27,275	1,436	10	33	10	33	75	85	45	55
1976	18,270	962	10	33	10	33	75	85	45	55
1977	17,139	902	10	33	10	33	75	85	45	55
1978	25,391	1,336	10	33	10	33	75	85	45	55
1979	14,631	770	10	33	10	33	75	85	45	55
1980	16,310	858	10	33	10	33	75	85	45	55
1981	16,338	860	10	33	10	33	75	85	45	55
1982	14,370	756	10	33	10	33	75	85	45	55
1983	21,293	1,121	10	33	10	33	75	85	45	55
1984	11,348	597	10	33	10	33	75	85	45	55
1985	12,635	665	10	33	10	33	75	85	45	55
1986	13,443	708	10	33	10	33	75	85	45	55
1987	9,439	497	10	33	10	33	62	76	41	51
1988	14,628	770	10	33	10	33	58	71	32	40
1989	15,405	811	10	37	10	37	80	98	54	66
1990	9,703	510	10	17	10	17	56	68	34	42
1991	7,137	376	10	17	10	17	58	71	39	47
1992	9,546	502	10	23	10	23	50	62	30	36
1993	8,075	425	10	17	10	17	37	45	11	13
1994	11,446	602	10	28	10	28	63	77	36	44
1995	11,887	625	10	17	10	17	60	74	38	46
1996	10,606	558	10	20	10	20	47	67	24	44
1997	10,705	563	5	15	5	15	50	70	24	44
1998	9,577	504	5	15	5	15	20	30	15	30
1999	9,205	484	5	15	5	15	58	68	25	40
2000	10,826	570	5	15	5	15	53	63	25	40
2001	8278	436	0	10	0	10	45	55	25	35
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0

M(min)= 0.020 Return time (m)= 1SW(min) 7 MSW(min) 16
M(max)= 0.040 1SW(max) 9 MSW(max) 18

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

Year	Catch (numbers)		Catch of Scottish fish in England	Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	(% 1SW)	min	max	min	max	min	max	min	max
			70%								
1971	216,873	135,527	57,335	15	35	15	35	62.8	87.9	39.9	59.9
1972	220,106	183,872	49,097	15	35	15	35	64.0	89.6	41.2	61.7
1973	259,773	204,825	59,700	15	35	15	35	62.4	87.4	39.9	59.8
1974	245,424	158,951	50,118	15	35	15	35	68.3	95.6	45.1	67.6
1975	181,940	180,828	50,778	15	35	15	35	67.1	93.9	44.0	66.1
1976	150,069	92,179	14,759	15	35	15	35	63.8	89.3	40.5	60.8
1977	154,306	118,645	49,186	15	35	15	35	67.9	95.0	44.6	66.9
1978	158,844	139,688	47,500	15	35	15	35	63.0	88.2	40.8	61.2
1979	160,791	116,514	39,552	15	35	15	35	65.3	91.4	43.1	64.6
1980	101,665	155,646	41,202	10	25	10	25	64.0	89.6	41.6	62.4
1981	129,690	156,683	61,511	10	25	10	25	63.3	88.6	41.0	61.4
1982	175,355	113,180	44,147	10	25	10	25	59.2	82.9	36.2	54.3
1983	170,843	126,104	67,231	10	25	10	25	64.2	89.8	39.5	59.3
1984	175,675	90,829	50,994	10	25	10	25	58.4	81.8	35.1	52.7
1985	133,073	95,012	48,753	10	25	10	25	51.5	72.2	31.1	46.7
1986	180,276	128,813	53,277	10	25	10	25	49.6	69.4	30.0	45.1
1987	139,252	88,519	29,999	10	25	10	25	53.8	75.3	32.4	48.6
1988	118,580	91,068	41696	10	25	10	25	33.6	47.0	23.4	35.0
1989	142,992	85,348	33577	5	15	5	15	31.3	43.8	22.4	33.5
1990	63,297	73,954	41224	5	15	5	15	33.2	46.5	23.0	34.5
1991	53,835	53,676	20089	5	15	5	15	30.7	42.9	22.0	32.9
1992	79,883	67,968	15712	5	15	5	15	26.8	37.5	20.7	31.0
1993	73,396	60,496	32186	5	15	5	15	29.4	41.2	21.5	32.3
1994	80,555	72,746	35381	5	15	5	15	27.6	38.6	20.9	31.3
1995	72,986	69,115	39908	5	15	5	15	25.8	36.1	20.3	30.5
1996	56,617	50,361	13936	5	15	5	15	24.0	33.6	19.6	29.4
1997	37,465	34,841	16442	5	15	5	15	25.5	35.7	20.1	30.2
1998	44,915	32,264	13699	5	15	5	15	20.2	28.3	18.3	27.5
1999	20,840	26,979	20125	5	15	5	15	20.7	28.9	18.7	28.0
2000	31,191	36,735	32516	5	15	5	15	18.2	25.5	17.8	26.7
2001	28,372	32,570	27086	5	15	5	15	17.0	23.8	17.1	26.1
2002	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0

M(min)= 0.020 Return time (m)= 1SW(min) 7 MSW(min) 17
M(max)= 0.040 1SW(max) 8 MSW(max) 18

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

Year	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	45287	26074	25	45	25	45	31	44	20	30
1972	31359	34151	25	45	25	45	32	45	21	31
1973	33317	33095	25	45	25	45	31	44	20	30
1974	43992	29406	25	45	25	45	34	48	23	34
1975	40424	27150	25	45	25	45	34	47	22	33
1976	38423	22403	25	45	25	45	32	45	20	30
1977	39958	20342	25	45	25	45	34	48	22	33
1978	45626	23266	25	45	25	45	31	44	20	31
1979	26445	15995	25	45	25	45	33	46	22	32
1980	19776	16942	20	35	20	35	32	45	21	31
1981	21048	18038	20	35	20	35	32	44	20	31
1982	32706	15062	20	35	20	35	30	41	18	27
1983	38774	19857	20	35	20	35	32	45	20	30
1984	37404	16384	20	35	20	35	29	41	18	26
1985	24939	19636	20	35	20	35	26	36	16	23
1986	22579	19584	20	35	20	35	25	35	15	23
1987	25533	15475	20	35	20	35	27	38	16	24
1988	30518	21094	20	35	20	35	17	24	12	18
1989	31949	18538	15	25	15	25	16	22	11	17
1990	17797	13970	15	25	15	25	17	23	11	17
1991	19773	11517	15	25	15	25	15	21	11	16
1992	21793	14873	15	25	15	25	13	19	10	16
1993	21121	11230	15	25	15	25	15	21	11	16
1994	18904	12658	15	25	15	25	14	19	10	16
1995	16935	9337	15	25	15	25	13	18	10	15
1996	9796	7559	15	25	15	25	12	17	10	15
1997	9407	5586	15	25	15	25	13	18	10	15
1998	8532	6984	15	25	15	25	10	14	9	14
1999	4343	3672	15	25	15	25	10	14	9	14
2000	5466	7144	15	25	15	25	9	13	9	13
2001	4260	5690	15	25	15	25	9	12	9	13
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0

M(min)=	0.020	Return time (m)=	1SW(min)	7	MSW(min)	16
M(max)=	0.040		1SW(max)	9	MSW(max)	18

Table 3.3.3.1t Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - FAROES

Year n/n+1	Catch (numbers)		Unrep. as % of total 1SW		Unrep. as % of total MSW		Exp. rate 1SW (%)		Exp. rate MSW (%)	
	1SW	MSW	min	max	min	max	min	max	min	max
1971	2620	105796	5	15	0	0	100	100	100	100
1972	2754	111187	5	15	0	0	100	100	100	100
1973	3121	126012	5	15	0	0	100	100	100	100
1974	2186	88276	5	15	0	0	100	100	100	100
1975	2798	112984	5	15	0	0	100	100	100	100
1976	1830	73900	5	15	0	0	100	100	100	100
1977	1291	52112	5	15	0	0	100	100	100	100
1978	974	39309	5	15	0	0	100	100	100	100
1979	1736	70082	5	15	0	0	100	100	100	100
1980	4523	182616	5	15	0	0	100	100	100	100
1981	7443	300542	5	15	0	0	100	100	100	100
1982	6859	276957	5	15	0	0	100	100	100	100
1983	15861	215349	5	15	0	0	100	100	100	100
1984	5534	138227	5	15	0	0	100	100	100	100
1985	378	158103	5	15	0	0	100	100	100	100
1986	1979	180934	5	15	0	0	100	100	100	100
1987	90	166244	5	15	0	0	100	100	100	100
1988	8637	87629	5	15	0	0	100	100	100	100
1989	1788	121965	5	15	0	0	100	100	100	100
1990	1989	140054	5	15	0	0	100	100	100	100
1991	943	84935	5	15	0	0	100	100	100	100
1992	68	35700	5	15	0	0	100	100	100	100
1993	6	30023	5	15	0	0	100	100	100	100
1994	15	31672	5	15	0	0	100	100	100	100
1995	18	34662	5	15	0	0	100	100	100	100
1996	101	28381	5	15	0	0	100	100	100	100
1997	0	0	10	20	0	0	100	100	100	100
1998	339	1,424	10	20	0	0	100	100	100	100
1999	0	0	10	20	0	0	100	100	100	100
2000	225	1,765	10	20	0	0	100	100	100	100
2001	0	0	10	20	0	0	100	100	100	100
2002	0	0	0	0	0	0	100	100	100	100
2003	0	0	0	0	0	0	100	100	100	100
2004	0	0	0	0	0	0	100	100	100	100
2005	0	0	0	0	0	0	100	100	100	100

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

Prop'n 1SW returning as grilse = min 0.170
max 0.270

Table 3.3.3.1u Input data for NEAC Area Pre Fishery Abundance analysis using Monte Carlo simulation - WEST GREENLAND.

Year	Catch (numbers) 1SW	MSW	Unrep. as % of total 1SW min	max	Unrep. as % of total MSW min	max	Exp. rate 1SW (%) min	max	Exp. rate MSW (%) min	max
1971	0	856369	0	0	5	15	100	100	100	100
1972	0	614244	0	0	5	15	100	100	100	100
1973	0	560048	0	0	5	15	100	100	100	100
1974	0	535475	0	0	5	15	100	100	100	100
1975	0	650641	0	0	5	15	100	100	100	100
1976	0	386513	0	0	5	15	100	100	100	100
1977	0	442368	0	0	5	15	100	100	100	100
1978	0	293731	0	0	5	15	100	100	100	100
1979	0	417665	0	0	5	15	100	100	100	100
1980	0	370807	0	0	5	15	100	100	100	100
1981	0	398738	0	0	5	15	100	100	100	100
1982	0	346302	0	0	5	15	100	100	100	100
1983	0	100000	0	0	5	15	100	100	100	100
1984	0	95498	0	0	5	15	100	100	100	100
1985	0	301045	0	0	5	15	100	100	100	100
1986	0	316832	0	0	5	15	100	100	100	100
1987	0	305696	0	0	5	15	100	100	100	100
1988	0	280818	0	0	5	15	100	100	100	100
1989	0	117422	0	0	5	15	100	100	100	100
1990	0	101859	0	0	5	15	100	100	100	100
1991	0	178113	0	0	5	15	100	100	100	100
1992	0	84342	0	0	5	15	100	100	100	100
1993	0	2,000	0	0	-25	25	100	100	100	100
1994	0	2,000	0	0	-25	25	100	100	100	100
1995	0	32422	0	0	5	15	100	100	100	100
1996	0	31944	0	0	10	20	100	100	100	100
1997	0	21402	0	0	9	19	100	100	100	100
1998	0	3957	0	0	3	13	100	100	100	100
1999	0	6169	0	0	40	60	100	100	100	100
2000	0	8171	0	0	30	50	100	100	100	100
2001	0	15,412	0	0	14	24	100	100	100	100
2002	0	0	0	0	0	0	100	100	100	100
2003	0	0	0	0	0	0	100	100	100	100
2004	0	0	0	0	0	0	100	100	100	100
2005	0	0	0	0	0	0	100	100	100	100

M(min)= 0.020 Return time (m)= 1SW(min) 7 MSW(min) 8
M(max)= 0.040 1SW(max) 8 MSW(max) 10

Table 3.3.5.1 **Sensitivity of Pre-Fishery Abundance estimates for 1SW and MSW stocks in Northern and Southern Europe to changes in input data to run-reconstruction model. [Based upon input data used in 2002 assessment]**

Country	Sea age	Input data for 2001: Catch	Non-rep' rate	Exploit'n rate	Extra catch	Time	Recruits (PFA)	Effect of changing:- Non-rep' rate by by adding 0.1	Exp'n rate by by adding 0.1	Time by by adding 2.0	'm' by adding 0.01	Effect of changing: Non-rep' rate by multiplying 1.2	Exploit'n rate by multiplying 1.2
Northern European Stock Complex - 1SW													
Iceland 1	1SW	13,586	0.02	0.50		8.0	35,247	0.4%	-0.6%	0.2%		0.0%	-0.6%
Iceland 2	1SW	4,976	0.02	0.50		8.0	12,910	0.1%	-0.2%	0.1%		0.0%	-0.2%
Finland	1SW	12,829	0.25	0.65		8.0	33,454	0.5%	-0.4%	0.2%	applied	0.2%	-0.5%
Norway-N	1SW	59,739	0.35	0.70		8.0	166,908	**3.0%**	-2.0%	1.0%		2.0%	-2.7%
Norway-M	1SW	88,096	0.35	0.60		8.0	287,159	**5.1%**	**-4.0%**	1.7%	to	**3.4%**	**-4.7%**
Norway-S	1SW	59,425	0.35	0.60		8.0	193,703	**3.4%**	**-2.7%**	1.2%		2.3%	-3.1%
Sweden	1SW	4,634	0.15	0.73		8.0	9,559	0.1%	-0.1%	0.1%	total	0.0%	-0.2%
Russia (Pechora)	1SW	31,636	0.10	0.65		7.5	67,724	0.8%	-0.9%	0.4%		0.1%	-1.1%
Russia (Archangelsk)	1SW	363	0.55	0.60		7.5	1,684	0.0%	0.0%	0.0%	model	0.1%	0.0%
Russia (Kola-Barent)	1SW	591	0.60	0.04		7.0	45,569	1.5%	**-3.2%**	0.3%		1.9%	-0.7%
Russia (Kola-White)	1SW	21,697	0.35	0.25		8.5	172,302	**3.1%**	**-4.8%**	1.0%		2.0%	**-2.8%**
Faroes	1SW	0	0.15	1.00		0.5	0	-	-	-		-	-
Total Northern Area - 1SW:							**1,026,219**				**8.3%**		
Northern European Stock Complex -MSW													
Iceland 1	MSW	2,707	0.02	0.60		17.0	7,667	0.1%	-0.1%	0.1%		0.0%	-0.1%
Iceland 2	MSW	2,587	0.02	0.60		17.0	7,327	0.1%	-0.1%	0.1%		0.0%	-0.1%
Finland	MSW	14,139	0.25	0.55		17.0	57,080	1.0%	-1.0%	0.4%	applied	0.5%	-1.1%
Norway-N	MSW	68,585	0.35	0.70		17.0	251,020	**5.3%**	**-3.7%**	1.8%		**3.5%**	**-4.9%**
Norway-M	MSW	53,031	0.35	0.60		17.0	226,441	**4.8%**	**-3.8%**	1.6%	to	**3.2%**	**-4.4%**
Norway-S	MSW	29,896	0.35	0.60		17.0	127,655	**2.7%**	-2.1%	0.9%		1.8%	**-2.5%**
Sweden	MSW	3,853	0.15	0.73		17.0	10,412	0.2%	-0.1%	0.1%	total	0.0%	-0.2%
Russia (Pechora)	MSW	12,364	0.10	0.65		20.0	38,511	0.6%	-0.6%	0.3%		0.1%	-0.8%
Russia (Archangelsk)	MSW	2,348	0.55	0.60		20.0	15,846	0.5%	-0.3%	0.1%	model	0.6%	-0.3%
Russia (Kola-Barent)	MSW	241	0.60	0.04		20.0	27,446	1.1%	-2.3%	0.2%		1.4%	-0.5%
Russia (Kola-White)	MSW	4,622	0.35	0.15		19.5	85,092	1.8%	**-4.0%**	0.6%		1.2%	-1.7%
Faroes	MSW	0	0.00	1.00		1.5	0	-	-	-		-	-
Total Northern Area - MSW:							**854,495**				**19.2%**		
Southern European Stock Complex - 1SW													
France	1SW	1,544	0.00	0.13		8.0	15,702	0.2%	-0.7%	0.1%		0.0%	-0.3%
Ireland	1SW	254,695	0.08	0.74		8.0	475,589	**6.1%**	**-6.0%**	**3.1%**	applied	0.9%	**-8.3%**
UK(Eng&Wales)	1SW	18,172	0.20	0.30		8.0	96,255	1.4%	**-2.5%**	0.6%	to	0.5%	-1.7%
UK(N Ireland) 1	1SW	21,827	0.05	0.50		8.0	58,416	0.7%	-1.0%	0.4%	total	0.1%	-1.0%
UK(N Ireland) 2	1SW	8,278	0.05	0.50		8.0	22,155	0.3%	-0.4%	0.1%	model	0.0%	-0.4%
UK(Scotland) E	1SW	28,372	0.10	0.20	18,960	7.5	221,138	**2.6%**	**-6.9%**	1.4%		0.5%	**-3.5%**
UK(Scotland) W	1SW	4,260	0.20	0.11		8.0	61,540	0.9%	**-3.1%**	0.4%		0.3%	-1.1%
Greenland	1SW	0	0.00	1.00		7.5	0	-	-	-		-	-
Total Southern Area - 1SW:							**950,795**				**8.2%**		
Southern European Stock Complex - MSW													
France	MSW	1,489	0.00	0.30		17.0	8,265	0.1%	-0.3%	0.1%		0.0%	-0.2%
Ireland	MSW	21,581	0.08	0.32		17.0	122,074	2.4%	**-4.6%**	1.2%	applied	0.3%	**-3.2%**
UK(Eng&Wales)	MSW	6,057	0.20	0.17		18.0	76,425	1.7%	**-4.5%**	0.8%	to	0.6%	-2.0%
UK(N Ireland) 1	MSW	1,149	0.05	0.30		17.0	6,714	0.1%	-0.3%	0.1%	total	0.0%	-0.2%
UK(N Ireland) 2	MSW	436	0.05	0.30		17.0	2,548	0.0%	-0.1%	0.0%	model	0.0%	-0.1%
UK(Scotland) E	MSW	32,570	0.10	0.23	8,126	17.5	279,718	**5.3%**	**-12.8%**	**2.8%**		1.0%	**-7.1%**
UK(Scotland) W	MSW	5,690	0.20	0.11		17.0	107,676	2.4%	**-8.2%**	1.1%		0.9%	-2.9%
Greenland	MSW	15,412	0.18	1.00		9.0	24,621	-	-	-		-	-
Total Southern Area - MSW:							**628,042**				**18.6%**		

Table 3.3.6.1. Exploitation indices calculated for national salmon stocks in the Faroes and West Greenland fisheries.

Fishery	Faroes 1SW			Faroes MSW			WG (MSW)		
Country	Contrib'n of 1SW salmon (CF1)	PFA Estimate (k)	Expl. index CF1/PFA $*10^3$	Contrib'n of MSW salmon (CF2)	PFA Estimate (k)	Expl. index CF2/PFA $*10^3$	Contrib'n of MSW salmon (CG2)	PFA Estimate (k)	Expl. index CG2/PFA $*10^3$
Iceland	0	64.4	0.00	0.006	66.4	0.09	0.001	66.4	0.02
Russia	0.1	191.8	0.52	0.183	185.1	0.99	0.000	185.1	0.00
Finland	0.05	27.9	1.79	0	16.7	0.00	0.001	16.7	0.06
Norway	0.3	444.2	0.68	0.396	405.7	0.98	0.027	405.7	0.07
Sweden	0.05	15.5	3.23	0.023	14.6	1.58	0.003	14.6	0.21
		Av.	**0.74**		**Av.**	**0.97**		**Av.**	**0.05**
Scotland	0.2	500.9	0.40	0.192	418.4	0.46	0.645	418.4	1.54
N. Ireland	0.05	106.6	0.47	0	11.2	0.00	0.000	11.2	0.00
Ireland	0.1	425.2	0.24	0.057	63.9	0.89	0.147	63.9	2.30
Eng. &Wales	0.1	113	0.88	0.023	53.5	0.43	0.149	53.5	2.79
France	0.05	29.6	1.69	0	6.9	0.00	0.027	6.9	3.91
		Av.	**0.43**		**Av.**	**0.49**		**Av.**	**1.75**

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

	National Model CLs		River Specific CLs		Conservation Limit used	
	1SW	MSW	1SW	MSW	1SW	MSW
Northern Europe						
Finland	27,242	15,128			27,242	15,128
Iceland	35,651	7,649			35,651	7,649
Norway[1]	136,058	80,649			136,058	80,649
Russia	99,747	44,203			99,747	44,203
Sweden			2,720	830	2,720	830
				Conservation Limit :	301,417	148,459
				Spawner Escapement Reserve:	336,572	218,239

[1]Norwegian Conservation Limits calculated on data from 1983

	National Model CLs		River Specific CLs		Conservation Limit used	
	1SW	MSW	1SW	MSW	1SW	MSW
Southern Europe						
France			17,400	5,100	17,400	5,100
Ireland	201,253	38,276			201,253	38,276
UK (E&W)			53,000	17,500	53,000	17,500
UK (NI)	16,715	2,325			16,715	2,325
UK (Scot)	187,977	196,605			187,977	196,605
				Conservation Limit :	476,345	259,807
				Spawner Escapement Reserve:	605,553	438,490

Table 3.5.1.1 Estimated number of RETURNING 1SW salmon by NEAC country and year

Year	Northern Europe							Southern Europe							NEAC Area	
	Finland	Iceland	Norway	Russia	Sweden	Total		France	Ireland	UK(EW)	UK(NI)	UK(Scot)	Total		Total	
						Est.	SD						Est.	SD	Est.	SD
1971	26,113	72,946	544,827	156,042	12,028	**811,958**	76,543	53,345	1,000,593	101,290	186,726	617,566	**1,959,520**	125,554	**2,771,477**	147,046
1972	41,153	60,178	632,646	118,355	9,546	**861,877**	88,202	106,781	1,078,824	90,792	162,478	554,105	**1,992,980**	131,175	**2,854,857**	158,071
1973	52,480	65,430	618,109	175,352	11,887	**923,259**	86,440	64,212	1,178,311	107,700	142,395	653,323	**2,145,941**	145,471	**3,069,199**	169,215
1974	50,589	49,823	592,105	175,002	17,256	**884,775**	84,994	30,172	1,349,101	131,474	154,559	608,708	**2,274,015**	158,017	**3,158,790**	179,425
1975	71,954	73,441	597,043	268,447	18,290	**1,029,176**	88,625	60,040	1,483,073	133,964	127,606	503,017	**2,307,699**	174,174	**3,336,875**	195,426
1976	62,884	60,719	560,885	186,336	10,447	**881,270**	80,425	54,996	1,009,015	90,195	88,784	433,918	**1,676,907**	122,683	**2,558,178**	146,695
1977	42,010	67,046	576,384	118,424	4,871	**808,736**	80,023	42,319	869,308	95,740	87,272	444,456	**1,539,094**	106,578	**2,347,831**	133,276
1978	29,668	82,305	470,803	120,763	5,583	**709,123**	65,083	43,932	761,459	108,950	113,282	507,334	**1,534,957**	96,184	**2,244,080**	116,135
1979	35,535	76,832	876,544	166,381	5,898	**1,161,191**	116,669	50,283	702,019	104,257	80,046	411,550	**1,348,155**	87,473	**2,509,345**	145,819
1980	26,514	29,686	610,038	118,659	7,462	**792,359**	84,426	105,468	539,023	94,305	101,268	262,956	**1,103,020**	70,747	**1,895,379**	110,149
1981	19,237	48,326	608,930	98,131	13,670	**788,294**	83,297	82,645	448,600	98,623	79,185	329,409	**1,038,462**	62,499	**1,826,756**	104,137
1982	15,708	42,075	480,428	85,996	11,976	**636,183**	61,918	51,231	654,082	82,687	115,084	460,706	**1,363,789**	82,850	**1,999,973**	103,431
1983	24,371	54,543	706,104	143,869	15,848	**944,735**	62,840	54,517	1,074,623	121,761	160,828	461,233	**1,872,962**	123,984	**2,817,697**	138,999
1984	36,741	31,505	731,312	154,440	22,283	**976,281**	67,027	90,757	628,515	105,097	63,381	493,609	**1,381,358**	83,665	**2,357,639**	107,203
1985	42,145	68,173	747,741	212,047	26,576	**1,096,681**	68,128	33,705	979,856	100,607	81,741	410,366	**1,606,275**	112,055	**2,702,957**	131,140
1986	43,782	103,480	646,455	181,558	28,145	**1,003,420**	58,383	60,546	1,039,550	118,246	92,011	512,161	**1,822,515**	127,489	**2,825,935**	140,221
1987	57,470	62,941	543,418	192,859	22,811	**879,500**	50,927	109,151	692,345	120,461	50,352	398,011	**1,370,320**	106,615	**2,249,820**	118,154
1988	34,002	107,309	499,231	132,251	18,666	**791,459**	45,172	37,568	915,639	157,387	118,931	600,729	**1,830,254**	122,263	**2,621,713**	130,341
1989	53,403	59,402	556,971	197,284	6,112	**873,172**	52,858	19,722	634,388	98,916	114,832	663,206	**1,531,065**	93,415	**2,404,236**	107,333
1990	48,439	52,403	498,198	163,686	14,244	**776,970**	46,936	34,429	381,812	71,679	94,352	320,359	**902,631**	55,417	**1,679,601**	72,623
1991	50,861	61,074	432,553	139,237	17,213	**700,937**	41,450	24,145	292,410	70,150	52,689	313,763	**753,157**	44,823	**1,454,094**	61,050
1992	80,296	80,670	365,254	173,624	18,838	**718,681**	37,069	44,207	360,287	71,200	106,757	462,084	**1,044,534**	61,006	**1,763,216**	71,385
1993	48,354	75,008	365,811	148,131	20,387	**657,691**	32,505	63,410	322,797	131,169	125,124	406,842	**1,049,343**	64,471	**1,707,034**	72,202
1994	37,898	50,468	500,628	175,437	17,504	**781,934**	48,214	49,595	479,765	177,337	85,721	440,799	**1,233,217**	78,515	**2,015,151**	92,137
1995	34,410	70,884	323,418	157,723	24,895	**611,330**	31,506	15,497	389,769	89,305	79,558	430,211	**1,004,342**	55,643	**1,615,672**	63,944
1996	67,264	55,097	246,508	214,496	15,337	**598,702**	30,853	18,955	423,173	70,835	82,746	316,933	**912,643**	56,864	**1,511,344**	64,695
1997	54,359	46,382	283,238	211,089	6,964	**602,033**	31,950	9,608	288,261	64,050	98,409	226,019	**686,346**	33,218	**1,288,379**	46,090
1998	69,067	68,205	370,212	231,664	3,996	**743,144**	40,331	18,835	377,631	70,430	213,910	306,863	**987,670**	48,374	**1,730,814**	62,981
1999	101,270	47,236	342,494	177,779	5,925	**674,703**	35,087	6,405	241,435	60,910	55,404	152,406	**516,560**	27,382	**1,191,263**	44,507
2000	101,462	43,516	564,564	193,540	11,851	**914,933**	50,827	16,600	298,765	97,084	80,370	246,070	**738,889**	37,258	**1,653,822**	63,021
2001	57,720	38,652	488,682	216,918	7,664	**809,635**	44,872	14,252	373,879	78,293	63,669	227,337	**757,430**	40,139	**1,567,065**	60,205
10yr Av.	65,210	57,612	385,081	190,040	13,336	**711,279**	38,321	25,736	355,576	91,061	99,167	321,556	**893,097**	50,287	**1,604,376**	64,117

Table 3.5.1.2 Estimated number of RETURNING MSW salmon by NEAC country and year

Year	Northern Europe							Southern Europe							NEAC Area	
	Finland	Iceland	Norway	Russia	Sweden	Total		France	Ireland	UK(EW)	UK(NI)	UK(Scot)	Total		Total	
						Est.	SD						Est.	SD	**Est.**	SD
1971	24,530	40,041	328,586	132,460	874	**526,490**	46,641	11,295	162,150	81,429	15,733	551,857	**822,464**	65,475	**1,348,955**	80,389
1972	38,188	61,902	452,647	134,750	622	**688,109**	66,366	22,603	173,623	119,056	13,759	712,167	**1,041,208**	82,483	**1,729,317**	105,868
1973	48,712	56,690	522,071	224,083	2,116	**853,672**	75,752	13,758	188,351	90,619	12,036	785,380	**1,090,144**	90,465	**1,943,816**	117,993
1974	49,067	49,964	487,516	210,769	1,361	**798,678**	70,064	6,390	213,033	65,249	13,149	560,650	**858,471**	70,248	**1,657,149**	99,215
1975	70,453	53,898	417,221	225,427	333	**767,331**	59,022	12,831	238,275	88,896	10,737	615,980	**966,719**	79,569	**1,734,050**	99,070
1976	62,239	45,926	432,140	195,496	1,009	**736,810**	62,162	9,357	163,395	48,696	7,476	390,850	**619,773**	50,526	**1,356,584**	80,106
1977	40,963	50,771	431,863	134,623	742	**658,961**	61,431	7,081	143,918	59,309	7,404	418,244	**635,958**	50,861	**1,294,919**	79,754
1978	24,923	65,822	283,921	116,435	577	**491,678**	39,937	7,375	125,530	48,804	9,603	532,106	**723,418**	62,515	**1,215,096**	74,182
1979	23,361	42,368	525,140	101,886	1,669	**694,423**	69,934	8,443	112,825	23,505	6,753	397,180	**548,705**	47,394	**1,243,129**	84,481
1980	24,232	59,428	615,353	170,003	2,873	**871,888**	82,622	17,617	125,182	75,752	8,544	474,554	**701,649**	55,854	**1,573,538**	99,730
1981	29,551	32,122	541,185	96,739	846	**700,443**	74,441	12,528	89,632	106,434	6,694	492,977	**708,264**	55,499	**1,408,707**	92,853
1982	37,711	26,297	446,775	85,394	3,043	**599,219**	57,272	7,590	37,571	41,081	9,687	416,573	**512,502**	43,925	**1,111,722**	72,177
1983	43,035	35,369	431,535	124,658	2,109	**636,706**	39,315	8,260	176,443	47,704	13,720	449,502	**695,629**	87,517	**1,332,335**	95,942
1984	40,579	33,297	437,837	124,050	2,940	**638,704**	38,090	13,536	78,426	38,397	5,342	375,126	**510,827**	37,147	**1,149,531**	53,205
1985	38,212	23,370	404,348	135,778	1,234	**602,942**	35,325	10,165	87,238	54,629	6,912	454,347	**613,292**	44,567	**1,216,234**	56,869
1986	26,652	30,762	484,271	134,178	1,178	**677,041**	42,443	10,280	97,153	74,218	7,783	583,717	**773,151**	60,739	**1,450,191**	74,099
1987	33,811	29,903	362,716	99,560	3,563	**529,554**	32,015	5,395	113,378	58,499	3,958	384,889	**566,120**	40,850	**1,095,674**	51,901
1988	23,020	25,544	305,964	99,890	3,389	**457,808**	26,328	15,421	55,495	72,232	11,252	597,699	**752,099**	60,885	**1,209,907**	66,334
1989	30,672	22,306	217,253	97,671	9,653	**377,555**	20,971	7,023	65,048	55,411	8,958	521,074	**657,514**	49,066	**1,035,069**	53,360
1990	29,971	22,734	258,733	124,912	6,546	**442,896**	24,149	7,023	34,688	68,435	8,107	427,031	**545,284**	39,896	**988,180**	46,635
1991	38,390	19,719	217,387	122,330	7,508	**405,335**	20,770	6,395	34,187	29,319	4,177	332,331	**406,409**	31,988	**811,744**	38,139
1992	37,238	24,668	235,542	116,504	9,843	**423,795**	22,063	8,310	43,791	21,252	9,553	447,750	**530,657**	40,678	**954,452**	46,275
1993	39,625	18,526	227,375	137,721	13,091	**436,339**	19,578	3,949	44,001	30,759	22,470	365,718	**466,897**	35,673	**903,236**	40,692
1994	34,906	21,264	223,014	122,735	9,751	**411,669**	20,088	7,889	54,554	51,742	7,912	448,183	**570,280**	43,376	**981,949**	47,802
1995	26,093	17,704	238,518	139,442	6,144	**427,901**	20,652	3,816	61,058	35,737	6,700	412,223	**519,533**	39,770	**947,434**	44,812
1996	18,371	15,446	237,920	104,854	7,798	**384,389**	19,961	6,710	42,395	36,596	7,509	314,583	**407,793**	30,533	**792,181**	36,478
1997	25,358	12,842	159,425	85,538	5,083	**288,246**	14,264	3,442	53,806	23,147	9,359	218,706	**308,461**	25,693	**596,708**	29,387
1998	22,748	11,700	191,972	105,848	2,853	**335,121**	16,148	2,909	32,663	14,509	12,919	240,224	**303,223**	22,007	**638,345**	27,295
1999	21,233	16,805	206,179	93,879	2,420	**340,515**	18,268	6,328	36,511	35,074	5,715	176,325	**259,953**	19,064	**600,468**	26,403
2000	44,952	6,598	283,271	163,092	5,331	**503,244**	24,369	4,422	58,472	35,697	7,672	276,854	**383,117**	27,578	**886,361**	36,802
2001	63,962	9,148	345,875	90,564	6,474	**516,022**	29,931	5,183	73,919	43,929	5,629	244,804	**373,465**	28,843	**889,487**	41,566
10yr Av.	33,449	15,470	234,909	116,018	6,879	**406,724**	20,532	5,296	50,117	32,844	9,544	314,537	**412,338**	31,321	**819,062**	37,751

Table 3.5.1.3 Estimated pre-fishery abundance of MATURING 1SW salmon (potential 1SW returns) by NEAC country and year

Year	Northern Europe							Southern Europe							NEAC Area	
	Finland	Iceland	Norway	Russia	Sweden	Total		France	Ireland	UK(EW)	UK(NI)	UK(Scot)	Total		Total	
						Est.	SD						Est.	SD	Est.	SD
1971	33,347	92,931	695,066	200,980	15,455	**1,037,779**	103,559	68,102	1,273,877	129,042	238,106	779,272	**2,488,399**	172,524	**3,526,178**	201,219
1972	52,500	76,683	807,165	151,868	12,300	**1,100,517**	119,965	136,172	1,373,989	115,735	207,278	698,462	**2,531,635**	184,475	**3,632,152**	220,051
1973	66,929	83,355	788,780	225,023	15,299	**1,179,385**	118,156	81,975	1,500,225	137,253	181,661	823,313	**2,724,428**	200,788	**3,903,813**	232,974
1974	64,470	63,477	754,844	223,921	22,080	**1,128,792**	112,187	38,570	1,717,847	167,389	197,073	767,478	**2,888,358**	221,187	**4,017,150**	248,012
1975	91,692	93,567	762,122	344,736	23,445	**1,315,563**	122,668	76,661	1,888,616	170,616	162,792	634,951	**2,933,636**	244,036	**4,249,199**	273,132
1976	80,099	77,333	715,440	239,340	13,398	**1,125,610**	109,433	70,167	1,284,389	114,877	113,267	548,038	**2,130,738**	167,528	**3,256,348**	200,103
1977	53,523	85,383	734,911	152,089	6,271	**1,032,178**	108,697	53,972	1,106,991	121,856	111,309	561,101	**1,955,229**	149,287	**2,987,407**	184,666
1978	37,806	104,814	600,192	155,101	7,161	**905,074**	87,402	56,025	969,338	138,619	144,423	640,675	**1,949,080**	132,366	**2,854,155**	158,619
1979	45,284	97,857	1,117,428	213,841	7,600	**1,482,010**	157,497	64,136	893,760	132,685	102,105	518,807	**1,711,494**	119,999	**3,193,503**	198,003
1980	33,964	37,832	778,865	152,509	9,736	**1,012,907**	114,263	134,537	686,611	120,346	129,365	332,342	**1,403,201**	96,733	**2,416,108**	149,711
1981	24,852	61,531	778,222	126,691	17,783	**1,009,079**	112,579	105,668	571,870	126,087	101,454	416,334	**1,321,413**	85,893	**2,330,492**	141,603
1982	20,339	53,607	614,318	110,767	15,610	**814,640**	83,888	65,633	833,563	105,830	147,168	582,065	**1,734,260**	116,345	**2,548,900**	143,435
1983	31,408	69,476	900,606	184,897	20,583	**1,206,970**	85,035	69,850	1,368,720	155,646	205,422	583,162	**2,382,800**	171,904	**3,589,769**	191,786
1984	46,936	40,133	931,326	197,928	28,565	**1,244,888**	91,313	115,871	800,489	133,976	81,051	623,198	**1,754,586**	115,575	**2,999,473**	147,295
1985	53,761	86,798	952,115	272,605	33,997	**1,399,276**	92,896	43,097	1,247,495	128,224	104,385	517,743	**2,040,945**	154,675	**3,440,221**	180,427
1986	55,887	131,807	823,854	233,081	36,021	**1,280,650**	80,411	77,405	1,323,468	150,727	117,512	645,591	**2,314,703**	174,759	**3,595,353**	192,371
1987	73,271	80,170	692,280	247,878	29,201	**1,122,800**	69,220	139,224	881,712	153,398	64,392	502,207	**1,740,934**	143,632	**2,863,733**	159,441
1988	43,437	136,663	636,177	169,607	23,954	**1,009,838**	61,033	48,082	1,165,818	200,456	151,773	758,711	**2,324,839**	167,062	**3,334,678**	177,861
1989	68,054	75,649	709,507	251,639	7,898	**1,112,747**	72,156	25,240	807,732	125,961	146,433	836,948	**1,942,314**	128,129	**3,055,062**	147,049
1990	61,711	66,744	634,479	208,676	18,226	**989,836**	63,696	43,947	486,256	91,301	120,309	404,603	**1,146,416**	76,229	**2,136,252**	99,338
1991	64,754	77,797	550,631	178,532	21,967	**893,680**	56,176	30,848	372,319	89,243	67,200	396,637	**956,247**	61,264	**1,849,927**	83,121
1992	102,174	102,730	464,828	221,488	24,002	**915,222**	50,452	56,399	458,822	90,599	136,016	583,306	**1,325,142**	84,022	**2,240,365**	98,005
1993	61,525	95,540	465,488	189,248	25,991	**837,792**	44,473	80,713	411,052	166,698	159,413	513,700	**1,331,577**	87,222	**2,169,369**	97,906
1994	48,227	64,297	637,256	224,863	22,312	**996,955**	65,847	63,258	610,598	225,559	109,239	556,042	**1,564,696**	105,370	**2,561,651**	124,253
1995	43,792	90,253	411,656	201,838	31,732	**779,271**	43,144	19,753	496,230	113,612	101,396	542,611	**1,273,602**	76,708	**2,052,873**	88,009
1996	85,601	70,185	313,680	274,647	19,544	**763,657**	42,627	24,193	538,710	90,078	105,421	399,439	**1,157,841**	78,085	**1,921,499**	88,963
1997	69,156	59,068	360,331	270,619	8,866	**768,041**	44,730	12,251	366,907	81,409	125,361	285,204	**871,132**	46,948	**1,639,173**	64,845
1998	87,888	86,841	471,050	297,731	5,092	**948,603**	55,756	24,018	480,693	89,589	272,437	386,798	**1,253,535**	67,515	**2,202,138**	87,562
1999	128,846	60,178	435,691	227,526	7,547	**859,789**	48,554	8,166	307,348	77,411	70,585	192,126	**655,635**	38,741	**1,515,424**	62,116
2000	129,093	55,417	718,371	248,303	15,092	**1,166,274**	70,094	21,174	380,553	123,479	102,397	310,049	**937,652**	54,332	**2,103,926**	88,686
2001	73,431	49,214	621,739	276,062	9,759	**1,030,205**	60,797	18,156	476,034	99,482	81,111	286,287	**961,070**	57,919	**1,991,275**	83,969
10yr Av.	82,973	73,372	490,009	243,232	16,994	**906,581**	52,647	32,808	452,695	115,792	126,338	405,556	**1,133,188**	69,686	**2,039,769**	88,431

Table 3.5.1.4 Estimated pre-fishery abundance of NON-MATURING 1SW salmon (potential MSW returns) by NEAC country and year

Year	Northern Europe							Southern Europe							NEAC Area	
	Finland	Iceland	Norway	Russia	Sweden	Total		France	Ireland	UK(EW)	UK(NI)	UK(Scot)	Total		Total	
						Est.	SD						Est.	SD	Est.	SD
1971	64,054	104,939	825,237	266,815	5,809	**1,266,854**	128,561	54,676	373,754	300,728	23,048	1,632,457	**2,384,663**	160,947	**3,651,517**	205,990
1972	81,508	96,140	944,150	432,426	8,160	**1,562,384**	151,877	35,142	377,680	225,954	20,161	1,648,035	**2,306,972**	180,764	**3,869,356**	236,098
1973	82,067	84,633	869,819	399,821	5,895	**1,442,236**	139,452	21,708	412,141	175,400	22,038	1,233,394	**1,864,681**	138,522	**3,306,916**	196,558
1974	117,699	91,297	760,741	430,715	4,635	**1,405,087**	120,438	32,043	452,734	214,031	18,001	1,321,126	**2,037,934**	158,309	**3,443,021**	198,915
1975	104,170	77,839	772,597	369,547	5,134	**1,329,286**	125,461	28,483	336,392	156,533	12,530	984,801	**1,518,740**	100,074	**2,848,026**	160,485
1976	68,505	85,565	756,489	254,603	3,504	**1,168,665**	124,966	19,473	278,521	145,523	12,409	903,001	**1,358,927**	101,516	**2,527,592**	161,003
1977	41,800	110,661	503,530	219,736	2,992	**878,720**	82,767	21,069	252,012	133,119	16,099	1,119,139	**1,541,438**	123,362	**2,420,158**	148,555
1978	39,082	71,527	917,178	198,964	5,186	**1,231,937**	145,596	19,687	218,280	72,792	11,315	821,197	**1,143,271**	97,467	**2,375,208**	175,209
1979	40,604	100,860	1,118,791	345,378	10,267	**1,615,901**	169,576	37,747	257,590	180,175	14,314	1,039,763	**1,529,589**	116,330	**3,145,490**	205,642
1980	49,512	56,018	1,047,613	235,779	9,877	**1,398,799**	157,472	28,582	202,622	232,645	11,223	1,081,898	**1,556,970**	112,901	**2,955,768**	193,762
1981	63,066	46,077	878,788	211,271	12,958	**1,212,160**	117,792	19,126	109,353	113,343	16,227	920,301	**1,178,350**	93,167	**2,390,510**	150,183
1982	71,841	60,876	824,200	269,537	9,775	**1,236,230**	78,067	19,027	332,506	116,434	22,985	933,677	**1,424,629**	161,360	**2,660,858**	179,253
1983	67,689	56,812	801,927	253,985	9,117	**1,189,529**	76,988	25,008	151,333	82,956	8,952	725,253	**993,503**	76,253	**2,183,032**	108,359
1984	63,726	40,206	746,151	277,387	6,245	**1,133,716**	69,433	18,919	163,967	108,379	11,584	847,788	**1,150,636**	85,949	**2,284,352**	110,490
1985	44,553	52,742	888,632	277,420	6,881	**1,270,229**	83,695	23,128	199,563	164,723	13,043	1,167,238	**1,567,695**	125,767	**2,837,924**	151,070
1986	56,540	51,253	683,551	213,573	10,727	**1,015,643**	64,314	14,408	223,919	134,450	6,635	815,298	**1,194,710**	83,936	**2,210,352**	105,743
1987	38,508	43,508	556,287	199,103	8,537	**845,943**	52,622	30,733	120,630	153,878	18,859	1,149,282	**1,473,382**	114,071	**2,319,325**	125,624
1988	51,328	38,321	421,153	200,265	19,868	**730,935**	41,559	18,046	144,479	133,003	15,007	1,057,777	**1,368,312**	95,958	**2,099,247**	104,571
1989	50,005	38,861	485,586	249,565	14,157	**838,175**	48,159	13,801	74,351	132,070	13,584	797,137	**1,030,943**	80,296	**1,869,118**	93,630
1990	63,998	33,348	386,145	230,965	13,958	**728,414**	40,828	11,756	64,960	57,466	6,999	598,619	**739,801**	62,701	**1,468,214**	74,822
1991	62,128	41,485	406,098	214,933	17,352	**741,995**	44,186	16,531	86,287	51,429	16,005	825,106	**995,358**	82,297	**1,737,353**	93,409
1992	66,035	31,138	390,098	253,485	22,640	**763,396**	38,923	8,444	83,054	63,446	37,642	667,702	**860,289**	71,510	**1,623,684**	81,417
1993	58,120	35,697	382,401	226,799	16,911	**719,927**	38,098	13,242	92,596	89,621	13,257	765,288	**974,004**	86,967	**1,693,931**	94,946
1994	43,473	29,783	409,929	258,553	10,939	**752,677**	40,777	6,414	103,659	62,350	11,227	705,446	**889,096**	85,277	**1,641,774**	94,524
1995	30,633	25,984	408,124	195,314	13,699	**673,754**	38,657	11,647	74,169	65,818	12,584	548,407	**712,625**	63,935	**1,386,379**	74,713
1996	42,266	21,500	267,472	155,734	8,596	**495,569**	27,592	6,128	91,736	41,894	15,676	379,866	**535,299**	50,689	**1,030,868**	57,712
1997	37,903	19,562	321,455	193,339	4,825	**577,084**	31,626	5,006	55,254	25,734	21,646	410,419	**518,059**	43,630	**1,095,143**	53,887
1998	35,399	28,094	344,813	170,348	4,070	**582,724**	36,582	10,641	61,211	60,600	9,580	299,969	**442,001**	35,675	**1,024,726**	51,098
1999	74,876	11,033	474,017	297,020	8,974	**865,921**	46,849	7,453	97,996	61,693	12,851	470,442	**650,435**	52,070	**1,516,356**	70,044
2000	106,617	15,297	578,347	162,997	10,876	**874,134**	58,120	8,848	124,306	76,559	9,434	419,065	**638,212**	49,387	**1,512,346**	76,269
10yr Av.	55,745	25,957	398,275	212,852	11,888	**704,718**	40,141	9,435	87,027	59,914	15,990	549,171	**721,538**	62,144	**1,426,256**	74,802

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

Year	Northern Europe							Southern Europe							NEAC Area	
	Finland	Iceland	Norway	Russia	Sweden	Total		France	Ireland	UK(EW)	UK(NI)	UK(Scot)	Total		Total	
						Est.	SD						Est.	SD	Est.	SD
1971	13,119	37,002	109,661	43,436	2,170	**168,385**	57,270	51,605	341,238	56,389	37,523	256,423	**743,177**	114,149	**948,564**	127,710
1972	20,862	30,522	127,624	72,288	1,715	**222,489**	66,017	103,301	373,914	52,653	32,599	209,944	**772,410**	118,866	**1,025,421**	135,968
1973	26,727	33,103	126,613	78,630	2,187	**234,158**	64,974	62,082	409,419	62,755	28,591	252,983	**815,830**	131,751	**1,083,090**	146,902
1974	25,609	25,305	120,852	94,583	3,210	**244,253**	63,948	29,182	467,465	76,450	30,964	211,574	**815,634**	143,098	**1,085,192**	156,737
1975	36,412	37,134	120,751	113,826	3,269	**274,259**	68,560	58,060	515,312	77,390	25,590	194,881	**871,232**	158,684	**1,182,625**	172,861
1976	31,837	30,699	113,886	110,728	1,911	**258,363**	61,327	53,176	349,068	50,710	17,870	172,860	**643,683**	112,302	**932,745**	127,956
1977	21,341	33,991	117,567	74,826	881	**214,614**	59,808	40,919	299,529	52,606	17,511	175,166	**585,730**	97,067	**834,336**	114,014
1978	15,002	41,547	96,659	59,252	1,017	**171,930**	49,146	42,497	263,059	60,142	22,713	223,176	**611,587**	87,663	**825,064**	100,499
1979	17,997	38,919	179,327	75,811	1,053	**274,188**	86,375	48,638	241,803	59,182	16,104	154,703	**520,431**	79,262	**833,538**	117,231
1980	13,403	15,054	126,872	74,080	1,335	**215,691**	62,796	102,038	186,969	52,228	20,413	111,975	**473,622**	65,487	**704,367**	90,730
1981	9,801	24,432	126,660	54,282	2,558	**193,301**	61,260	79,925	228,685	54,554	15,979	142,731	**521,874**	59,756	**739,607**	85,578
1982	7,910	21,321	99,706	50,251	2,213	**160,080**	46,036	49,551	218,199	45,170	23,259	202,090	**538,269**	75,922	**719,671**	88,789
1983	12,273	27,644	165,874	65,462	2,886	**246,496**	48,876	52,717	371,415	66,098	32,058	200,134	**722,422**	113,444	**996,562**	123,525
1984	18,579	16,104	165,986	81,205	3,941	**269,711**	51,534	87,797	262,235	55,726	12,726	227,733	**646,217**	78,648	**932,031**	94,028
1985	21,325	34,565	175,942	93,654	4,803	**295,724**	54,149	32,605	281,339	53,047	16,353	214,243	**597,587**	99,959	**927,876**	113,684
1986	22,202	52,751	153,373	103,392	5,062	**284,029**	47,130	57,146	323,273	62,961	18,546	262,311	**724,237**	116,254	**1,061,018**	125,444
1987	29,259	31,871	128,726	96,265	4,114	**258,364**	41,903	103,151	243,452	64,329	15,703	193,375	**620,011**	99,300	**910,246**	107,779
1988	17,126	54,439	119,766	87,469	3,291	**227,653**	36,233	35,468	351,284	84,366	42,462	414,537	**928,117**	112,296	**1,210,209**	117,996
1989	21,485	30,091	191,078	96,436	1,123	**310,122**	45,505	18,622	202,544	52,145	13,096	464,489	**750,895**	85,538	**1,091,109**	96,889
1990	19,601	26,539	171,125	97,367	2,601	**290,695**	40,686	32,529	137,152	37,792	36,019	227,595	**471,087**	51,506	**788,320**	65,637
1991	20,661	30,857	146,509	83,347	3,124	**253,640**	35,866	22,745	117,404	37,994	18,807	229,101	**426,052**	42,312	**710,549**	55,468
1992	32,521	40,882	123,839	116,960	3,401	**276,721**	33,027	41,707	96,150	39,119	47,160	346,001	**570,138**	56,978	**887,740**	65,858
1993	19,658	38,103	123,406	114,444	3,741	**261,249**	29,326	59,810	135,473	75,121	74,000	298,750	**643,155**	62,076	**942,506**	68,655
1994	15,476	25,573	174,105	116,166	4,972	**310,719**	43,377	46,795	174,342	101,555	25,921	327,531	**676,144**	73,624	**1,012,436**	85,452
1995	13,962	36,044	110,342	121,791	9,561	**255,656**	28,771	13,828	87,279	52,775	26,446	328,087	**508,415**	50,362	**800,115**	58,001
1996	34,128	27,963	82,799	139,059	5,905	**261,891**	29,221	16,892	159,933	44,172	36,152	241,643	**498,793**	52,928	**788,646**	60,459
1997	27,574	23,515	105,848	159,313	2,655	**295,391**	30,489	8,548	93,499	41,268	40,094	172,624	**356,033**	32,484	**674,939**	44,552
1998	35,158	34,727	140,594	164,604	1,137	**341,493**	38,372	16,770	153,910	46,352	161,001	246,183	**624,218**	47,732	**1,000,438**	61,243
1999	41,012	24,005	128,948	163,711	1,708	**335,379**	33,082	5,715	56,642	42,548	20,551	123,807	**249,264**	26,625	**608,648**	42,465
2000	40,998	21,984	215,065	140,910	3,454	**400,427**	47,061	14,808	79,830	68,951	33,816	204,524	**401,929**	37,207	**824,340**	59,992
2001	23,384	19,708	186,783	167,534	2,204	**379,904**	41,682	12,708	98,308	55,553	31,973	190,443	**388,985**	39,890	**788,597**	57,694
10yr.av.	28,387	29,250	139,173	140,449	3,874	**311,883**	35,441	23,758	113,537	56,741	49,712	247,959	**491,707**	47,991	**832,841**	60,437

Table 3.5.1.6 Estimated number of MSW SPAWNERS by NEAC country and year

Year	Northern Europe							Southern Europe							NEAC Area	
	Finland	Iceland	Norway	Russia	Sweden	Total		France	Ireland	UK(EW)	UK(NI)	UK(Scot)	Total		Total	
						Est.	SD						Est.	SD	Est.	SD
1971	11,360	16,194	66,568	14,400	215	92,542	35,445	7,235	87,095	44,771	7,887	329,739	476,726	63,432	585,462	72,663
1972	17,582	25,086	91,895	58,681	159	168,317	50,094	14,483	93,130	65,426	6,901	411,295	591,235	79,745	784,639	94,174
1973	22,579	23,172	104,772	65,894	515	193,759	56,957	8,788	101,528	50,190	6,041	459,488	626,034	87,421	842,965	104,339
1974	22,451	20,177	100,094	99,816	331	222,692	53,099	4,080	114,100	36,105	6,594	303,060	463,939	67,789	706,808	86,110
1975	32,590	21,851	84,471	87,244	82	204,386	44,733	8,211	128,078	48,971	5,378	332,020	522,659	76,812	748,896	88,888
1976	29,128	18,645	87,598	86,495	257	203,478	47,296	5,977	86,953	26,817	3,746	231,977	355,470	49,169	577,593	68,224
1977	18,911	20,619	87,029	72,048	180	178,169	46,459	4,481	76,944	32,485	3,719	227,946	345,576	48,913	544,363	67,460
1978	11,632	26,857	57,746	50,721	144	120,243	30,017	4,710	67,589	26,712	4,827	308,604	412,443	60,524	559,544	67,559
1979	13,225	17,127	109,778	44,819	413	168,235	52,274	5,388	60,467	12,959	3,388	216,333	298,534	45,535	483,896	69,325
1980	13,912	24,078	125,388	48,059	678	188,036	61,315	11,247	67,240	41,601	4,287	261,309	385,685	54,718	597,799	82,180
1981	16,865	12,992	110,373	66,772	207	194,217	55,768	8,448	48,011	58,253	3,367	277,610	395,690	54,330	602,899	77,858
1982	21,489	10,621	91,344	40,797	757	154,388	41,722	5,070	18,731	22,525	4,851	257,925	309,102	43,237	474,110	60,085
1983	24,287	14,292	103,870	49,228	528	177,913	31,401	5,560	133,959	26,158	6,887	268,860	441,425	87,067	633,629	92,556
1984	23,050	13,526	104,072	62,468	735	190,325	30,259	9,096	44,591	20,816	2,679	241,891	319,072	36,574	522,924	47,468
1985	21,717	9,484	94,897	51,453	305	168,372	28,185	6,835	56,563	29,890	3,471	311,827	408,586	44,010	586,443	52,262
1986	15,185	12,401	114,630	52,632	291	182,739	33,675	6,880	53,562	40,270	3,904	399,922	504,538	59,967	699,677	68,775
1987	19,149	12,163	88,061	53,568	906	161,684	25,672	3,595	77,194	31,884	2,138	256,052	370,864	40,272	544,711	47,758
1988	13,055	10,334	73,284	44,998	828	132,164	21,045	10,421	23,556	39,372	7,222	457,961	538,533	60,458	681,031	64,016
1989	14,258	9,018	75,219	50,993	2,431	142,901	18,347	4,723	28,354	30,198	3,603	402,865	469,743	48,819	621,662	52,153
1990	13,893	9,205	89,915	48,434	1,637	153,880	20,951	4,723	12,344	37,168	5,036	327,365	386,636	39,678	549,721	44,869
1991	17,763	8,002	74,070	60,503	1,843	154,180	18,188	4,295	19,200	16,085	2,391	258,203	300,175	31,883	462,357	36,706
1992	17,268	9,992	80,415	58,480	2,470	158,632	19,173	5,610	21,448	11,715	6,412	353,564	398,750	40,547	567,375	44,852
1993	18,530	7,480	75,950	55,755	3,155	153,390	17,456	2,649	27,461	17,597	19,780	284,536	352,023	35,515	512,892	39,573
1994	16,248	8,619	74,988	65,315	2,475	159,025	18,168	5,589	27,812	29,215	4,761	351,422	418,799	43,099	586,442	46,772
1995	12,018	7,205	80,942	64,734	1,771	159,464	18,579	2,721	34,431	21,514	3,900	323,457	386,022	39,631	552,691	43,770
1996	10,375	6,292	79,830	63,453	2,284	155,942	17,758	4,768	19,070	22,279	5,050	249,124	300,291	30,419	462,525	35,223
1997	14,343	5,184	57,805	52,600	1,485	126,233	13,141	2,441	36,990	14,730	6,283	172,937	233,382	25,655	364,799	28,825
1998	12,944	4,743	70,169	42,016	833	125,962	14,781	2,063	12,461	9,566	10,140	195,628	229,857	21,962	360,562	26,473
1999	10,860	6,821	73,098	54,512	698	139,168	16,560	4,497	19,255	27,213	3,882	141,739	196,586	19,027	342,575	25,225
2000	22,759	2,676	103,089	59,158	1,549	186,555	22,312	3,145	40,000	28,215	5,222	227,027	303,609	27,543	492,840	35,447
2001	32,317	3,745	127,264	89,527	1,910	251,018	27,515	3,694	50,606	36,353	3,959	201,416	296,028	28,814	550,792	39,841
10yr.av.	16,766	6,276	82,355	60,555	1,863	161,539	18,544	3,718	28,953	21,840	6,939	250,085	311,535	31,221	479,349	36,600

Table 3.5.2.1 Input data for the forecast model for Southern European MSW salmon stocks. (See text for explanation of data sources.)

Year	Habitat	Lagged eggs	PFA
1977	1915	4,881,591	1,542,421
1978	1951	4,808,109	1,143,533
1979	2058	4,541,188	1,529,837
1980	1823	3,698,662	1,559,713
1981	1912	3,249,157	1,178,577
1982	1703	3,273,494	1,424,093
1983	1416	3,163,490	994,806
1984	1257	3,038,648	1,150,359
1985	1410	3,094,417	1,568,086
1986	1688	2,984,705	1,195,120
1987	1627	3,762,336	1,474,693
1988	1698	3,272,991	1,367,850
1989	1642	3,466,012	1,032,277
1990	1503	3,990,425	739,319
1991	1357	3,942,158	995,542
1992	1381	4,211,723	861,097
1993	1252	4,254,457	974,718
1994	1329	3,532,550	888,908
1995	1311	2,938,459	711,978
1996	1470	3,138,096	535,690
1997	1594	3,469,051	517,974
1998	1849	3,412,299	442,299
1999	1741	3,286,164	650,946
2000	1634	2,913,060	624,131
2001	1685	2,445,038	
2002	1865	2,360,306	

Table 3.5.2.2. Analysis of variance of log(*PFA/Eggs*). e.g. *Habitat|logEggs* signifies that *Habitat* has been tested given that log*Eggs* is already included in the model.

Source	***df***	***SSq***	***Ms***	***F ratio***	***p Value***
Habitat|logEggs	1	0.0801	0.0801	1.89	0.185
logEggs|Habitat	1	0.0886	0.0886	2.09	0.164
Year	1	1.5968	1.5968	37.64	0.000
Year|Habitat+logEggs	1	1.2623	2.1623	50.98	0.000
Habitat|Year+logEggs	1	0.0649	0.0649	1.53	0.231
logEggs|Year+Habitat	1	0.5344	0.5344	12.60	0.002
Residual	20	0.8484	0.0424		
Total	23	3.1377	0.1364		

Table 3.5.2.3 PFA predictions and 95% bootstrapped confidence limits for non-maturing (potential MSW) salmon for the southern European stock group .

Year	Egg Numbers	Prediction	Lower limit	Upper limit
2001	2445	575,000	369,000	904,000
2002	2360	552,000	343,000	892,000

Table 3.5.2.4 Bootstrapped probability distribution of forecast for 2002

Probability level	Forecast
10%	418,706
20%	463,962
30%	500,049
40%	532,903
50%	552,000
60%	603,756
70%	659,714
80%	731,029
90%	813,182

Table 3.6.1. Percentage change in gear units over the period 1991-2001 for countries where such data are available (excludes rod fisheries).

Country	Type of gear units	% Change in gear units over 1991 to 2001
UK (England & Wales)	Gill net Sweep net Hand-held net Fixed engine	-43 -47 -46 -50
UK (Scotland)	Fixed engine Net and coble	-88 -74
UK (N. Ireland)	Drift net Draft net Bag nets and boxes	-9 -51 -67
Norway	Bag net Bend net Lift net	-16 -70 -100
Ireland[1]	Drift net Draft net Other nets	+19 +1 -12
France	Commercial nets in freshwater Commercial nets in estuary	-85 -55

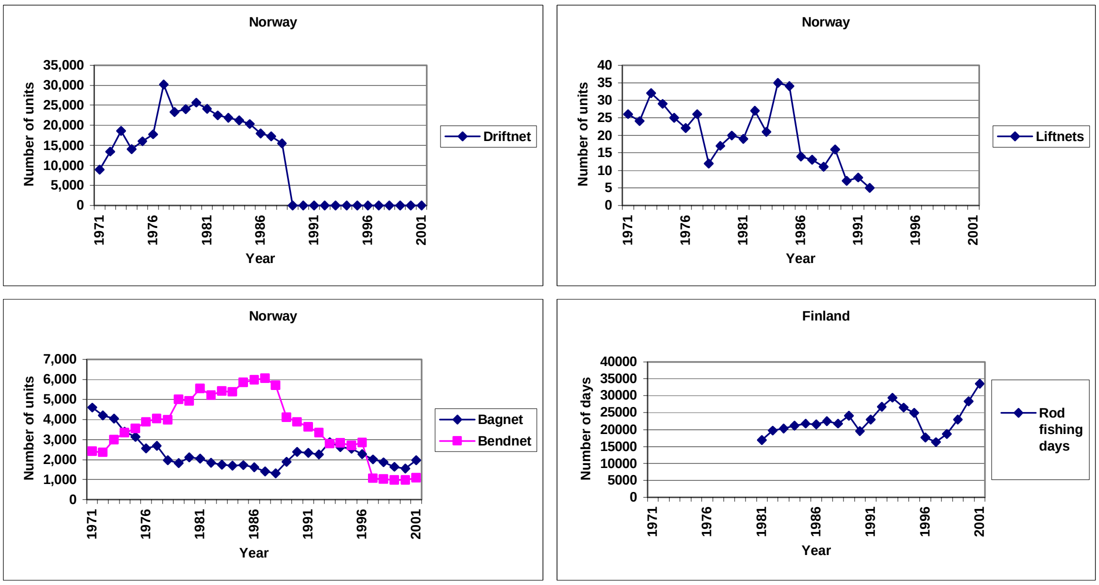
[1] The percentage increase in Ireland reflects changes in reporting procedures rather than a change in the number of licenses issued.

Table 3.7.1. Captures of Atlantic salmon post-smolts and mackerel in surface trawls west of the Voering Plateau 13-16, June 2001.

	Salmon post-smolts		**Mackerel**		
Trawl station	Number	Catch (numbers) per trawl hr	Weight (kg)	Catch (kg) per trawl hr	No.post-smolts per kg mackerel
276	0	0	0	0	0.000
278	0	0	31	15.3	0.000
280	0	0	30	14.9	0.000
281	0	0	348	174.0	0.000
282	0	0	0	0.0	0.000
283	2	1.0	150	74.4	0.013
284	1	1.1	780	835.7	0.001
285	18	8.8	360	175.6	0.050
286	14	6.9	1200	590.2	0.012
287	6	3.0	1400	694.2	0.004
288	35	17.6	1100	554.6	0.032
289	93	93.0	1100	1100.0	0.085
290	0	0	60	60.0	0.000
291	29	14.1	1400	682.9	0.021
Total	**198**		**7959**		

Figure 3.2.3.1 Overview of effort as reported for various fisheries and countries 1971 – 2001 in the Northern (A) and Southern (B) NEAC area.

A. (Northern NEAC Area)



B. (Southern NEAC Area)

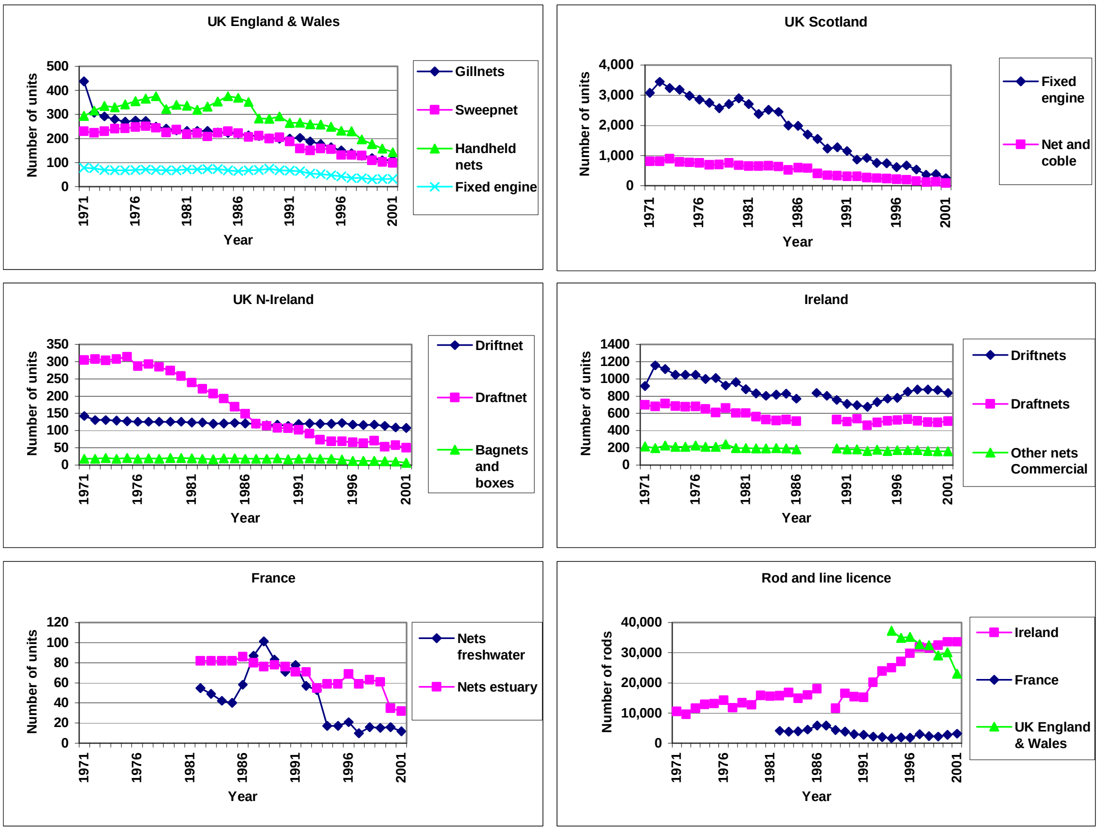


Figure 3.2.4.1 Nominal catches of salmon and 5-year running mean in the Southern and Northern NEAC areas, 1971-2001

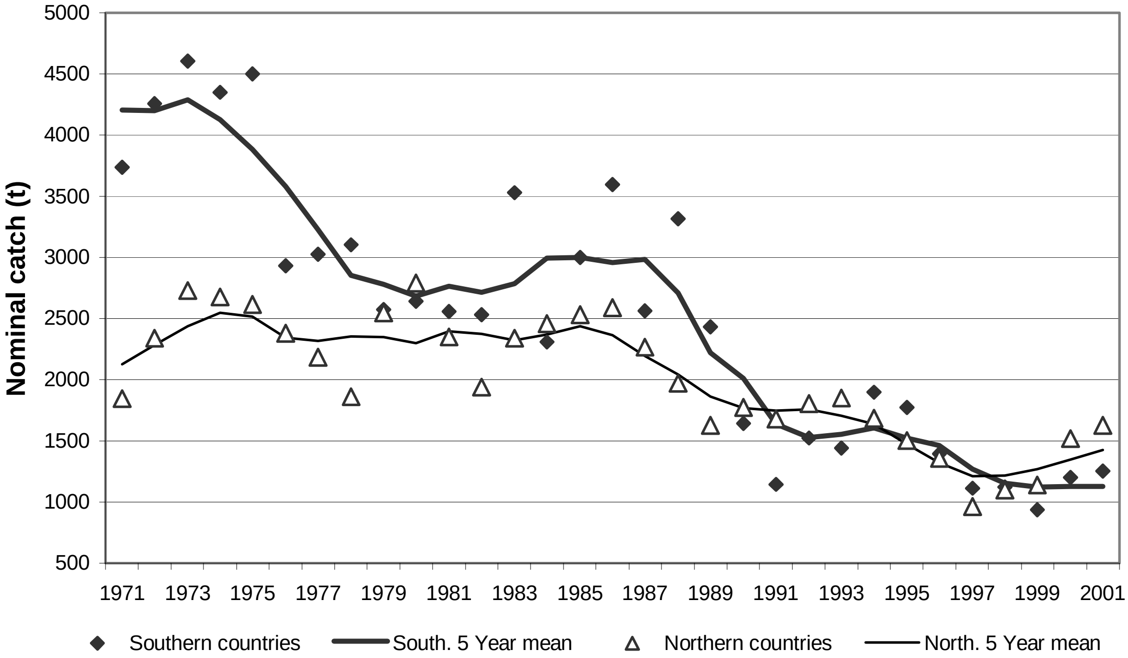
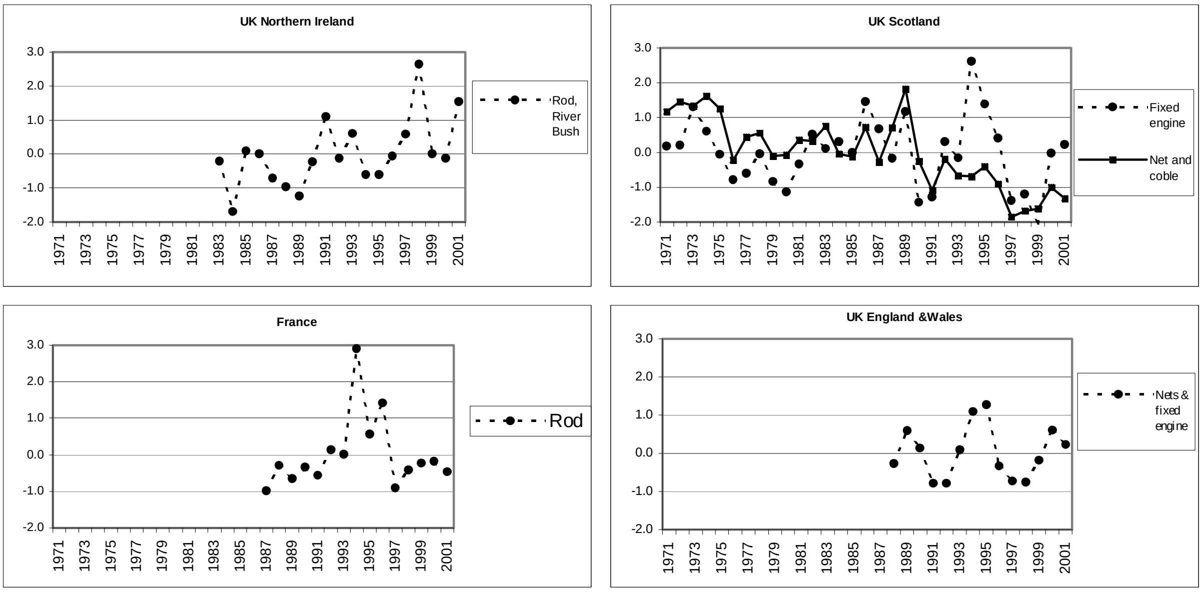


Fig. 3.2.5.1. CPUE indices in various fisheries of the NEAC countries. Vertical axes represent standardized (Z-score) index values, or averages of several series, relative to the average of the time-series (0.0).

Southern NEAC area



Northern NEAC area

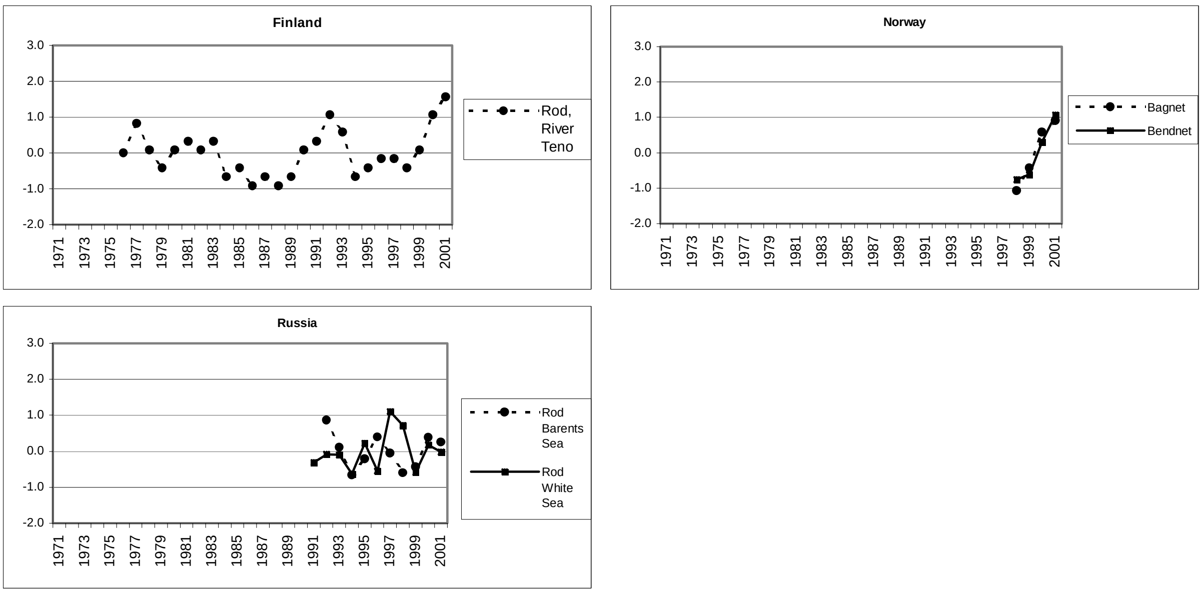


Figure 3.2.6.1 Percentage of 1 SW salmon in the reported catch of the Northern countries of the NEAC area.

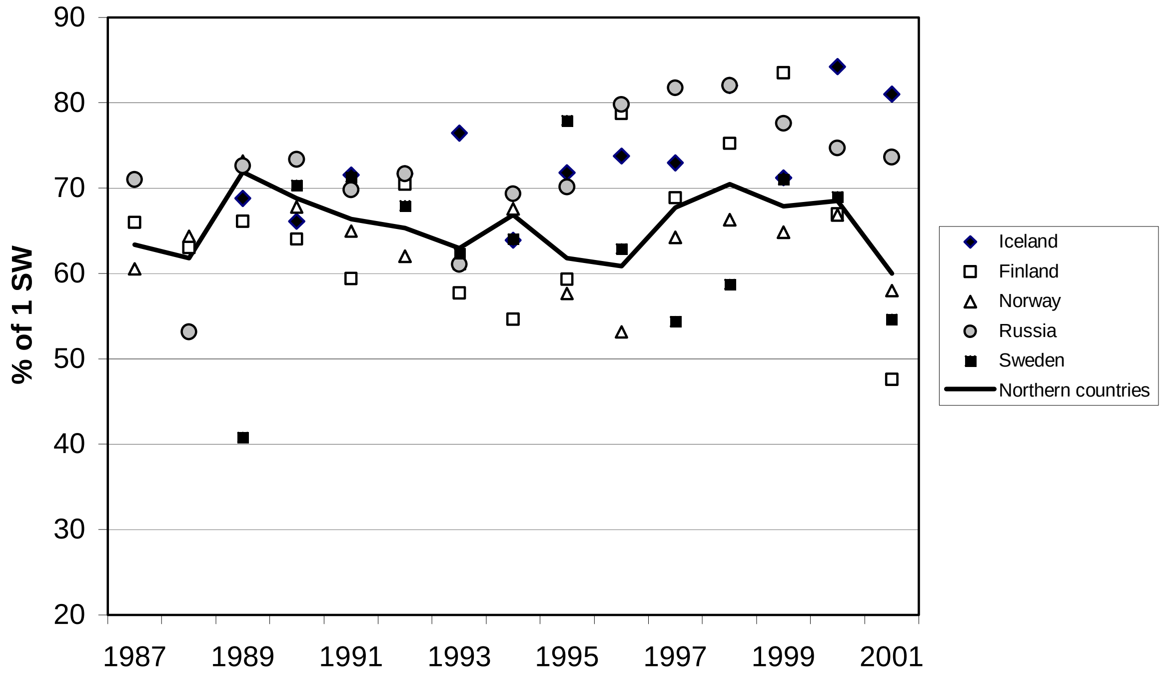


Figure 3.2.6.2 Percentage of 1 SW salmon in the reported catch of the Southern countries of the NEAC area.

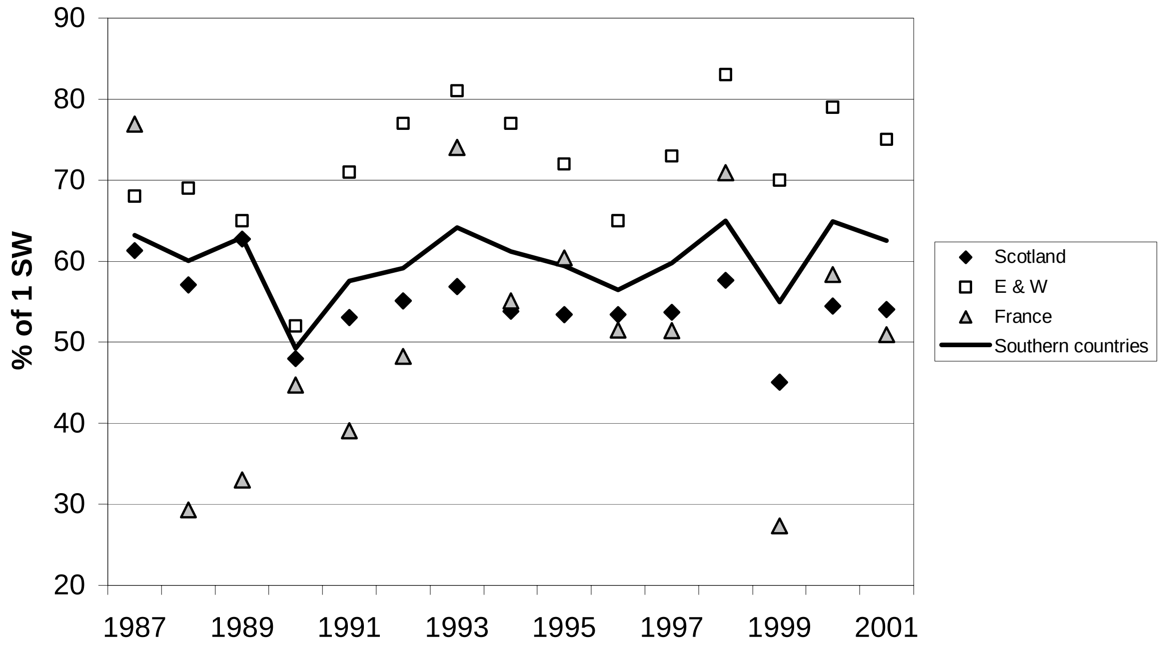


Fig. 3.3.1.1. An overview of the estimated survival indices of wild and hatchery smolts to adult returns to homewaters (prior to coastal fisheries) in Northern and Southern NEAC area. Index values represent averages of standardized (Z-score) survival estimates for monitored rivers and experimental facilities,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

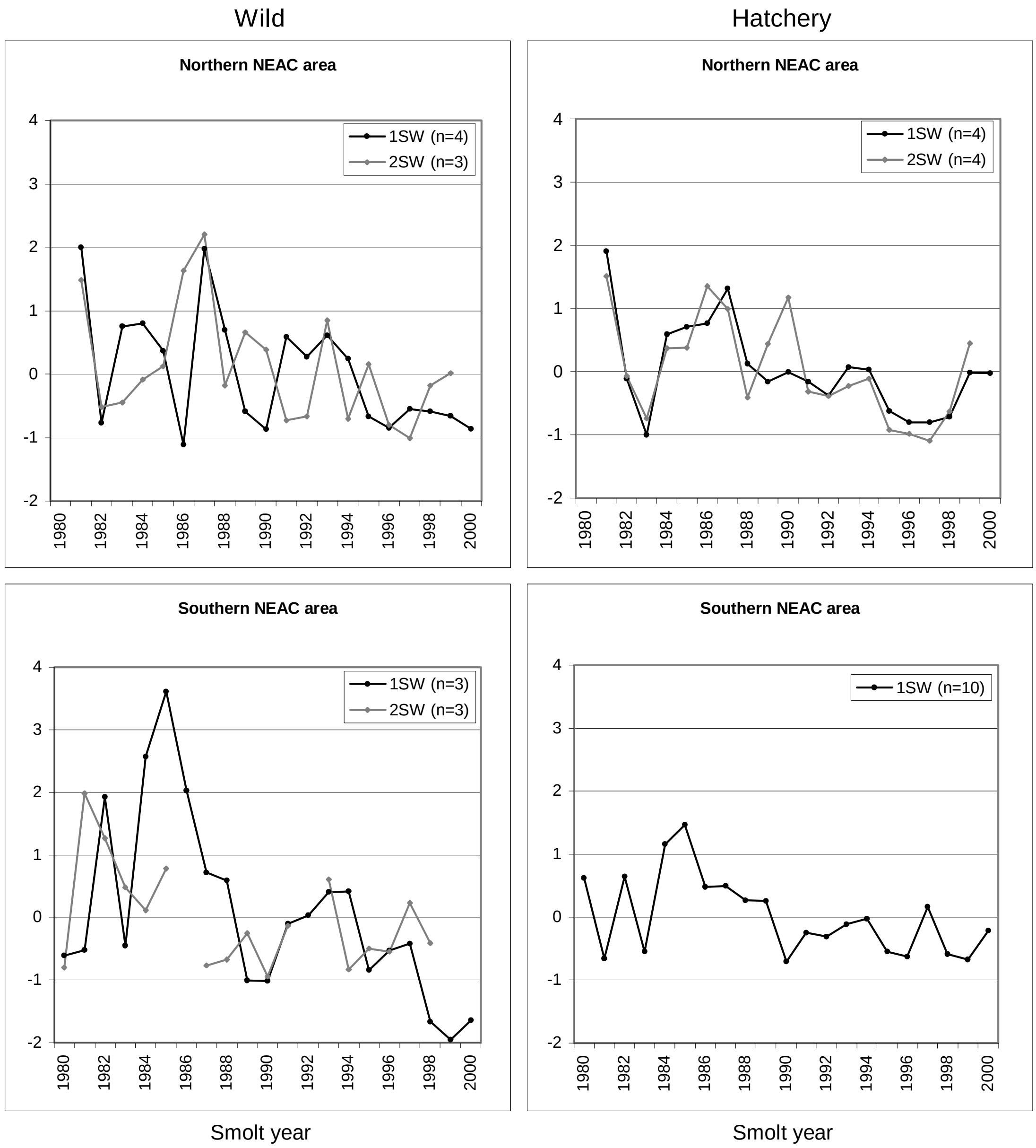
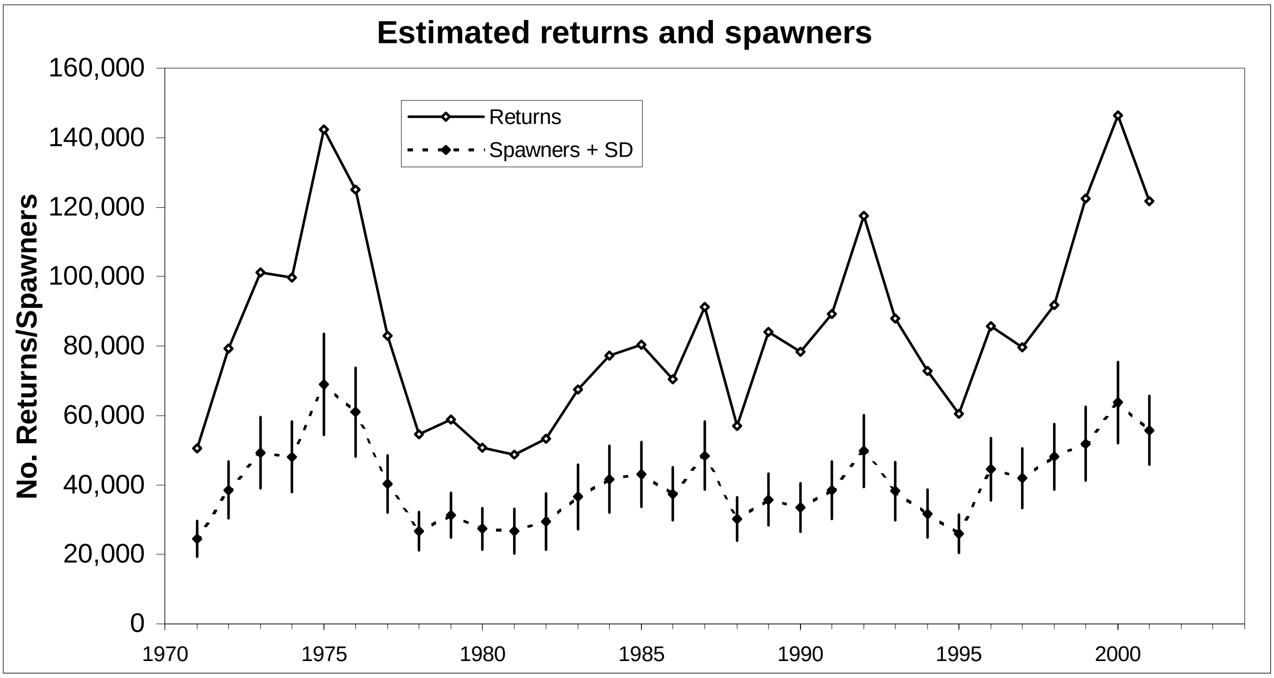
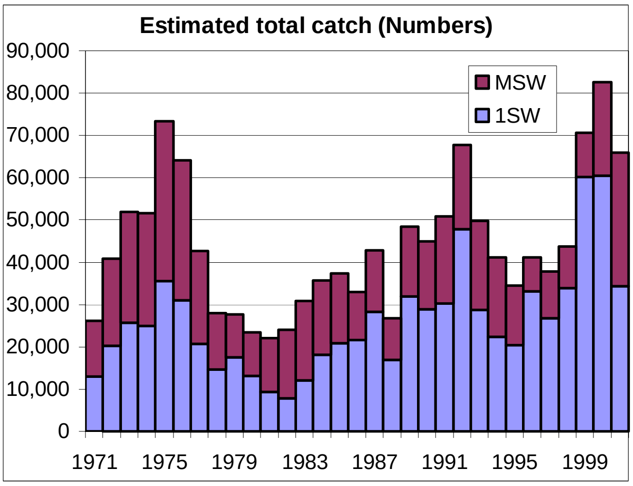
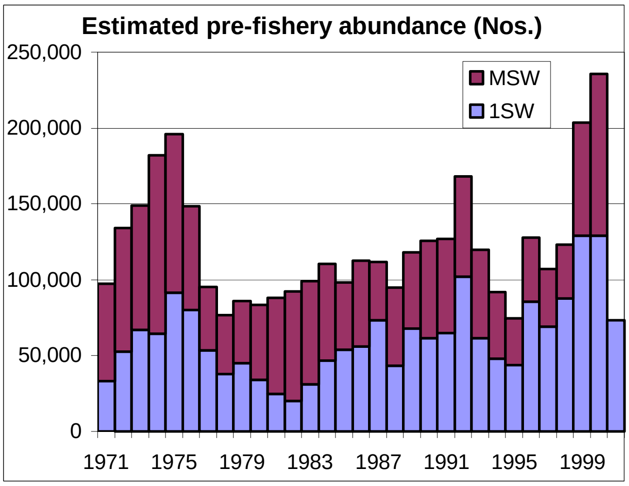
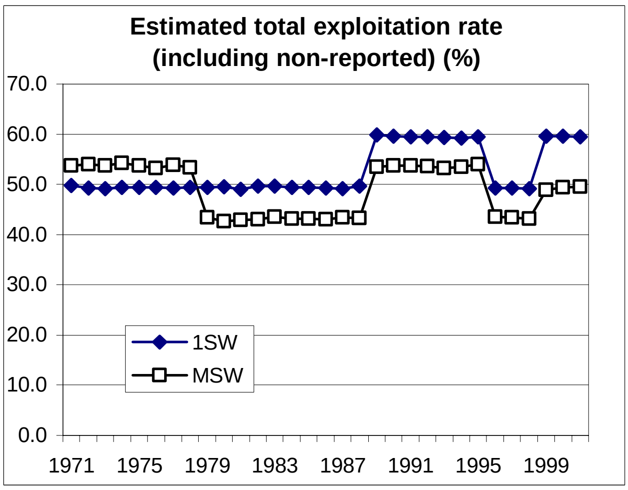


Figure 3.3.4.1a
SUMMARY OF FISHERIES AND STOCK DESCRIPTION
FINLAND (including Norwegian R. Teno catch)









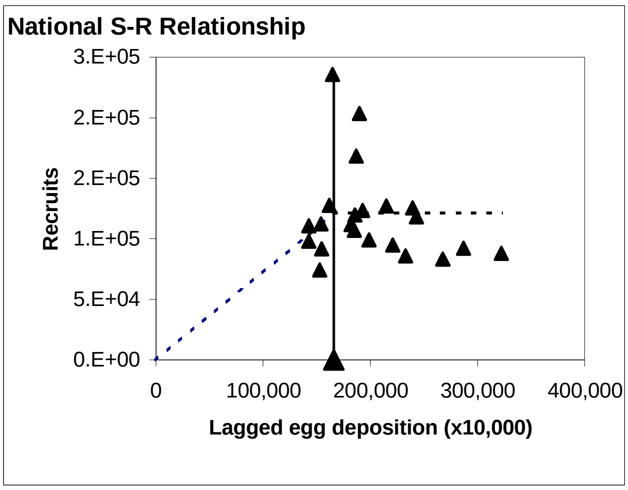


Figure 3.3.4.1b
SUMMARY OF FISHERIES AND STOCK DESCRIPTION
France

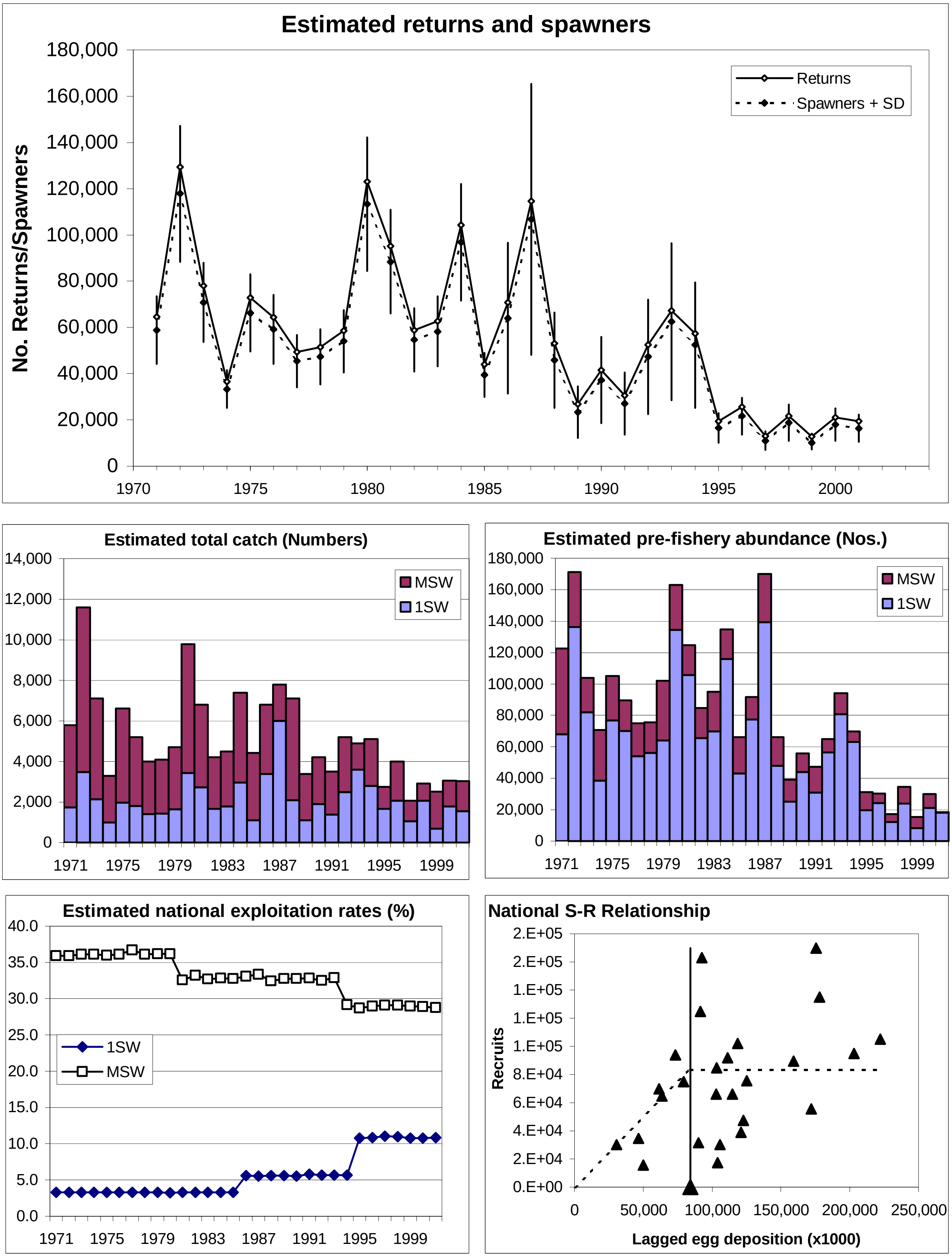
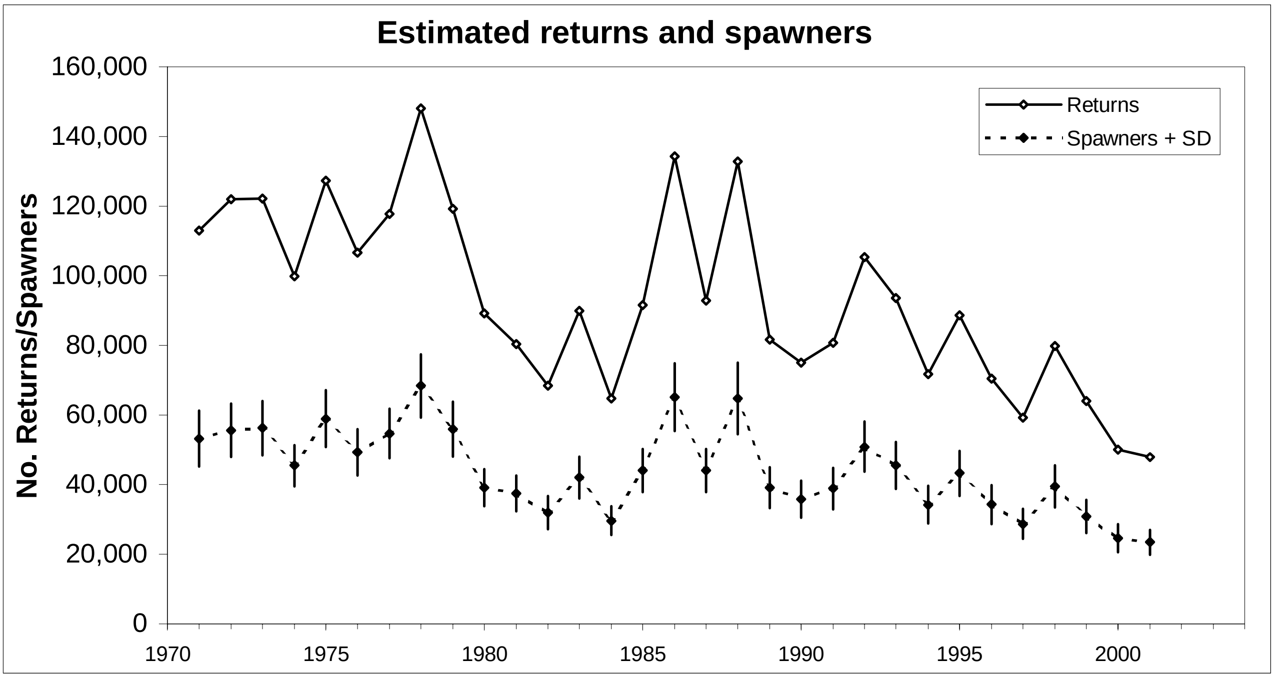
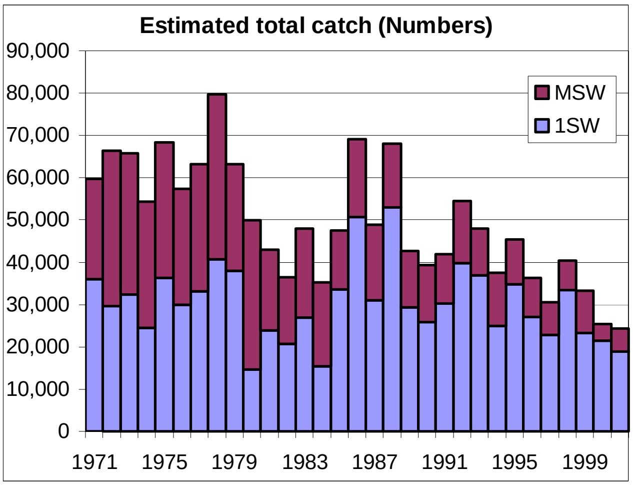


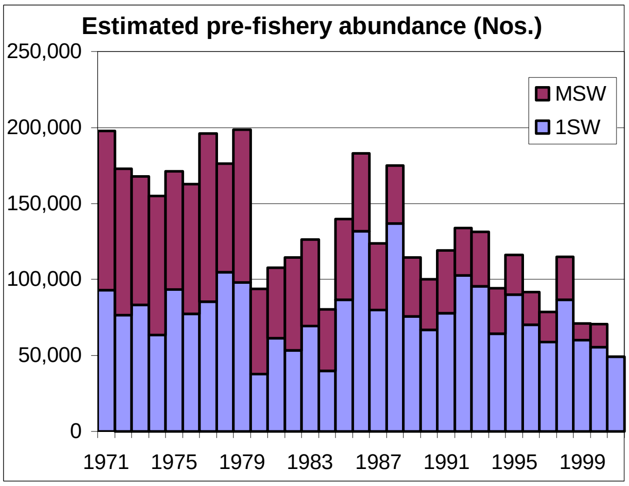
Figure 3.3.4.1c

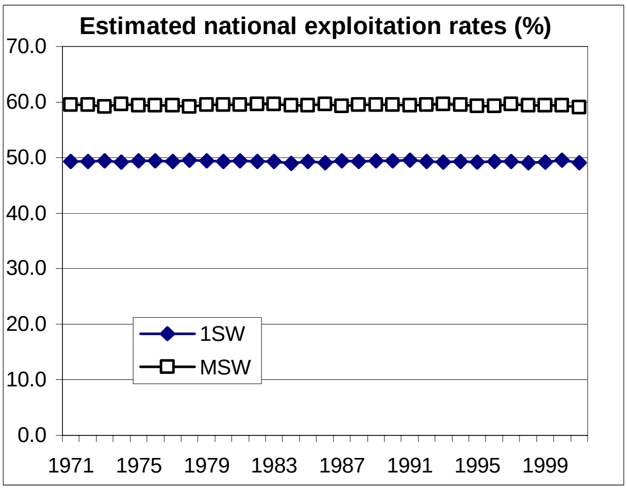
SUMMARY OF FISHERIES AND STOCK DESCRIPTION

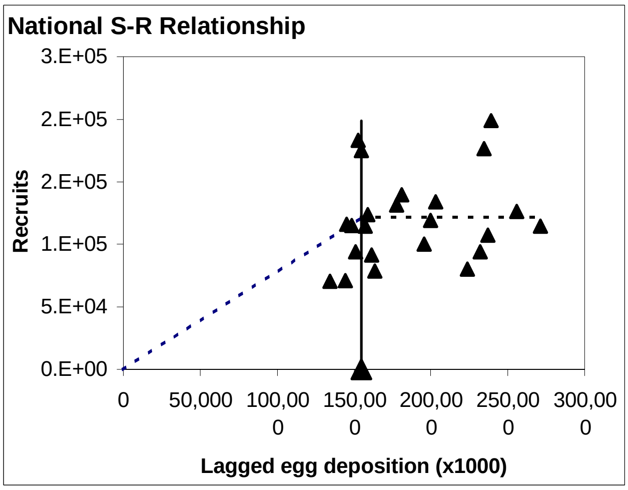
ICELAND





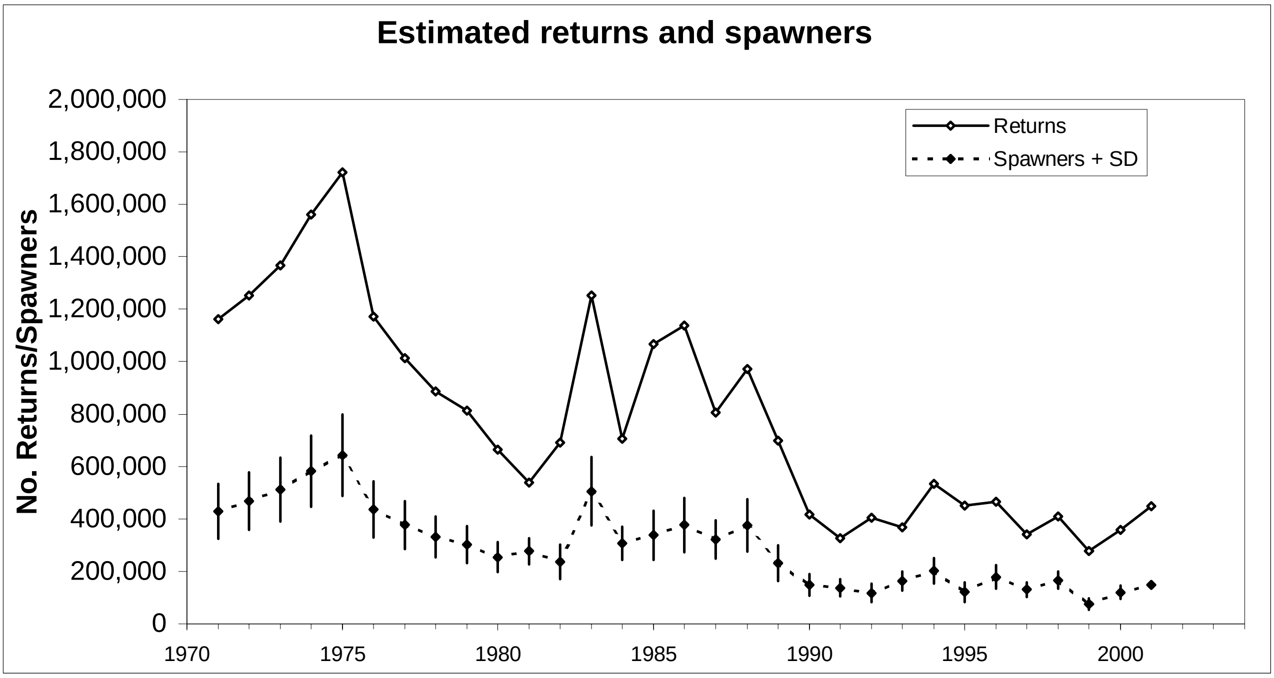


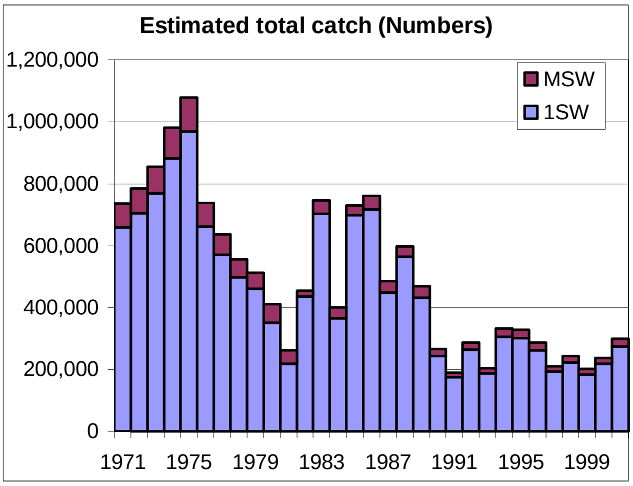


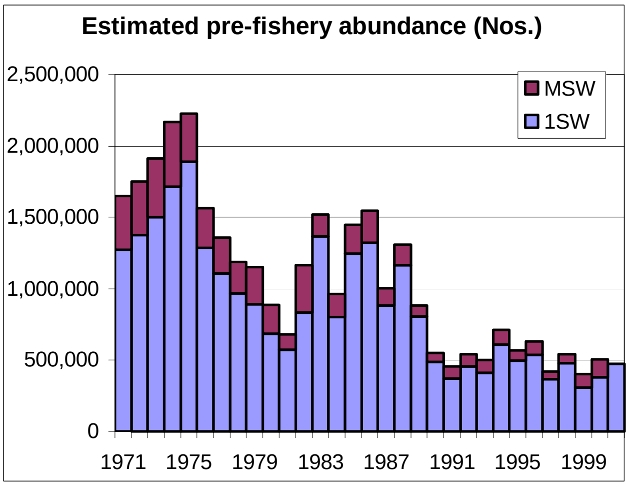


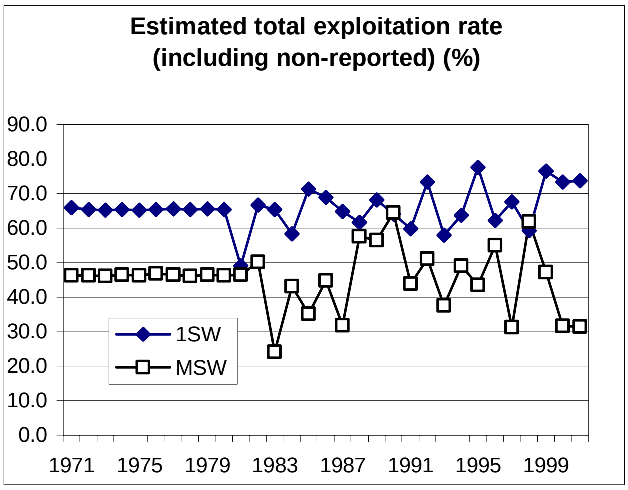
 O:\ACFM\WGREPS\WGNAS\REPORTS\2002\Sec3.Doc

Figure 3.3.4.1d
SUMMARY OF FISHERIES AND STOCK DESCRIPTION
IRELAND









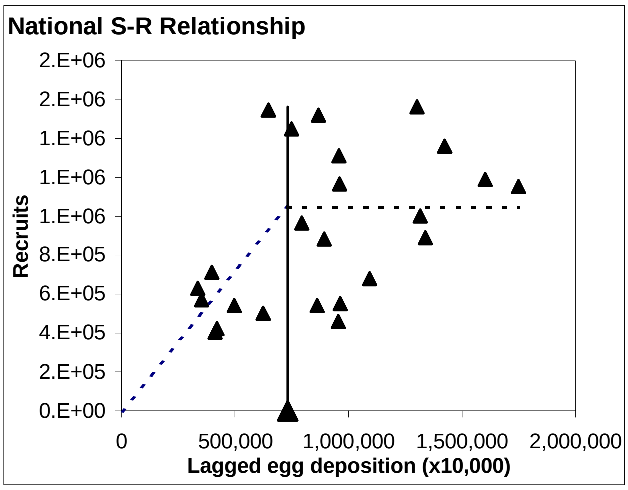
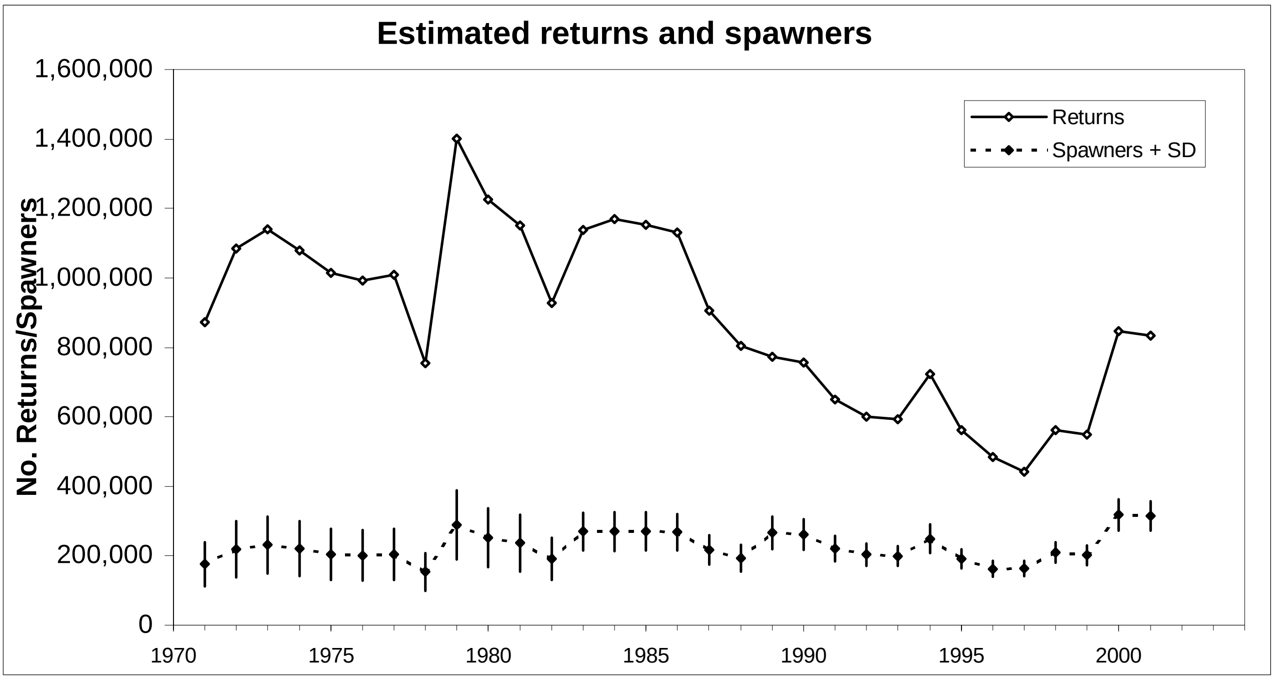
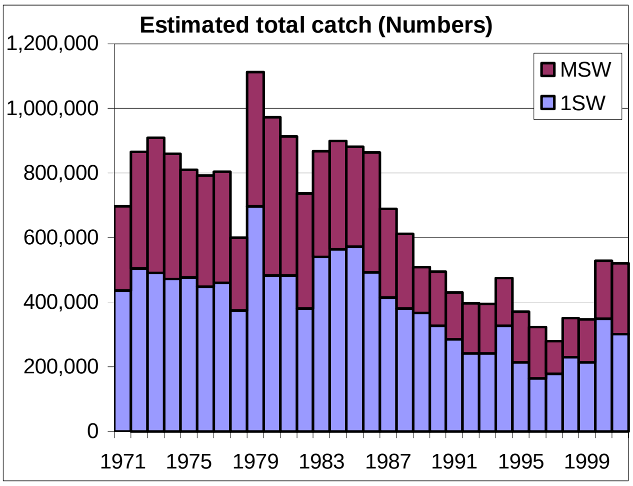
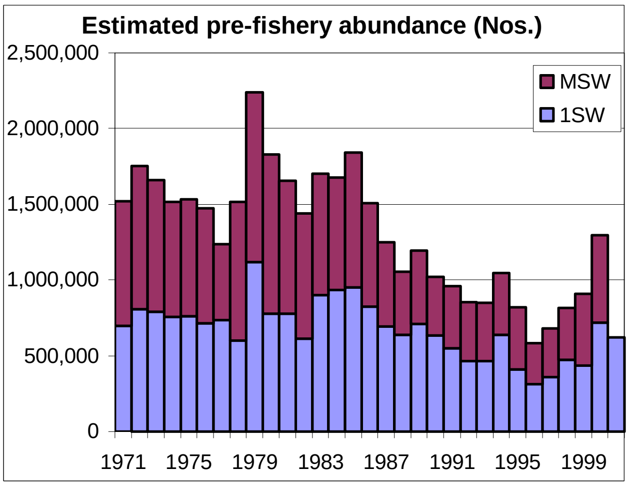
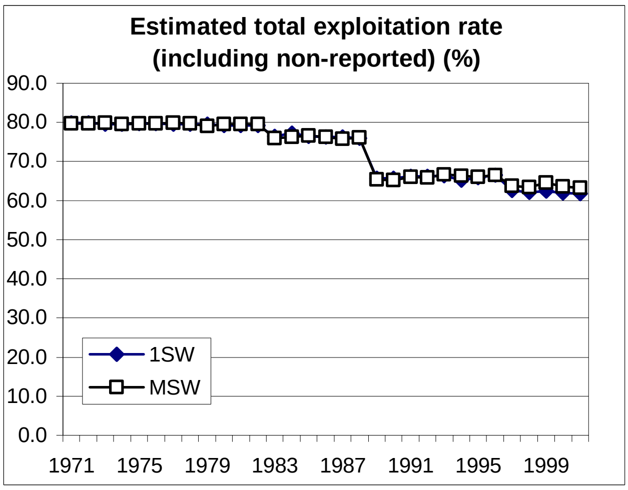


Figure 3.3.4.1e
SUMMARY OF FISHERIES AND STOCK DESCRIPTION
NORWAY (minus Norwegian catches from the R. Teno)









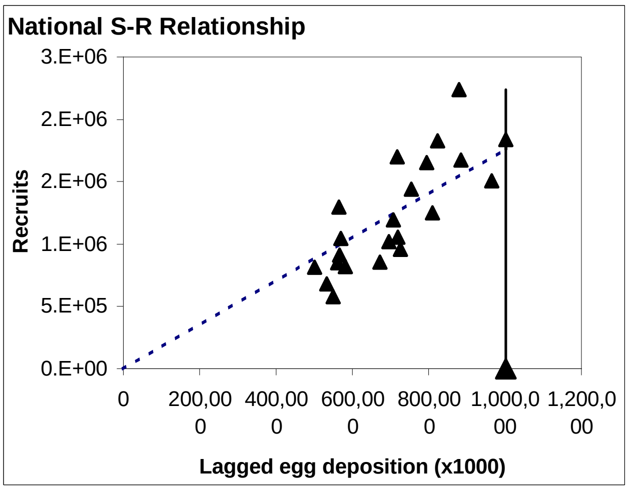
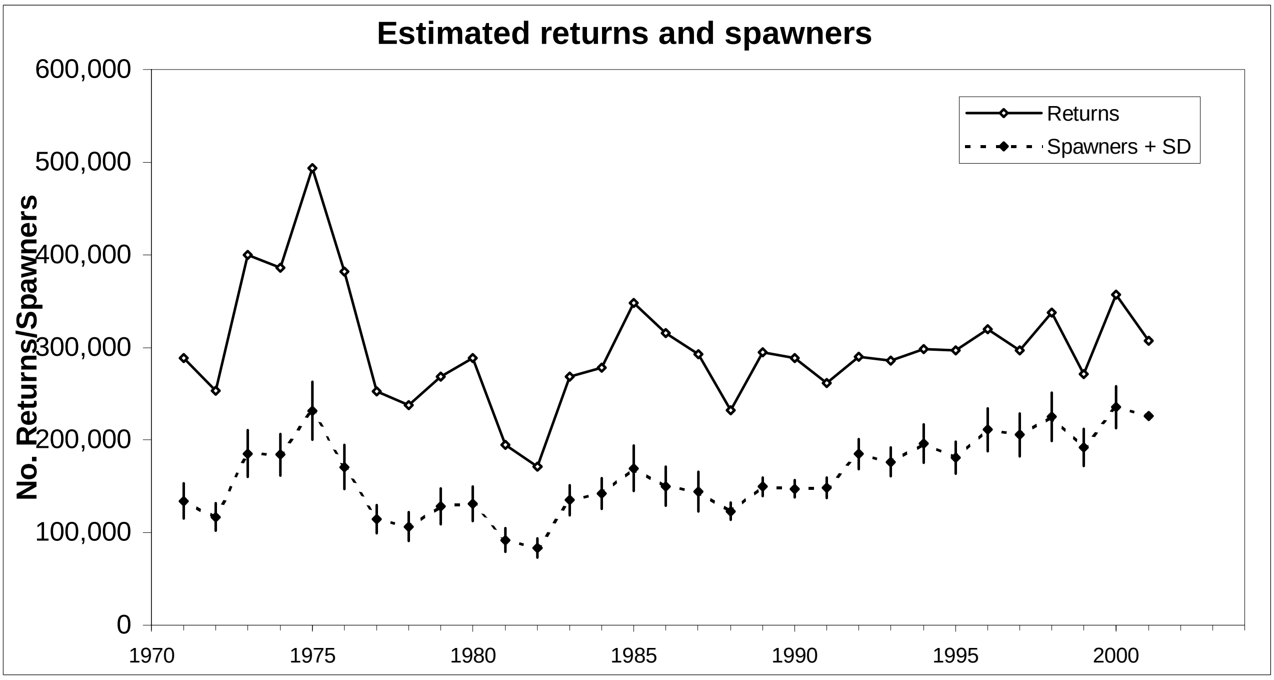
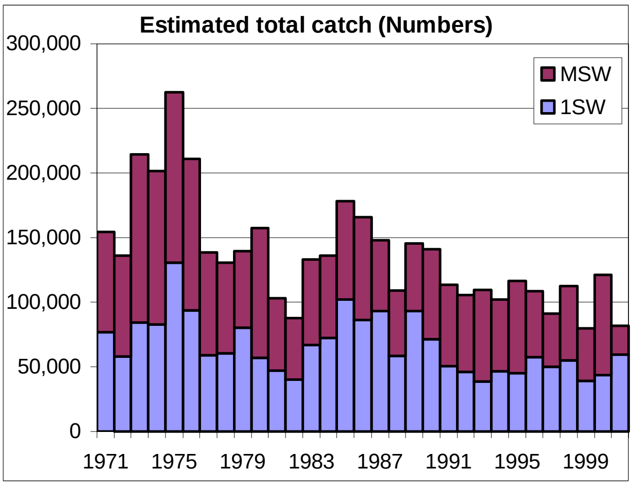
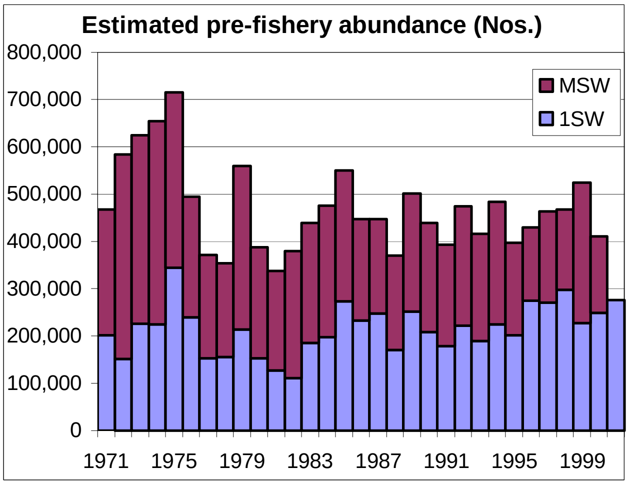
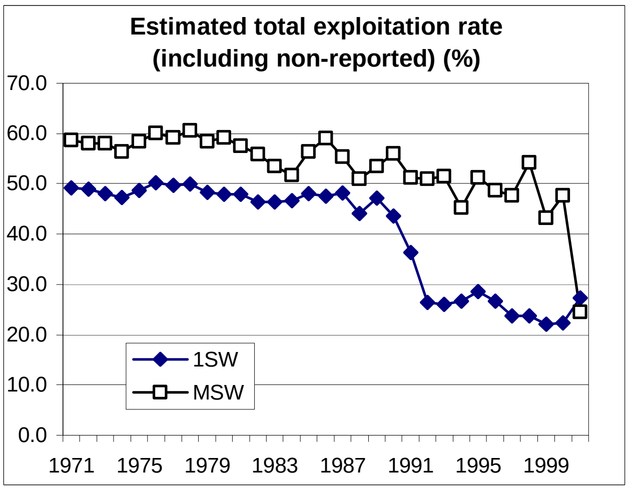


Figure 3.3.4.1f
SUMMARY OF FISHERIES AND STOCK DESCRIPTION
RUSSIA









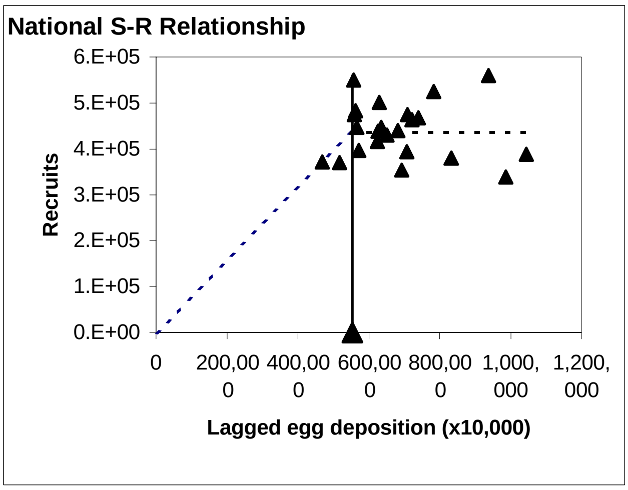


Figure 3.3.4.1g
SUMMARY OF FISHERIES AND STOCK DESCRIPTION
SWEDEN

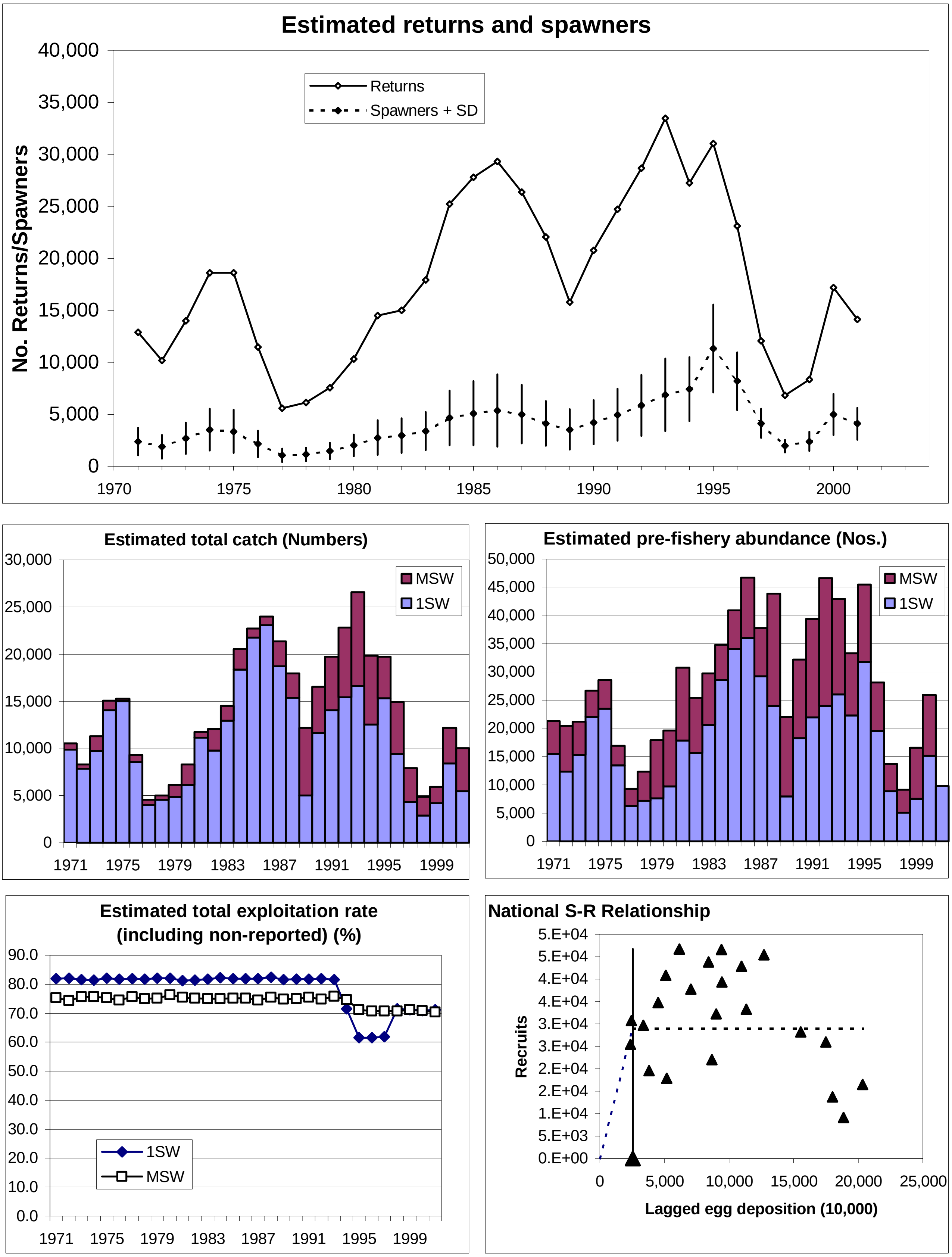
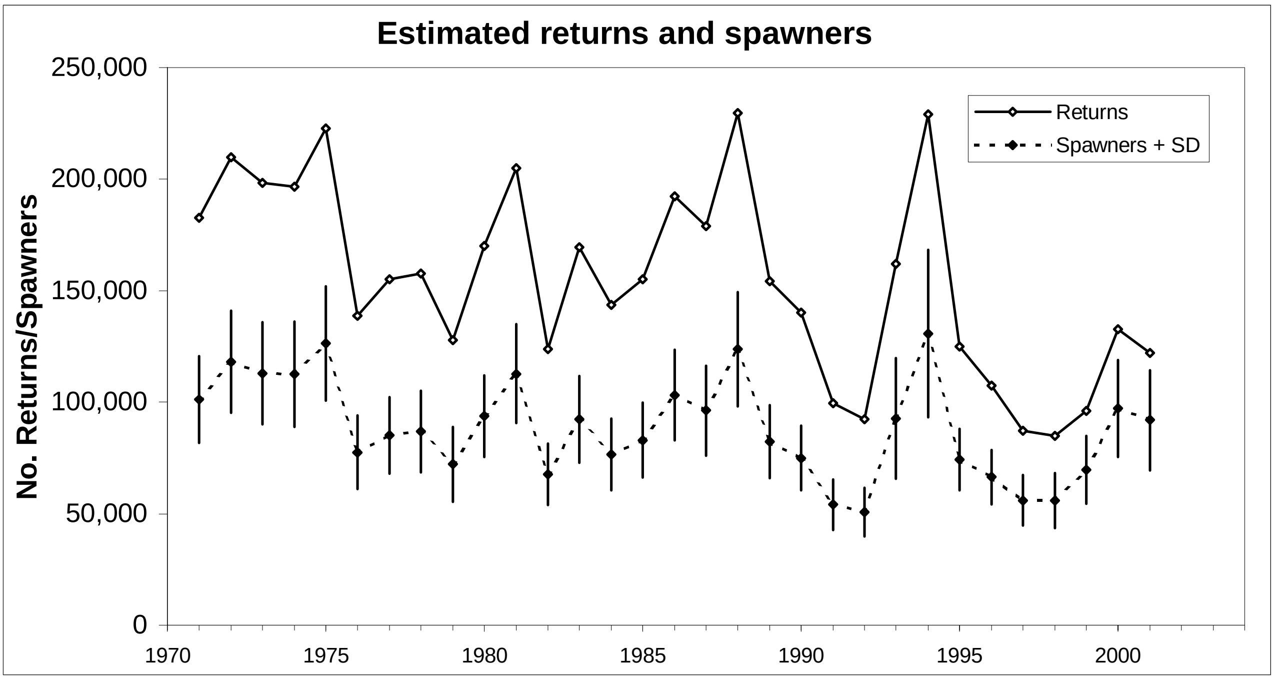
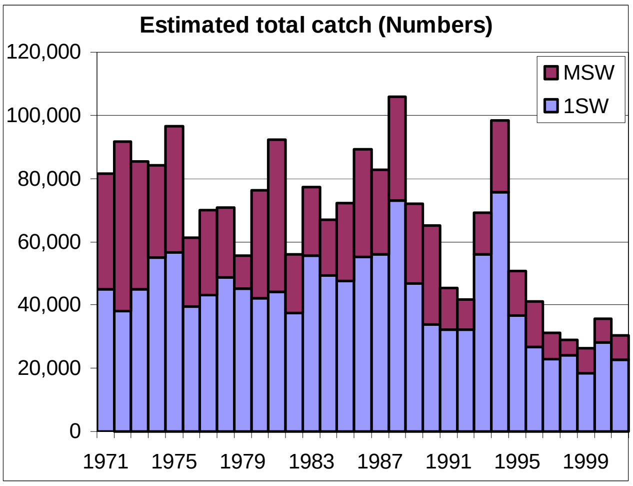


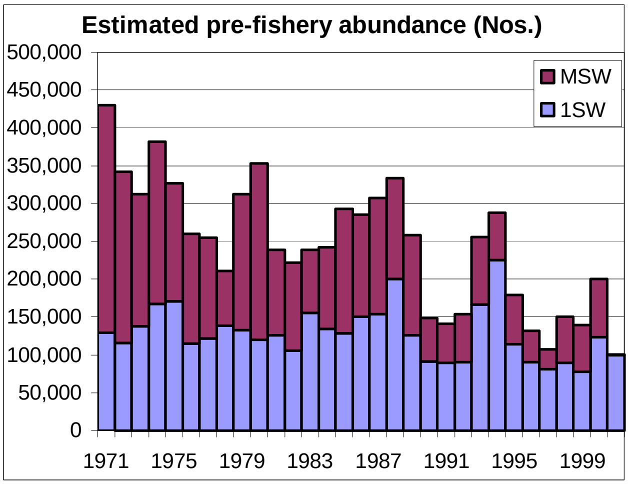
Figure 3.3.4.1h

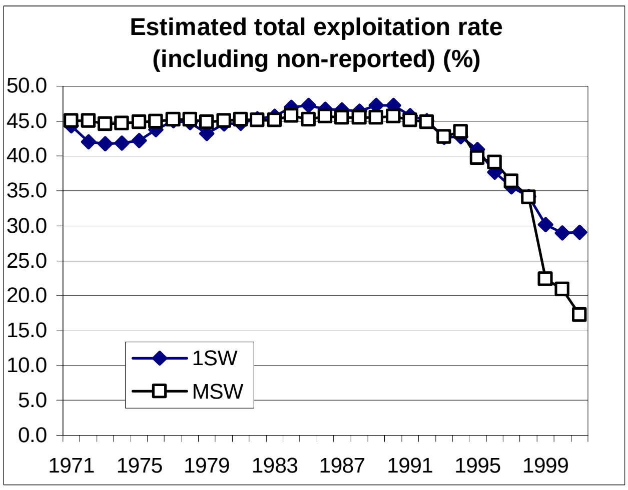
SUMMARY OF FISHERIES AND STOCK DESCRIPTION

UK(England and Wales)









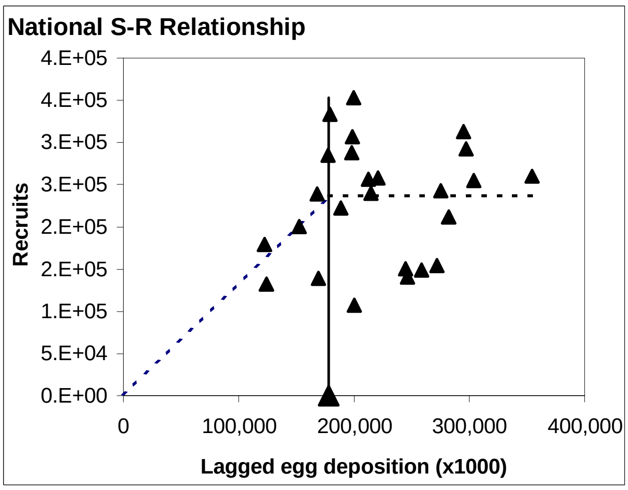
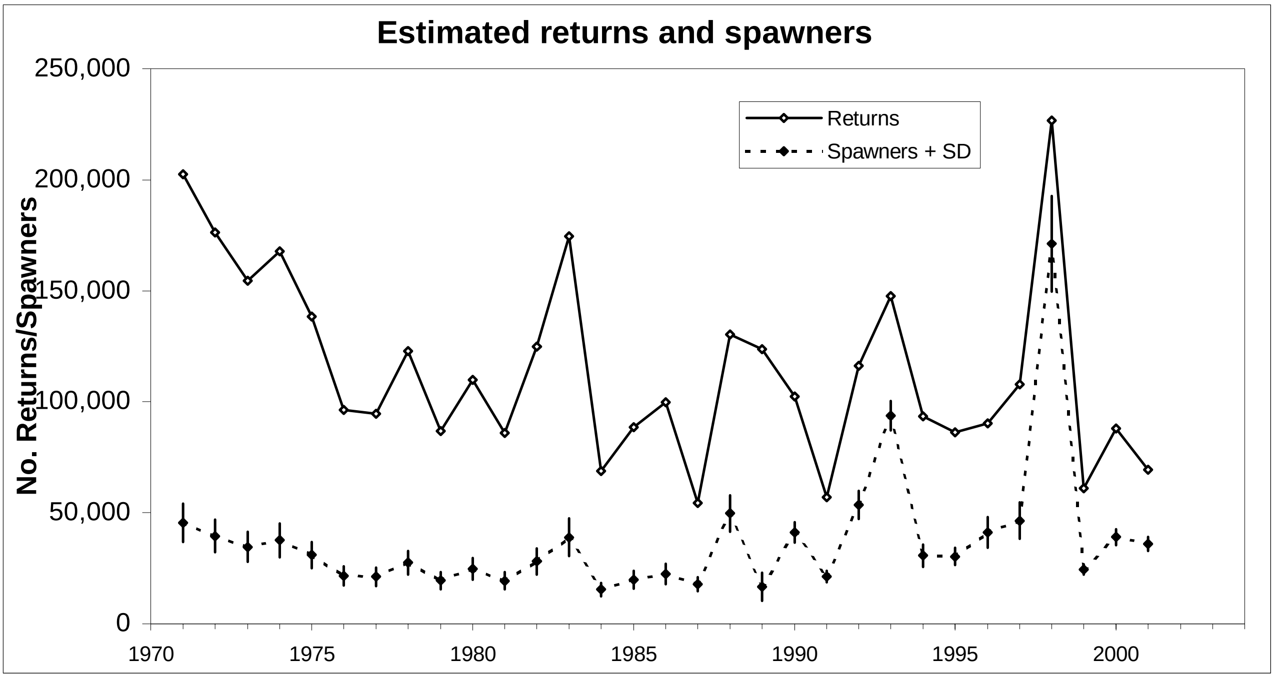
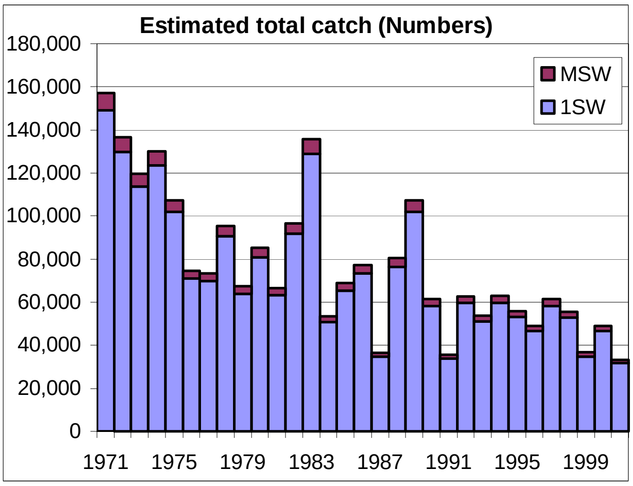
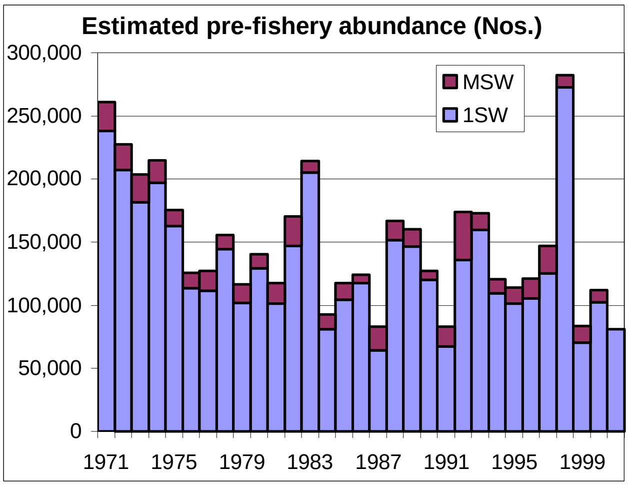
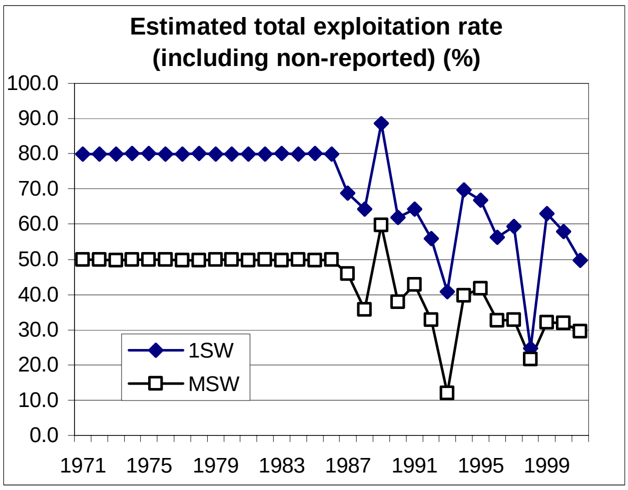


Figure 3.3.4.1i
SUMMARY OF FISHERIES AND STOCK DESCRIPTION
UK(Northern Ireland)









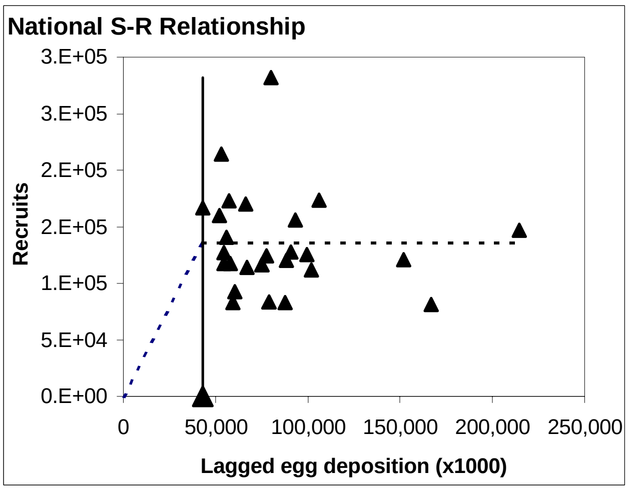
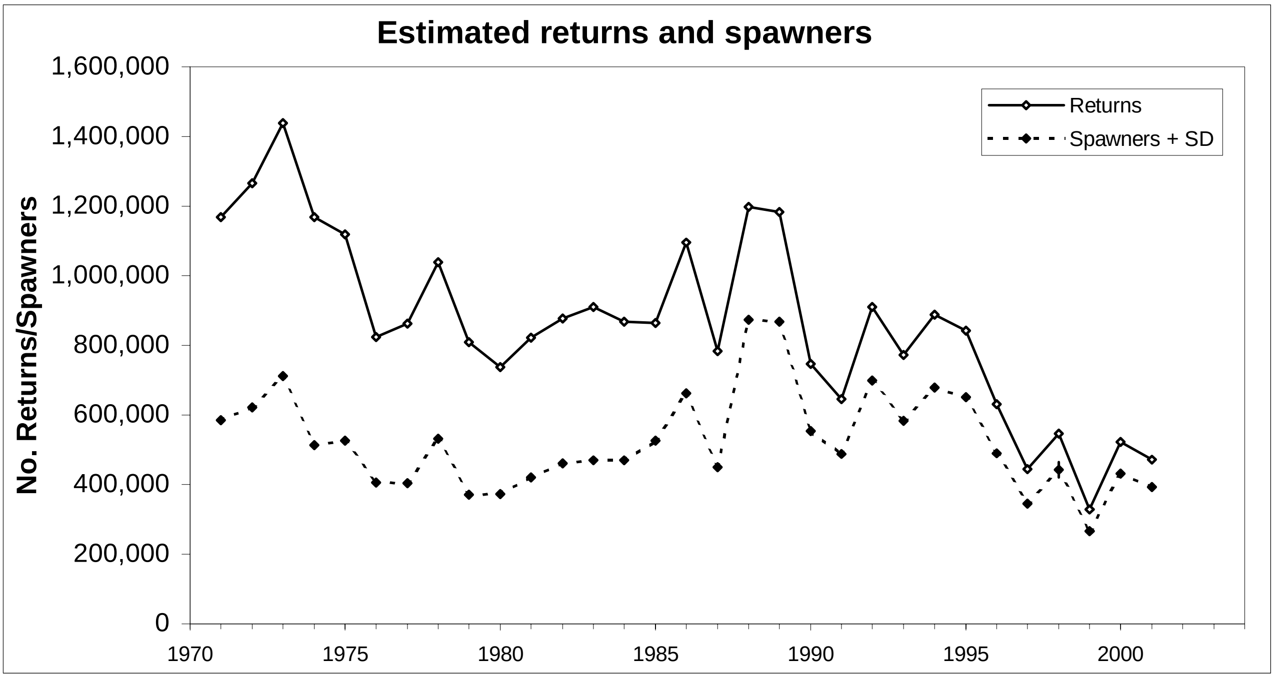
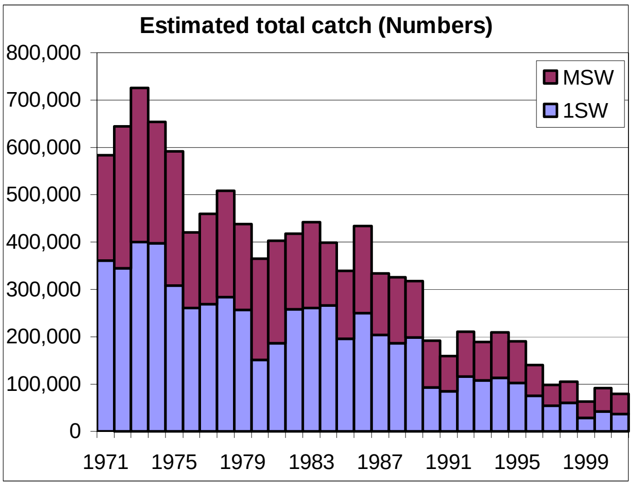


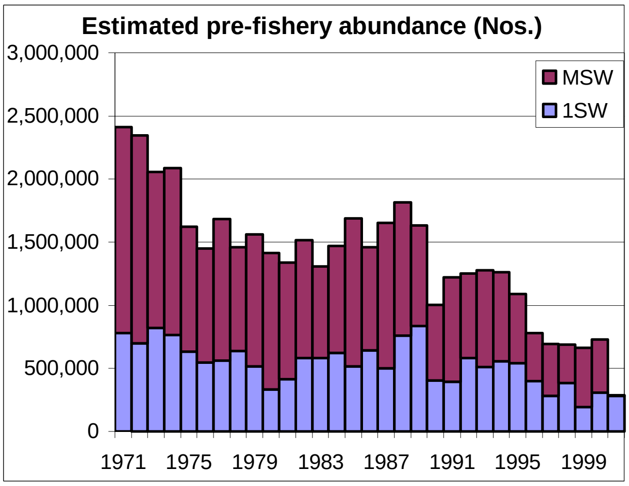
Figure 3.3.4.1j

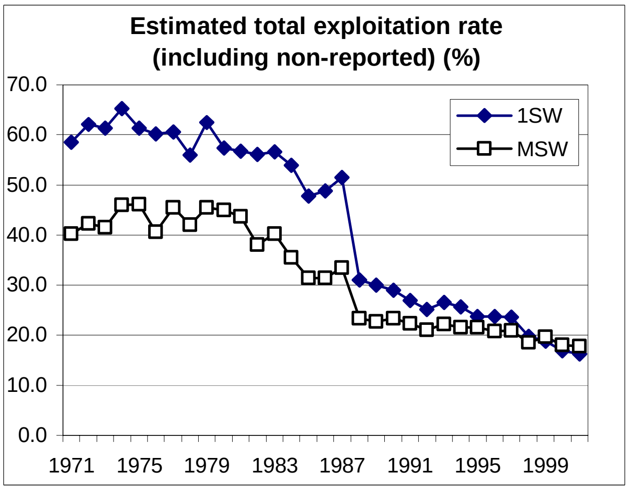
SUMMARY OF FISHERIES AND STOCK DESCRIPTION

UK(Scotland)









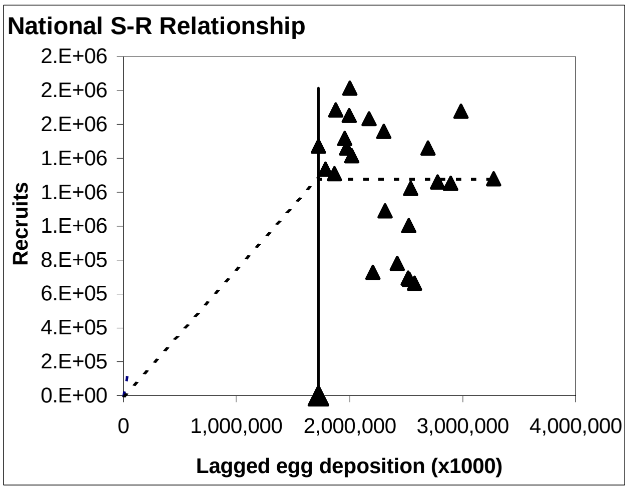
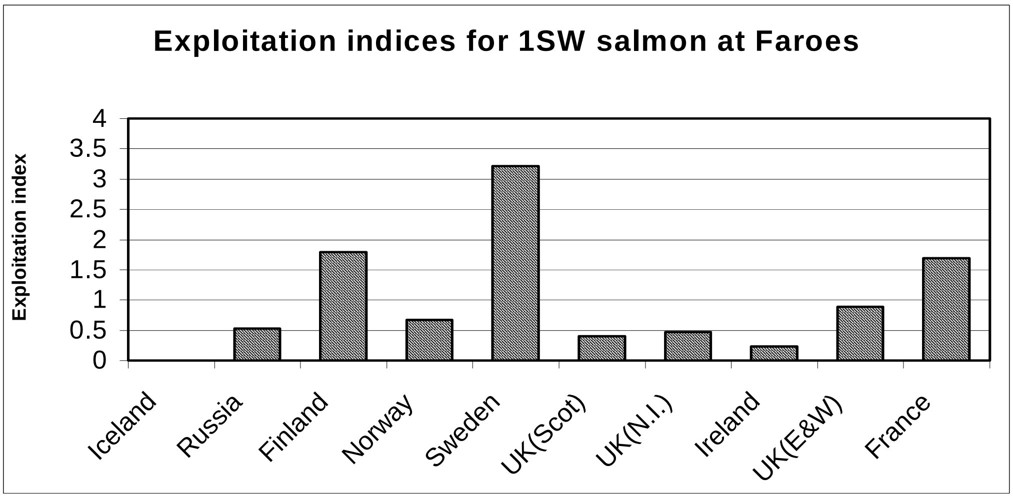
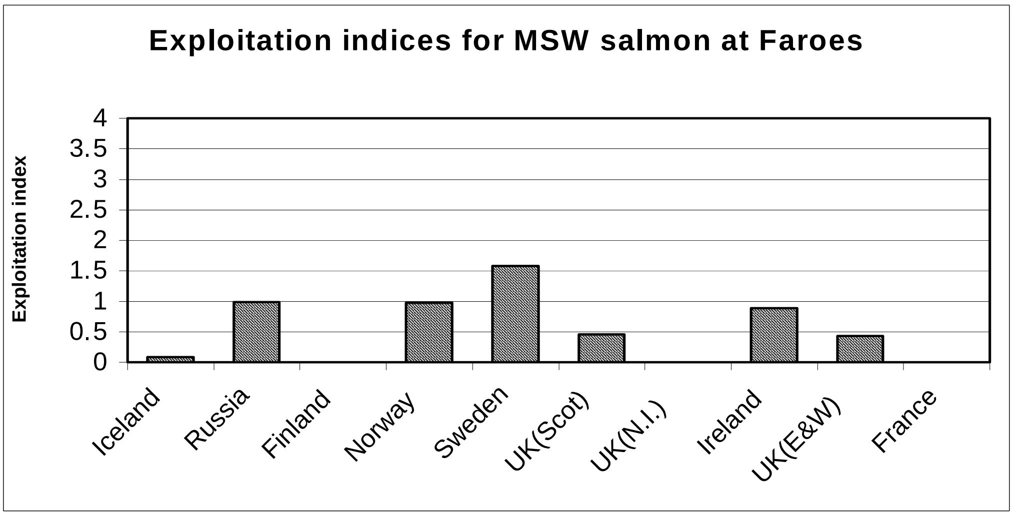


Figure 3.3.6.1. Exploitation indices for national salmon stocks in the Faroes and West Greenland fisheries





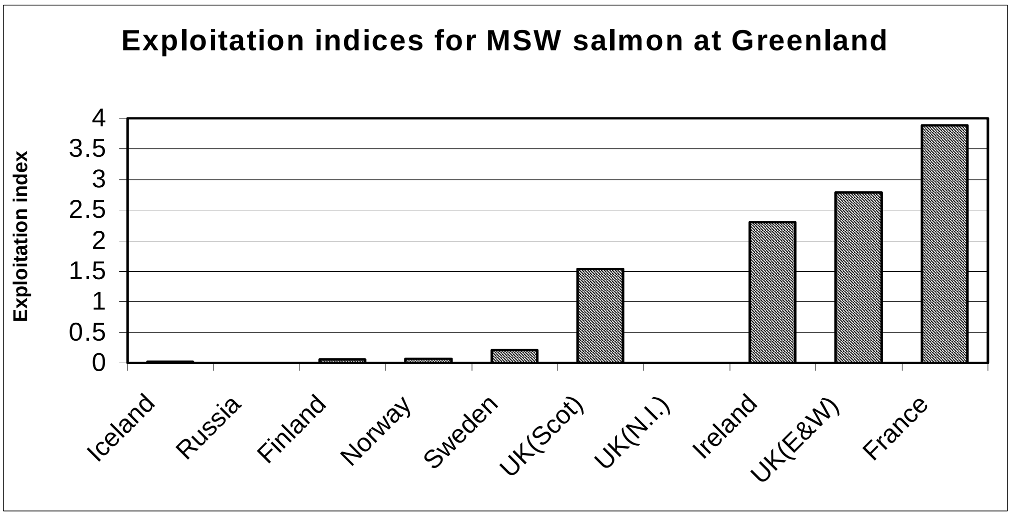
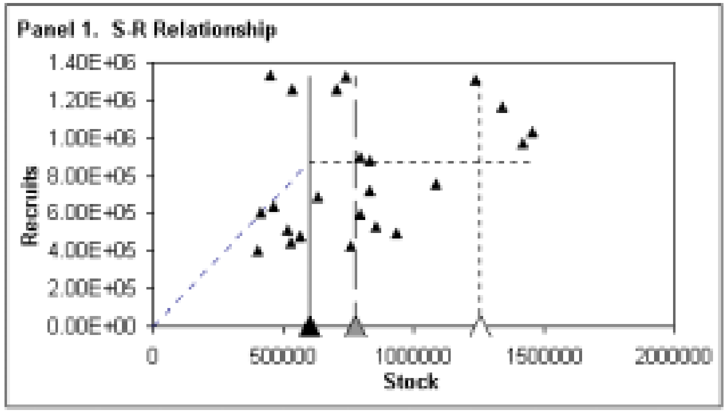


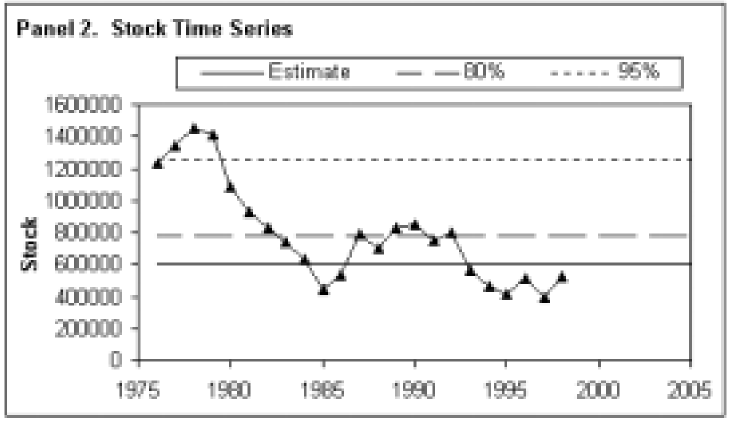
Figure 3.4.2.1 ESTIMATING REFERENCE POINTS FROM NOISY STOCK-RECRUITMENT DATA

Input data:

Year	Stock	Recruits
1975		
1976	1,237,237	1,304,323
1977	1,338,879	1,163,026
1978	1,452,365	1,030,334
1979	1,415,866	972,673
1980	1,083,518	751,420
1981	932,942	496,993
1982	829,527	879,796
1983	741,970	1,326,481
1984	632,291	691,309
1985	448,307	1,329,195
1986	532,079	1,257,963
1987	793,598	894,008
1988	705,670	1,253,827
1989	831,784	725,099
1990	852,781	531,434
1991	754,693	425,903
1992	796,406	597,981
1993	566,035	476,305
1994	463,534	633,216
1995	412,901	599,599
1996	514,821	510,517
1997	398,628	403,938
1998	525,416	441,166
1999		
2000		
2001		
2002		
2003		
2004		
2005		

	Estimate	80%	95%
Conservation limit:	598,838	777,973	1,252,155





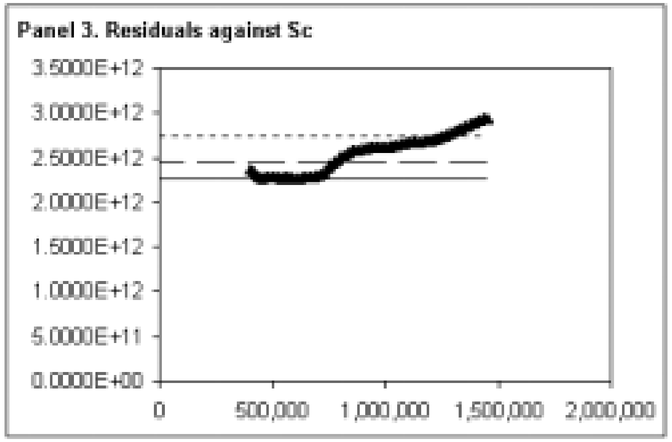
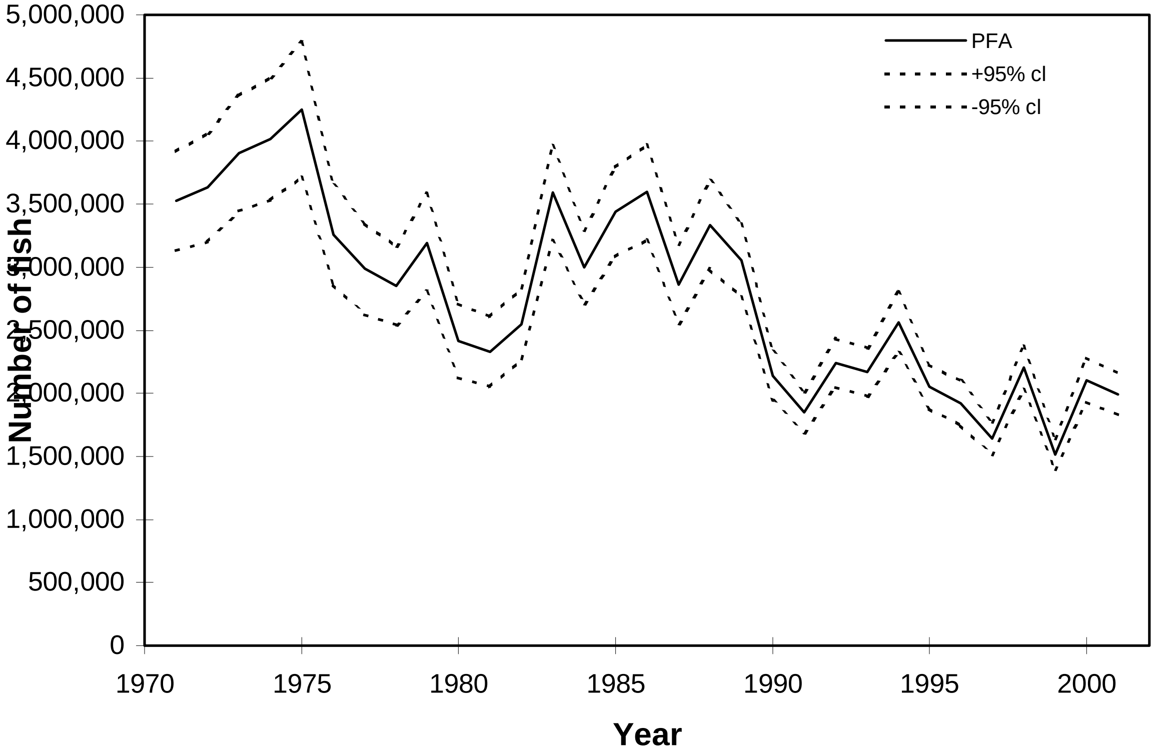


Figure 3.5.1.1 Estimated recruitment (PFA) in the NEAC area 1970-2001

a) Maturing 1SW recruits (potential 1SW returns)

(Recruits in Year N become spawners in Year N)



b) Non-maturing 1SW recruits (potential MSW returns)

(Recruits in Year N become spawners in Year N+1)

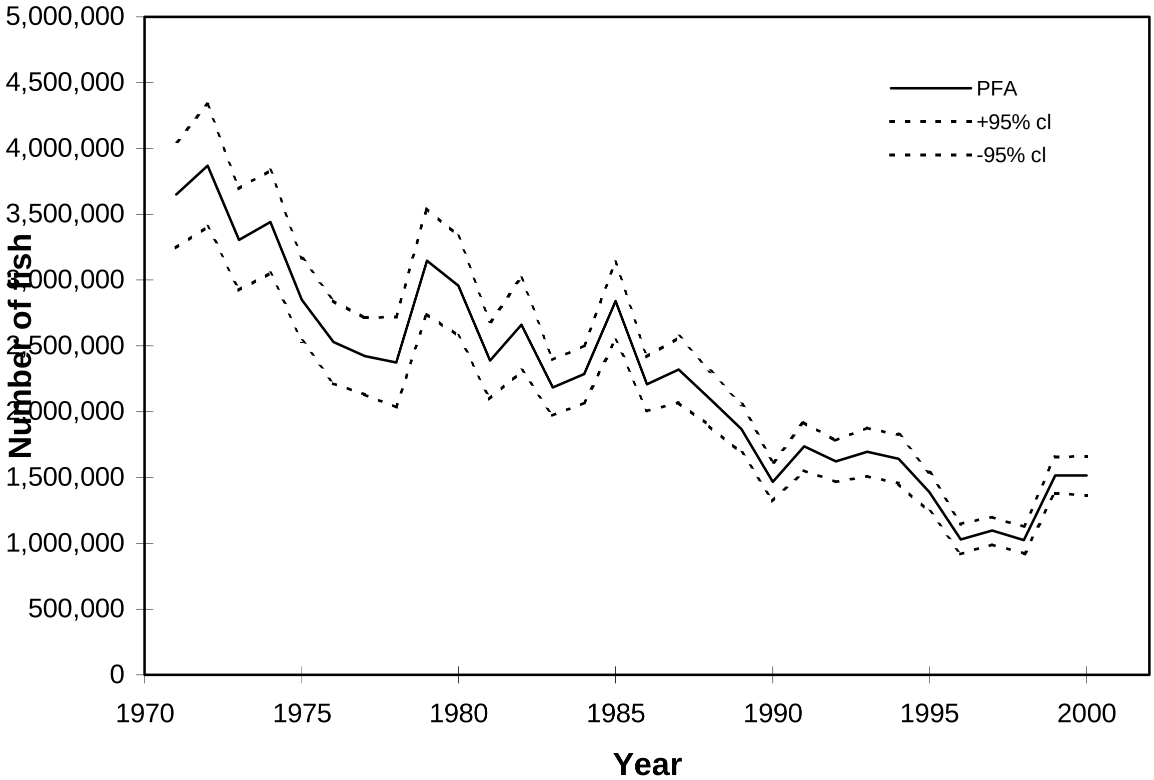
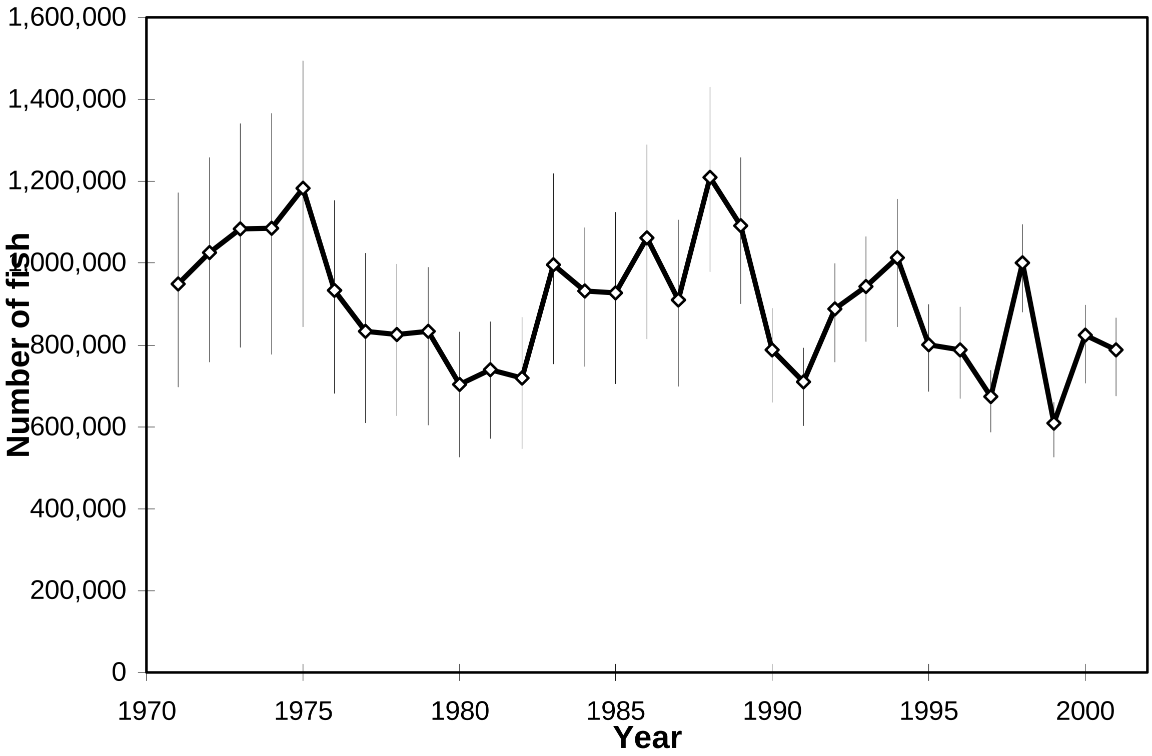


Figure 3.5.1.2 Estimated spawning escapement in the NEAC area 1970-2001

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



b) MSW spawners (and 95% confidence limits)

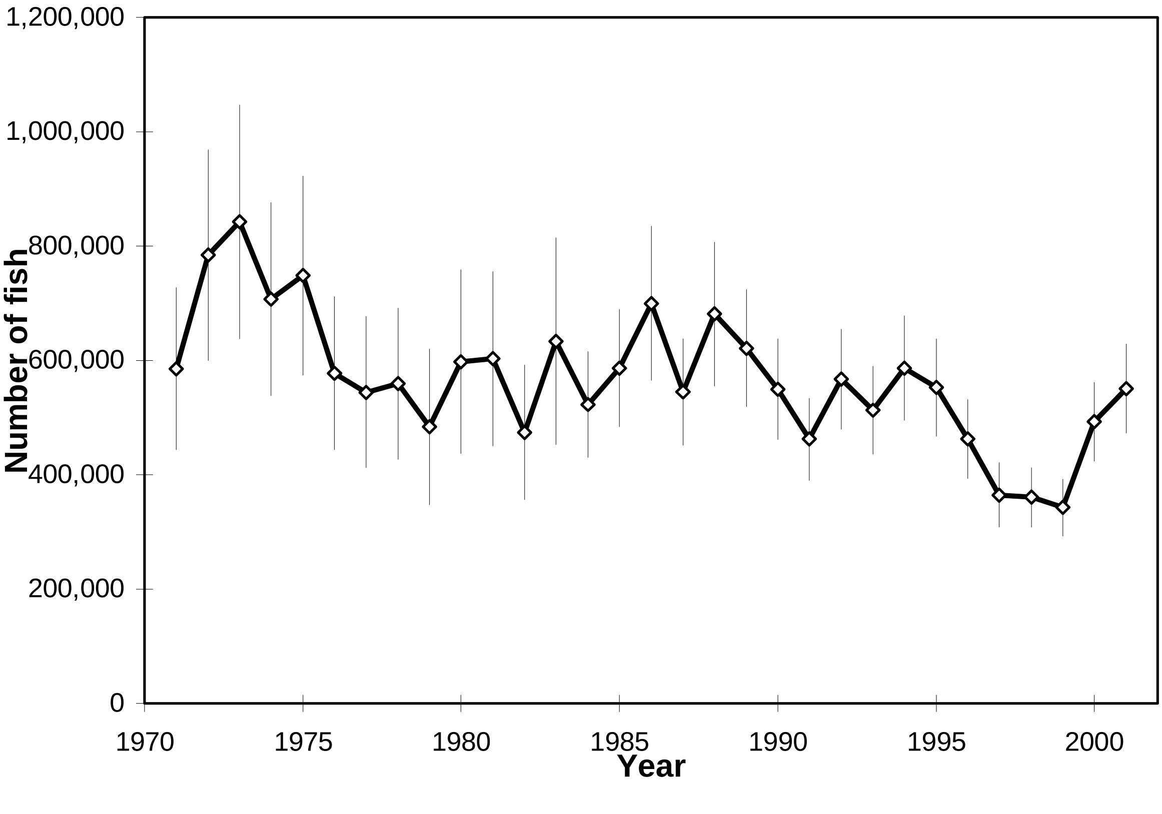
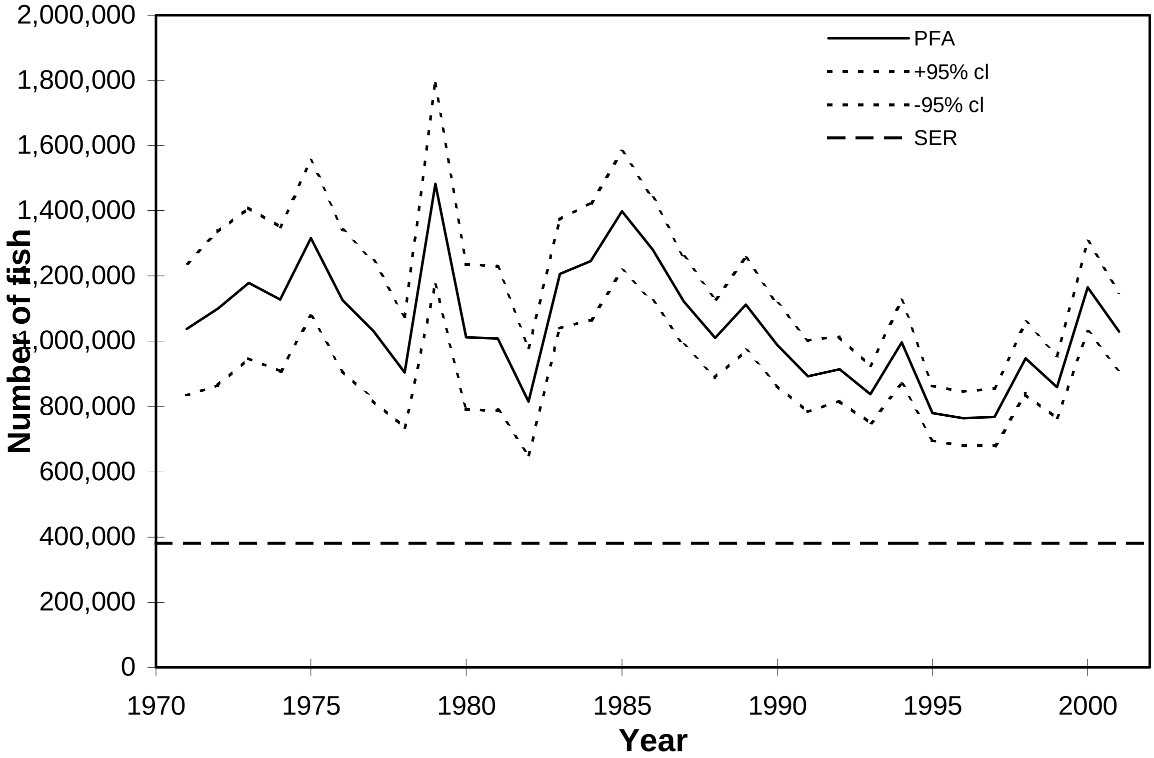


Figure 3.5.1.3 Estimated recruitment (PFA) and Spawning Escapement Reserve (SER) for maturing and non-maturing salmon in Northern Europe, 1971-2001

a) Maturing 1SW recruits (potential 1SW returns)

(Recruits in Year N become spawners in Year N)



b) Non-maturing 1SW recruits (potential MSW returns)

(Recruits in Year N become spawners in Year N+1)

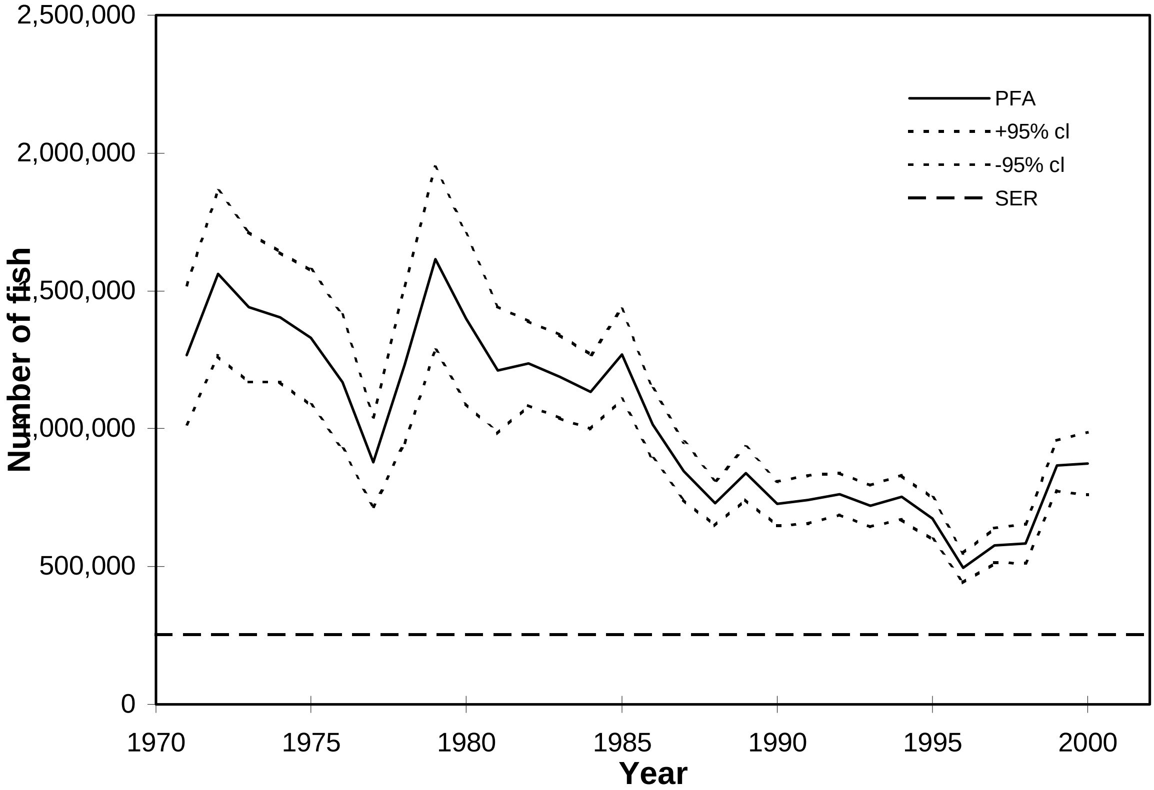
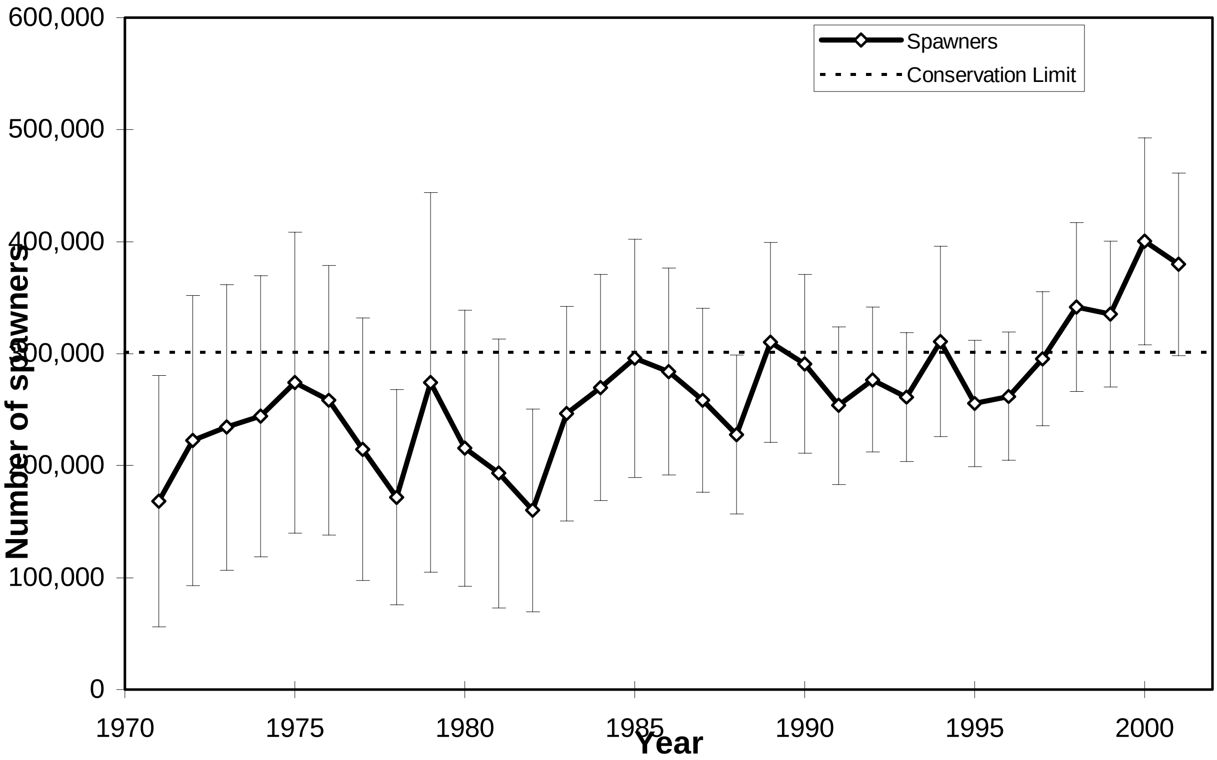


Figure 3.5.1.4 Estimated spawning escapement of maturing and non-maturing salmon in Northern Europe, 1971-2001

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



b) MSW spawners (and 95% confidence limits)

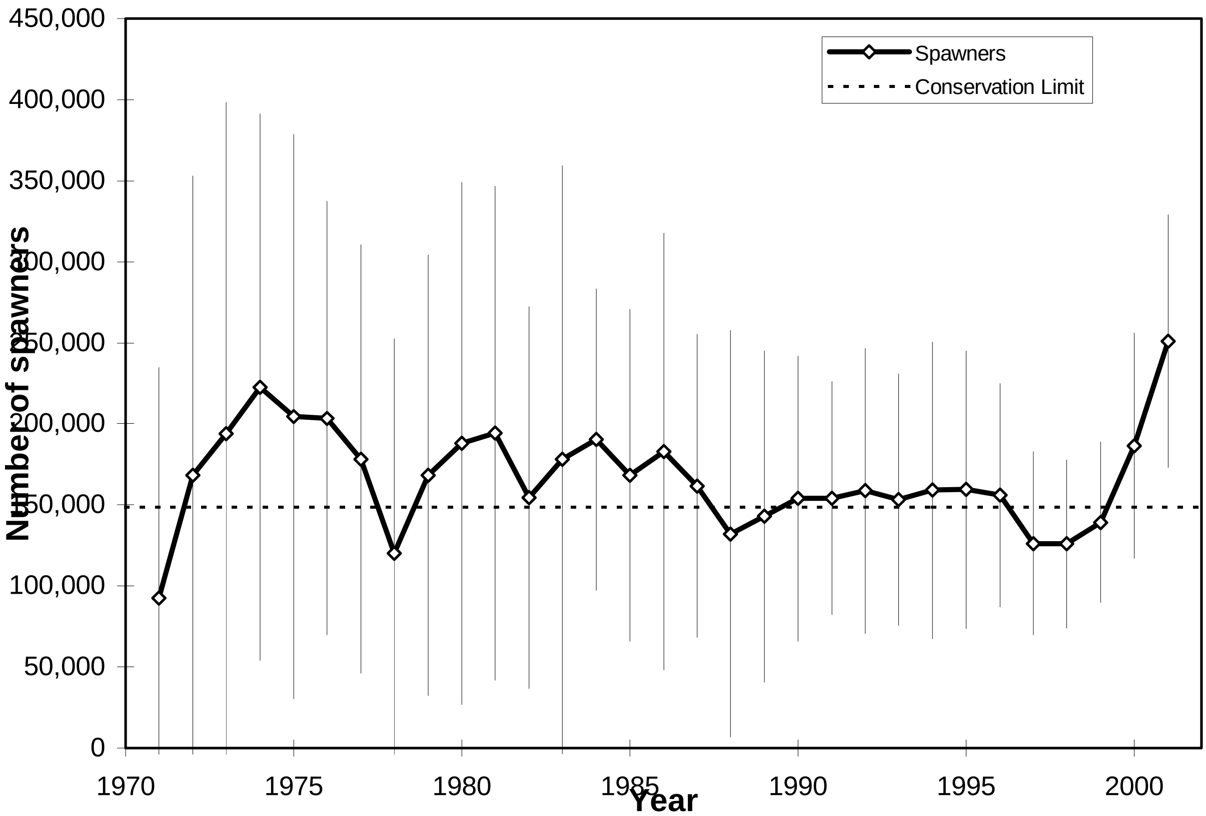
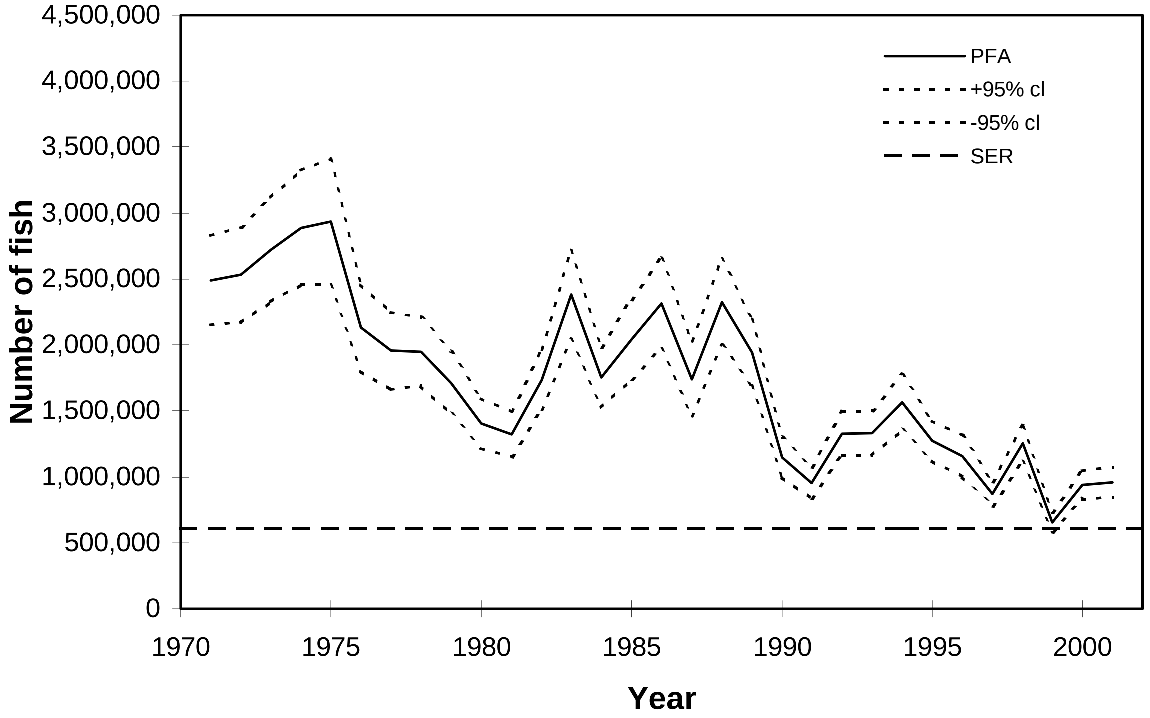


Figure 3.5.1.5 Estimated recruitment (PFA) and Spawning Escapement Reserve (SER) for maturing and non-maturing salmon in Southern Europe, 1971-2001

a) Maturing 1SW recruits (potential 1SW returns)

(Recruits in Year N become spawners in Year N)



b) Non-maturing 1SW recruits (potential MSW returns)

(Recruits in Year N become spawners in Year N+1)

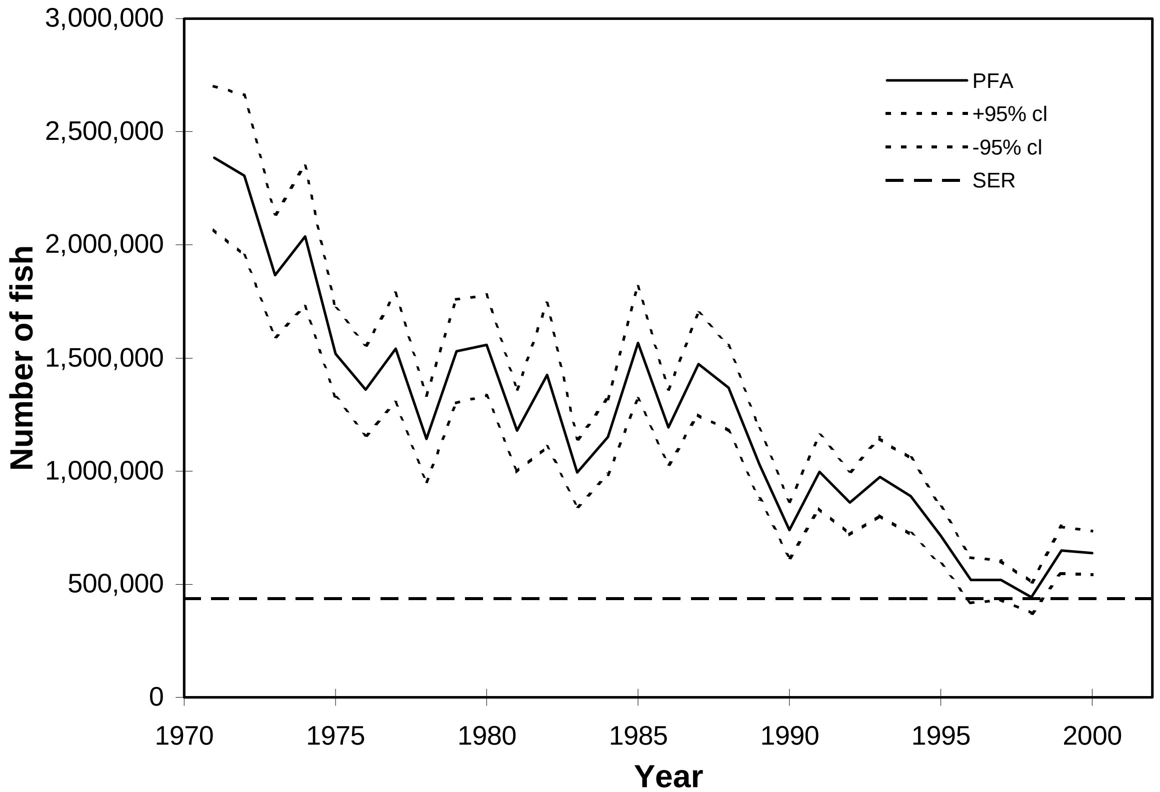
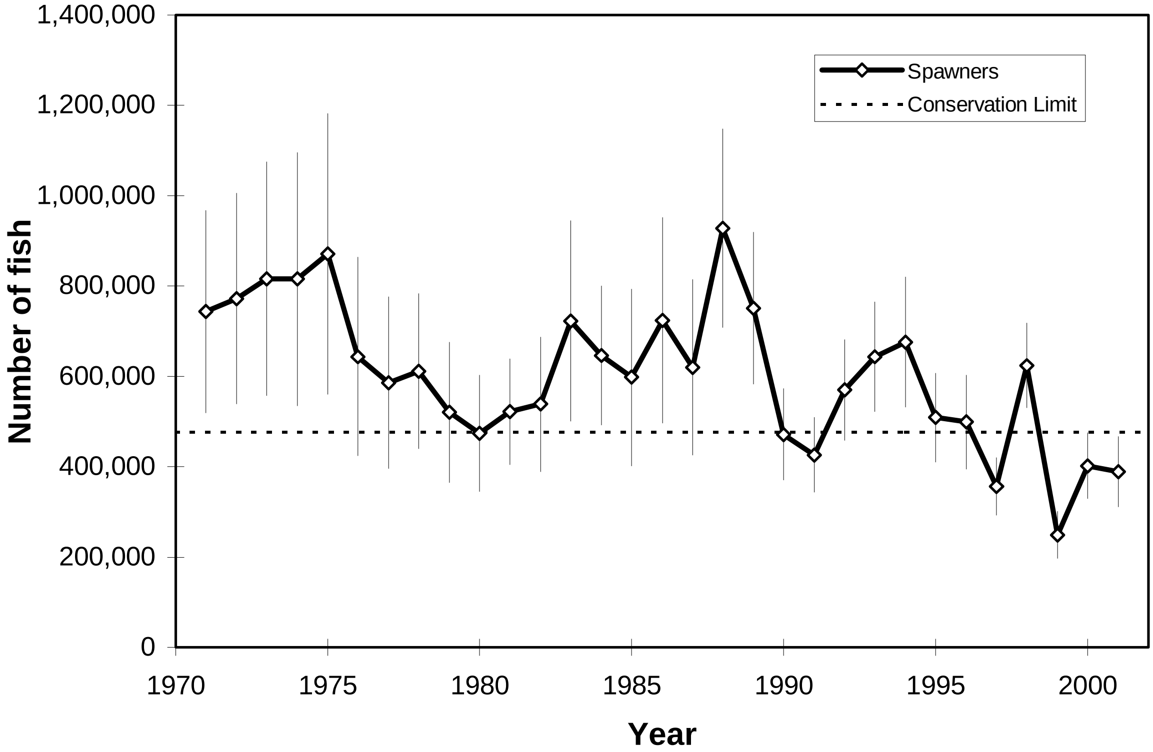


Figure 3.5.1.6 Estimated spawning escapement of maturing and non-maturing salmon in Southern Europe, 1971-2001

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



b) MSW spawners (and 95% confidence limits)

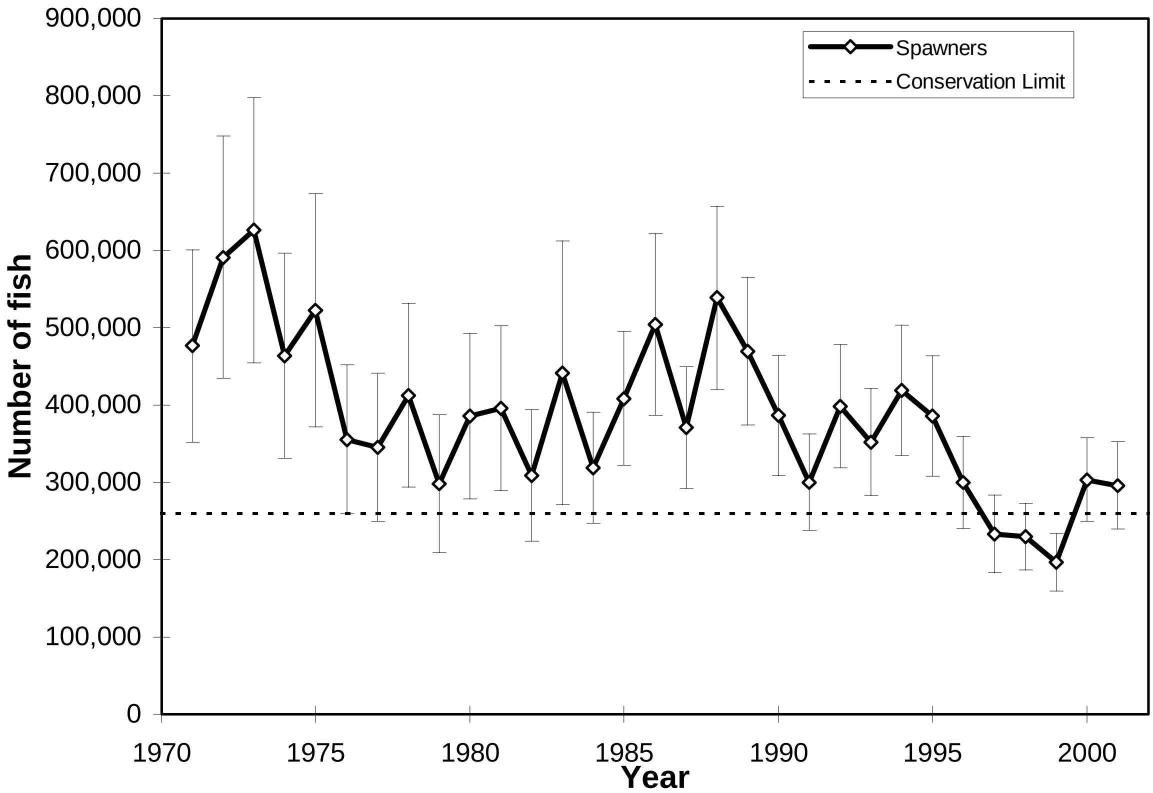


Figure 3.5.2.1 Pair-wise plots of data for Southern European Salmon.

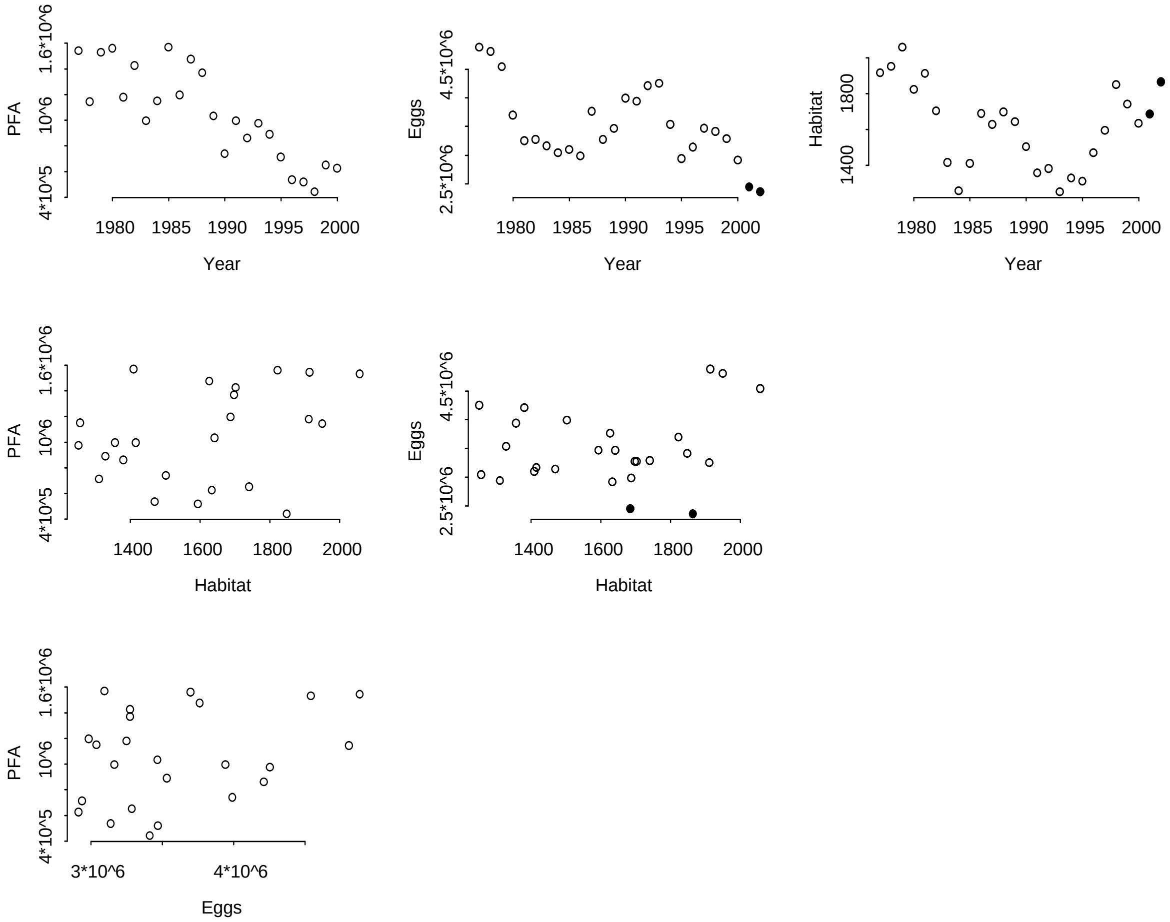


Figure 3.5.2.2 Aggregate prediction error for different models.

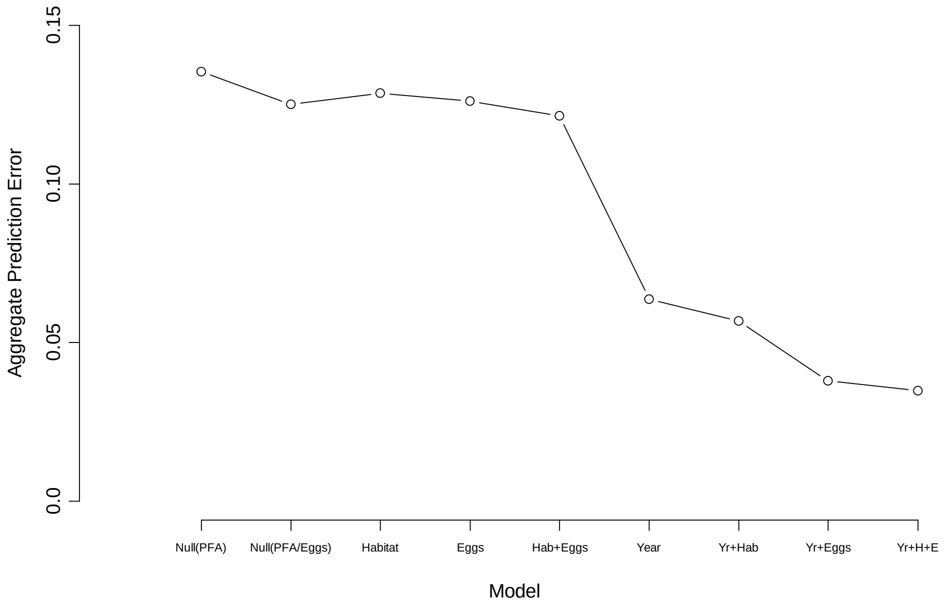


Figure 3.5.2.3 *PFA* trends and predictions for non-maturing salmon from the NEAC southern European stock.

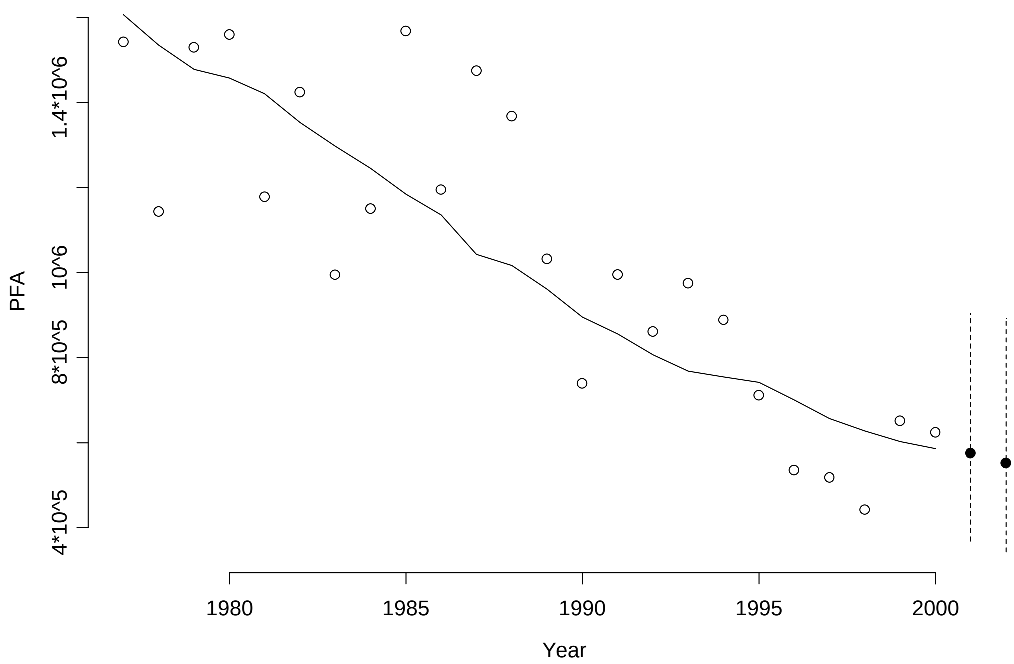


Figure 3.7.1.1. Vertical distribution of catch per trawl hour (CPUE) and prevalence of trawl hauls with post-smolt captures in the Norwegian Sea , May-August 2001

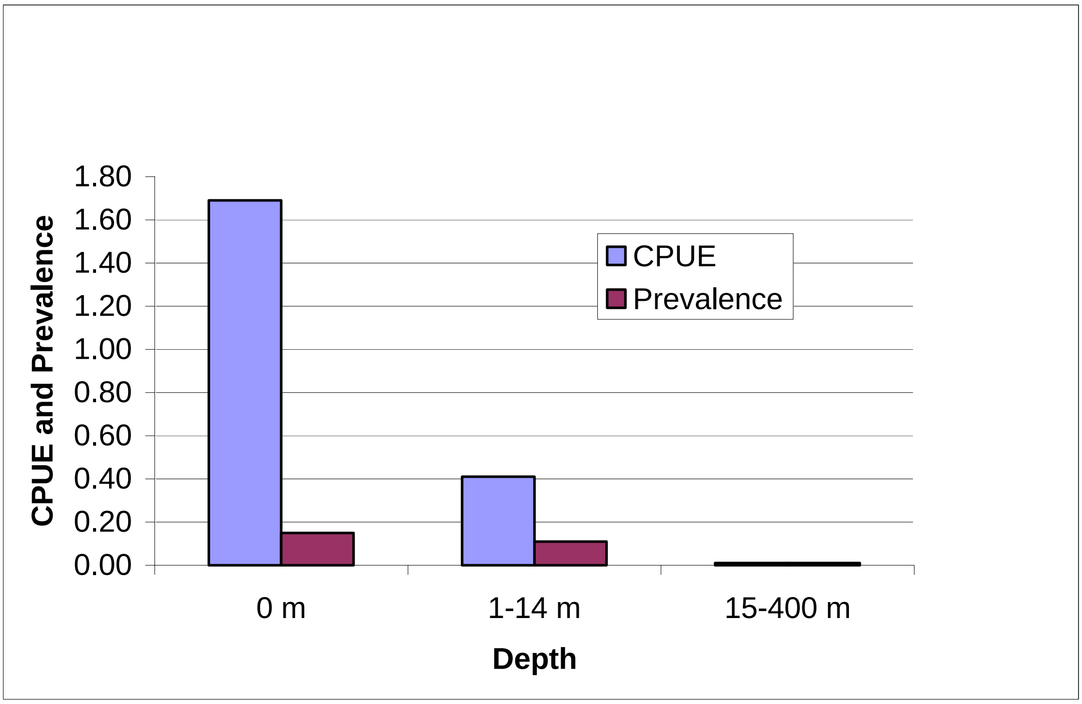
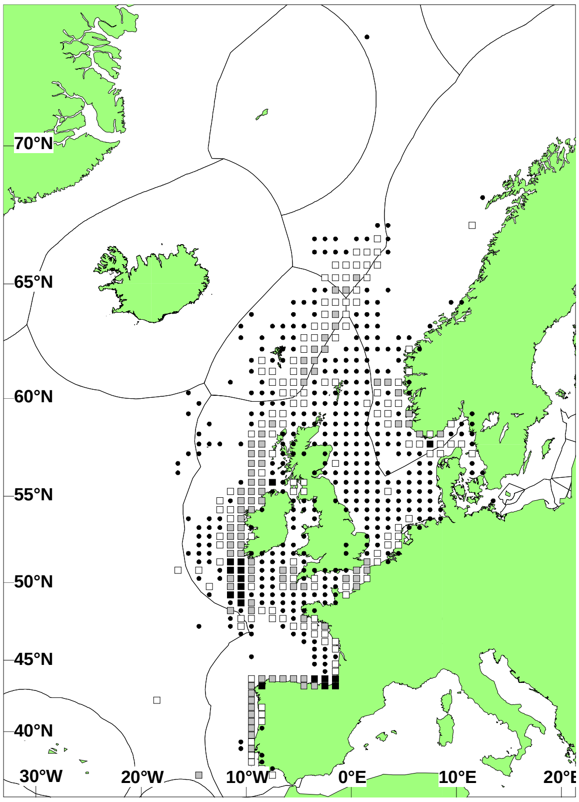


Figure 3.7.1.2. Distribution of the total mackerel catches 1977-2000 by statistical rectangle in 2nd (left) and 3rd (right) quarter (from ICES 2002/G:03).



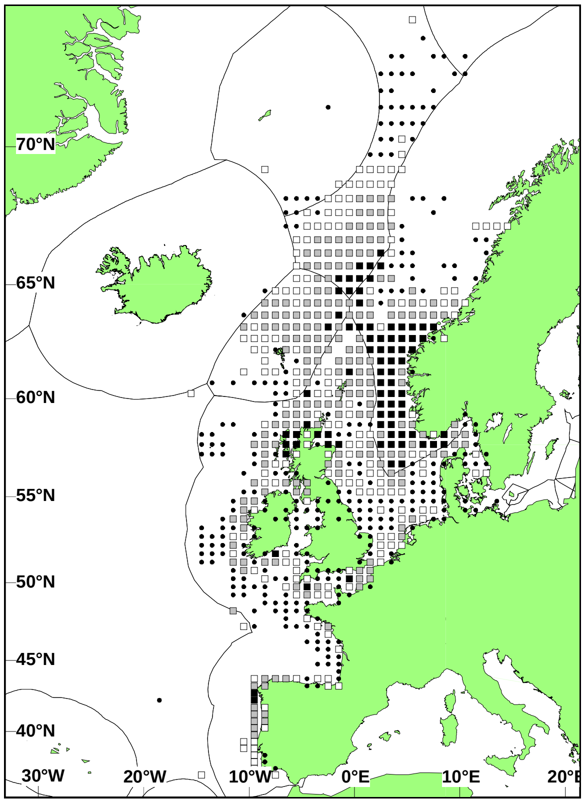


Figure 3.7.1.3. Simultaneous occurrence of post-smolts and mackerel in an IMR salmon survey in the Norwegian Sea, 13- 16 June 2001. Stars indicate captures of post- smolts and mackerel. Circles indicate mackerel captures without post-smolt, and black triangle indicates salmon only.

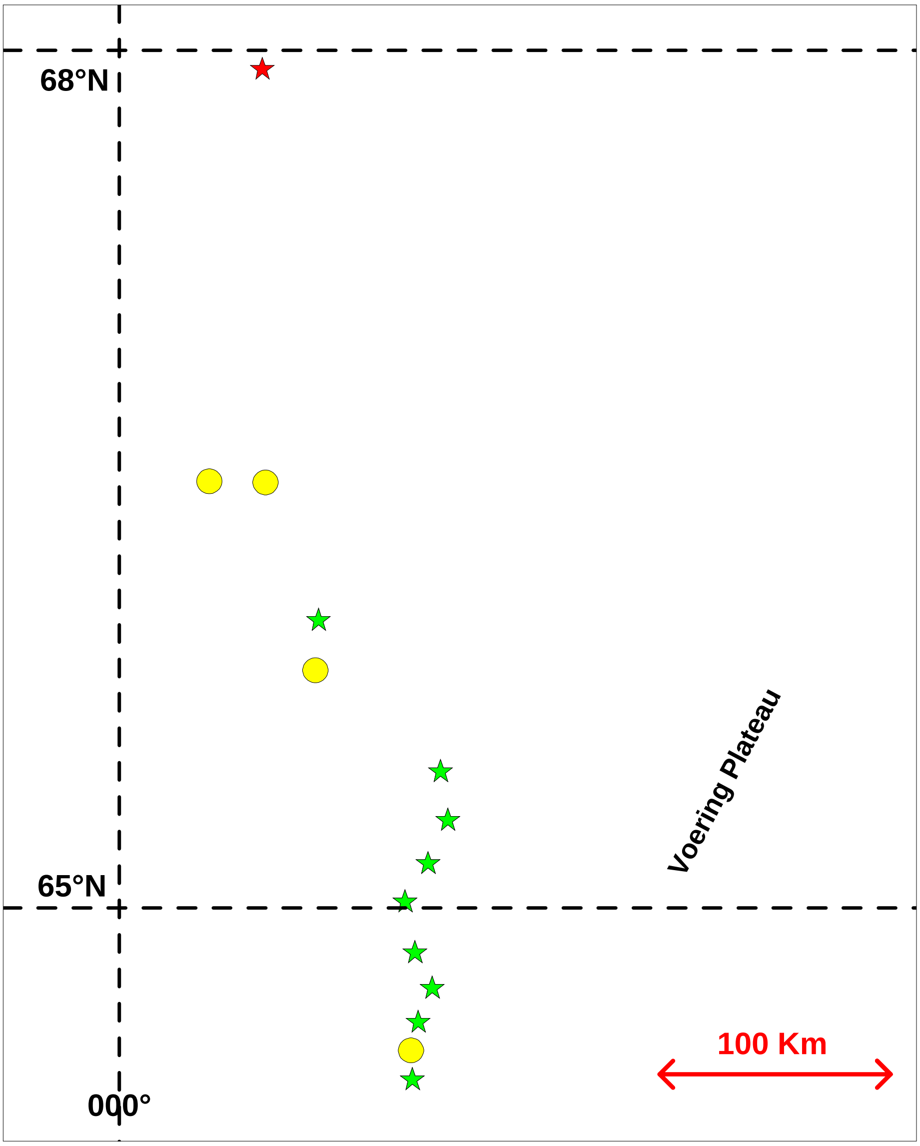


Figure 3.7.1.4. Capture of post-smolts from IMR research survey 13-16 July 2001 superimposed on distribution of commercial captures of mackerel in 2nd quarter 2000 (ICES 2002/ACFM:6). Legends- Post-smolt trawling: crosses- no post-smolts; filled triangles-post-smolt captures. Mackerel legends are presented in the figure.

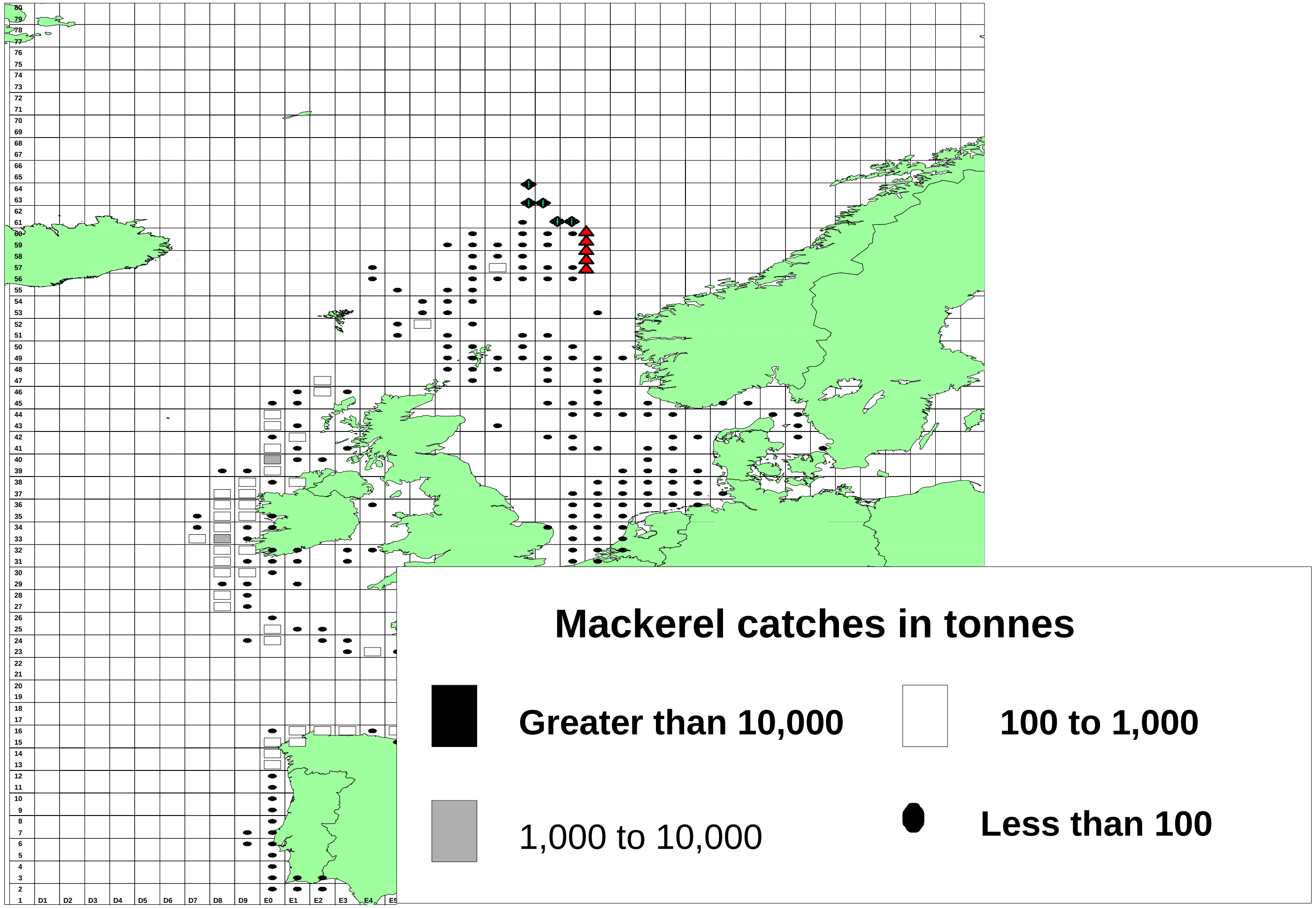


Figure 3.7.1.5. Post-smolt captures in pelagic surveys 1990 - 2000. Post-smolt legends in figure. Mackerel fishing areas 1977 - 2000 are superimposed as a shaded area. The higest trawl captures occurred in international areas close to the Norwegian EEZ. Norwegian purse seine capture areas are hatched.

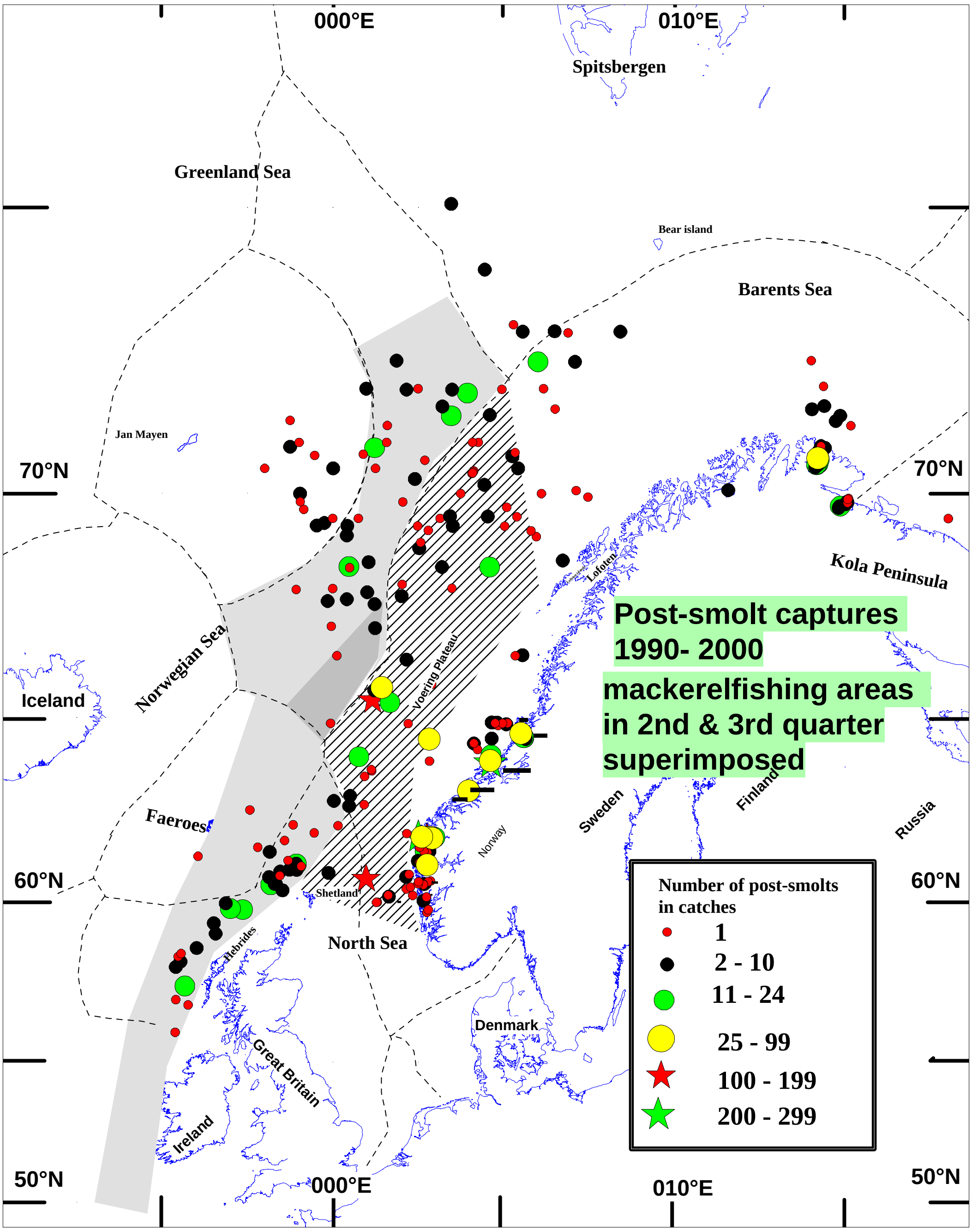


Figure 3.7.2.1. Pelagic trawl tows in 2001 presented for survey areas where salmon could be expected to occur in time and space during summer months. The tows are divided into three groups depending on the maximum depth of the head-rope.

Legends: Circle: 0 m; Star: 2 –14 m; Triangle: 15 – 400 m.

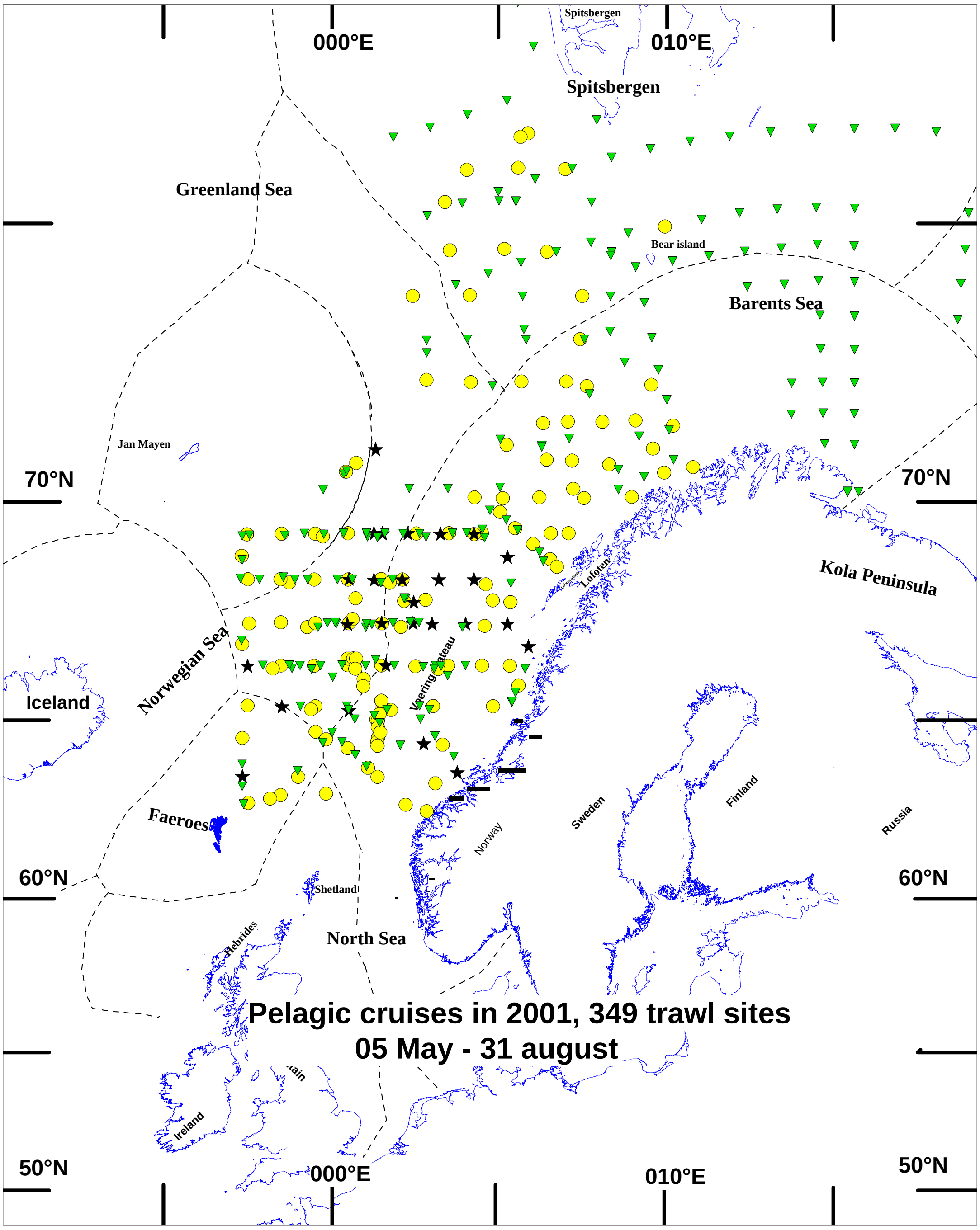
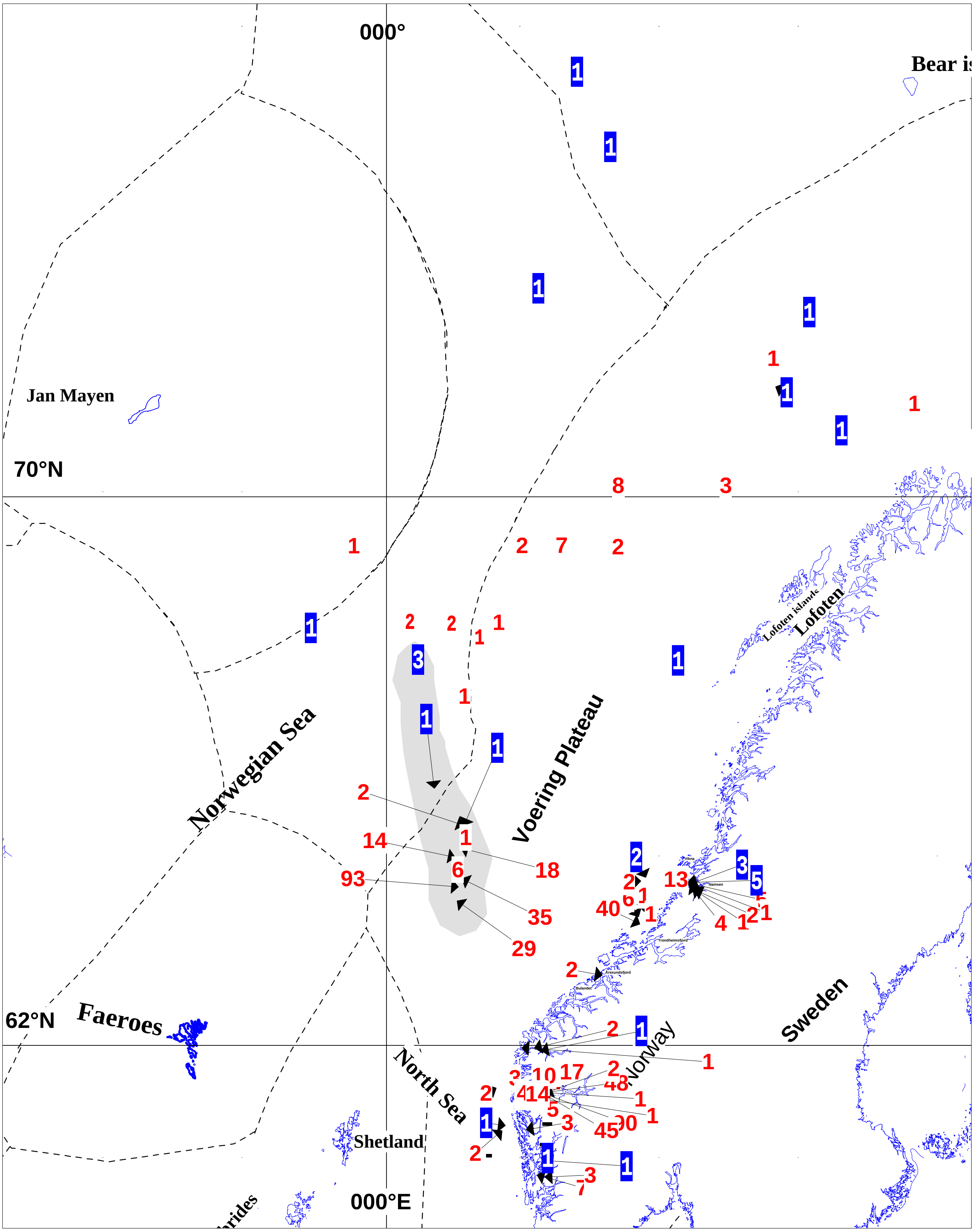


Figure 3.7.2.2. Distribution of catches of post-smolts (numbers captured in black) and salmon (numbers captured in white on dark). Hyphenated lines delineate EEZs. Dedicated salmon survey in shaded area.



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

Three user groups exploited salmon in Canada in 2001: Aboriginal peoples, residents fishing for food in Labrador, and recreational fishers. Commercial quotas normally fished by Aboriginal peoples in Ungava Bay (zone Q11) remained closed. Hence there were no commercial fisheries in Canada in 2001.

The following management measures were in effect in 2001:

Aboriginal peoples' food fisheries: In Québec, Aboriginal peoples' food fisheries took place subject to agreements or through permits issued to the bands. There are 10 bands with subsistence fisheries in addition to the fishing activities of the Inuit in Ungava (Q11), who fished in estuaries or within rivers. The permits generally stipulate gear, season, and catch limits. Catches for subsistence fisheries have to be reported collectively by each Aboriginal user group. However, if reports are not available, the catches are estimated. In the Maritimes and Newfoundland (SFAs 1 to 23), food fishery harvest agreements were signed with several Aboriginal peoples groups (mostly First Nations) in 2001. The signed agreements often included allocations of small and large salmon. Harvests which occurred both within and outside agreements were obtained directly from the Aboriginal peoples. Under agreements reached in 2001, several Aboriginal communities in Nova Scotia were permitted to retain "adipose clipped" 1SW salmon from 5 Atlantic coast rivers (Musquodoboit, Sackville, Mushamush, LaHave, and Tusket) in SFA's 20 and 21, using methods that permitted live release of wild fish. Harvest by Aboriginal peoples with recreational licenses are reported under the recreational harvest categories.

Residents food fisheries in Labrador: In the Lake Melville (SFA 1) and the coastal southern Labrador (SFA 2) areas, DFO allowed a food fishery for local residents. Residents who requested a license were permitted to retain a maximum of four (4) salmon of any size while fishing for trout and charr; 4 salmon tags accompanied each license. The license restricted the fishing gear to a gillnet of 15 fathoms (27.4 m) and 3.5 inches (89 mm) mesh. The seasons were June 15-July 2 and July 24-August 19 in SFA 1 and July 15-August 31 in SFA 2. All licensees were to complete logbooks.

Recreational fisheries: Recreational fisheries management in 2001 varied by area (Figure 4.1.1.2). Except in Québec and Labrador (SFA 1 and 2), only small salmon could be retained in the recreational fisheries.

The seasonal bag limits in the recreational fishery remained at eight small salmon in New Brunswick and in Nova Scotia. In SFA 16 and in Nepisiquit River (SFA 15) of New Brunswick, the small salmon daily retention limit remained at one fish. In the remainder of SFA 15 and in Nova Scotia (SFA 18), the daily retention limits were two small salmon. The maximum daily catch limit was four fish daily. In SFA 17 (PEI), the season and daily bag limits were 7 and 1 respectively. Catch-and-release fishing only for all sizes of Atlantic salmon was in effect in SFA 19 of Nova Scotia. SFAs 20-23 of Nova Scotia and New Brunswick were closed to all salmon angling, except for four acid-impacted rivers on the Atlantic coast of Nova Scotia, where retention of small salmon, mostly of hatchery origin, was allowed. Eight Atlantic coast rivers of Nova Scotia were opened for a hook and release fishery from June 1 to July 15 in 2001.

For insular Newfoundland (SFAs 3 to 14A) and the Strait of Belle Isle of Labrador (SFA 14B), the third year of a three-year management plan was continued for the recreational fishery which allowed differing seasonal retention limits based on the status of the salmon stocks in the rivers. Retention limits ranged from a seasonal limit of 6 fish on Class I rivers, to no retention and catch-and-release only on Class IV rivers (five rivers in 2001). Some rivers were closed to all angling and were not assigned a class number. The river classification scheme rated individual rivers as Class I (highest) to Class IV (lowest) according to their ability to sustain angling activities as follows:

Class I – large rivers with a seasonal bag limit of 6 fish,

Class II – smaller rivers with a seasonal bag limit of 4 fish,

Class III – rivers with a seasonal bag limit of 2 fish,

Class IV – rivers with catch and release only.

Special class – with various management plans.

In SFAs 1 and 2 of Labrador, there was a seasonal limit of four fish, only one of which could be a large salmon, except in those rivers of SFA crossed by the new Trans Labrador Highway, where a seasonal retention limit of 2 small salmon was imposed.

In Québec, management rules were set before the season opening as a way to reach conservation limits on each river. Three different fishing permits are sold. The first allows a landing total of 7 salmon for the season. The second is a one day permit and allows a landing total of 2 salmon. The third is a catch and release permit only. The northern zones (Q8, Q9 and Q11) include 44 rivers that were managed mainly on a zonal basis. Sport fishing was permitted on all rivers except five, and retention of both small and large salmon was allowed throughout the northern zones. The daily limit was three fish in Q9, two in Q8, and one in zone Q11. Release of large salmon occurred mainly on a voluntary basis. The 74 rivers of the southern zones were managed river by river. Fishing was not allowed on four rivers, retention of small salmon only was in force on 37 rivers, and retention of small and large was allowed on 29 rivers. On these rivers, fishing for the day would end if the first fish caught was a large salmon. If the first fish was a small salmon, then fishing could continue on most rivers until the second fish, small or large was caught.

USA

There was no fishery for sea-run Atlantic salmon in the USA in 2001; as a result of angling closures since 1999, effort measured by license sales was 0.

France (Islands of Saint-Pierre and Miquelon)

For the Saint-Pierre and Miquelon fisheries in 2001, there were 10 professional and 42 recreational gillnet licenses issued. The number of professional fishermen has increased by two licenses from 2000 and the number of recreational licenses increased by seven licenses since 2000, the maximum level encountered since 1995. No salmon fishing was allowed within 360 m of the mouths of two rivers (Belle-RiviΠre and Dolisie), as Article 12 of the 2001 salmon fishing regulations indicated the possibility of salmon spawning in these rivers.

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

4.1.2 Catch and catch per unit effort (CPUE)

Canada

The provisional harvest of salmon in 2001 by all users was 145 t, about 5% less than the 2000 harvest of 153 t (Table 2.1.1.1; Figure 4.1.2.1). The 2001 harvest was 48,760 small salmon and 12,102 large salmon, 12% fewer small salmon and 15% more large salmon, compared to 2000 (Table 4.1.2.1). The dramatic decline in harvested tonnage since 1988 is in large part the result of the reductions in commercial fisheries effort, the closure of the insular Newfoundland commercial fishery in 1992, the closure of the Labrador commercial fishery in 1998, and the closure of the Québec commercial fishery in 2000 (Figure 4.1.2.1). These reductions were introduced as a result of declining abundance of salmon.

The 2001 harvest of small and large salmon, by number, was divided among the three user groups in different proportions depending on the province and the fish-size group exploited (Table 4.1.2.1). Newfoundland reported the largest proportion of the total harvest of small salmon and Québec reported the greatest share of the large salmon harvest. Recreational fisheries exploited the greatest number of small salmon in each province, accounting for 84% of the total small salmon harvests in eastern Canada. Unlike years previous to 1999 when commercial fisheries took the largest share of large salmon, food fisheries (including the Labrador resident food fishery) accounted for the largest share in 2001 (55% by number).

Aboriginal peoples' food fisheries: Harvests in 2001 (by weight) were up 12% from 2000 and 14% above the previous 5-year average harvest. In some cases, particularly in the Maritime provinces, Aboriginal peoples' food fisheries harvests in 2001 were less than the allocations.

Aboriginal peoples' food fisheries			
		% large	
Year	**Harvest (t)**	**by weight**	**by number**
1990	31.9	78	
1991	29.1	87	
1992	34.2	83	
1993	42.6	83	
1994	41.7	83	58
1995	32.8	82	56
1996	47.9	87	65
1997	39.4	91	74
1998	47.9	83	63
1999	45.9	73	49
2000	45.7	68	41
2001	51.2	74	50

Residents fishing for food in Labrador: The estimated catch for the entire fishery in 2001 was 5.0 t, about 2,100 fish (76% small salmon by number).

Recreational fisheries: Harvest in recreational fisheries in 2001 totalled 46,446 small and large salmon, 16% below the previous 5-year average and 8% below the 2000 harvest level (Figure 4.1.2.2). The small salmon harvest of 40,948 fish was a decrease of 16% from the previous 5-year mean. The large salmon harvest of 5,498 fish was a 10% decline from the previous five-year mean. Small and large salmon harvests were down 11% and up 19% from 2000, respectively. The small salmon size group has contributed 87% on average of the total harvests since the imposition of catch-and-release recreational fisheries in the Maritimes and insular Newfoundland (SFA 3 to 14B, 15 to 23) in 1984 (Figure 4.1.2.2).

Recreational catches (including retained and released fish) of small salmon in 2001 were similar to or above the 1984 to 1991 mean in only two fishing areas of Québec (Q1,Q3), SFA 7 of Newfoundland and throughout Labrador (Figure 4.1.2.3). Small salmon catches were among the lowest observed in the majority of the fishing areas of the Maritimes and Newfoundland and lower than average in most of Québec. Large salmon catches were lower than average and among the lowest throughout mainland Canada but were above average on the southwest coast and Northern Peninsula of Newfoundland, (SFA 12, 14A) and in Labrador (SFAs 1,2, and 14B).

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 2001 were closed to retention of all sizes of salmon (Figure 4.1.1.2).

Hook-and-released salmon fisheries: In 2001, about 56,600 salmon (about 25,400 large and 31,200 small) were caught and released (Table 4.1.2.2), representing about 55% of the total number caught, including retained fish. This was a 9% decrease from the number released in 2000. Most of the fish released were in Newfoundland (44%), followed by New Brunswick (43%), Québec (10%), Nova Scotia (3%), and Prince Edward Island (0.3%). Expressed as a proportion of the fish caught, that is, the sum of the retained and released fish, Nova Scotia released the highest percentage (90%), followed by New Brunswick (60%), Newfoundland (55%), Prince Edward Island (47%), and Québec (37%).

Commercial fisheries: All commercial fisheries for Atlantic salmon were closed in Canada in 2001 and the catch therefore was 0. Catches have decreased from a peak in 1980 of almost 2,500 t to 0 currently as a result of effort reductions, low abundance of stocks, and closures of fisheries (Figure 4.1.2.4).

Unreported catches: Canada's unreported catch estimate for 2001 is about 81 t, compared to 136 t in 2000. Estimates were included for all provinces (but not for all areas within some of the provinces) and were provided mainly by enforcement staff. In all areas, most unreported catch arises from illegal fishing or illegal retention of bycatch of salmon.

By stock groupings used for Canadian stocks throughout the report, the unreported catch estimates for 2001 were:

Stock Area	Unreported Catch (t)
Labrador	4
Newfoundland	45
Gulf	< 1
Scotia-Fundy	< 1
Québec	32
Total	81

USA

All fisheries (commercial and recreational) for sea-run Atlantic salmon within the USA are now closed, including rivers previously open to catch-and-release fishing. Thus, there was no harvest of sea-run Atlantic salmon in the USA in 2001. Unreported catches in the USA were estimated to be 0 t.

France (Islands of Saint-Pierre and Miquelon)

The harvest in 2001 was reported to be 2.2 t from professional and recreational fishermen, approximately the same as 1998 through 2000 (Table 2.1.1.1). Professional and recreational fishermen caught 1544 and 611 kg of salmon, respectively. There was no estimate available of unreported catch for 2001.

4.1.3 Origin and composition of catches

In the past, salmon from both Canada and the USA have been taken in the commercial fisheries of eastern Canada. These fisheries have since been closed. The remaining Aboriginal Peoples' and resident food fisheries that exist in Labrador may intercept some salmon from other areas of North America although there are no reports of tagged fish being captured there in 2001. The fisheries of Saint-Pierre and Miquelon catch salmon of both Canadian and US origin. Little if any sampling occurs in these remaining fisheries.

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

The returns to the majority of the rivers in Newfoundland and to most rivers of the Gulf of St. Lawrence and Québec were comprised exclusively of wild salmon (Figure 4.1.3.1). Hatchery-origin salmon made up varying proportions of the total returns and were most abundant in the rivers of the Bay of Fundy, the Atlantic coast of Nova Scotia and the USA. Aquaculture escapees were noted in the returns to seven rivers of the Bay of Fundy and the coast of Maine (Saint John, Magaguadavic, St. Croix, Union, Dennys, Narraguagus, and Penobscot). However, their numbers in the Saint John and Penobscot Rivers were low (14 and 1 respectively) and composed less than 0.01% of the returns.

Aquaculture production of Atlantic salmon in eastern Canada has increased annually, exceeding 10,000 t in 1992 and rising to over 33,000 t in 2001 (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. This is more than that year's total returns of all wild and hatchery origin salmon (13,000 to 21,000 fish) to the entire Bay of Fundy and Atlantic coast of Nova Scotia area (SFA 19 to 23). The documented minimum numbers of farmed salmon that escaped in 1999 and 2000 from the North American East Coast industry (Canada and USA combined) were 50,000 and 175,000 respectively. There were no reported escapes in 2001.

In the Magaguadavic River (SFA 23; Table 4.1.3.1), which is located in close proximity to the centre of the aquaculture production area, the proportion of the adult run composed of aquaculture escapees has been high (greater than 50%) since 1994. Escaped fish were not observed between 1983 and 1988. Since 1992, escaped fish have comprised between 33% and 90% of adult salmon counts. However, while farmed fish have dominated the run in terms of percentages, in absolute terms their numbers showed a declining trend up until 2000. In 2001, this trend was reversed and four times more escapees (132) entered the river than in the previous year. An upturn compared to 2000 of escapees in the returns to the nearby St. Croix River was also noted (Table 4.1.3.1). The cause of the upturn in this region is unknown. Farm escapees were also monitored in Maine's Union, Dennys, and Narraguagus rivers. Percentages of returns that were of farmed origin were 100, 82, and 32%, respectively in 2001. These values are roughly similar to those observed at these sites in the last few years (Table 4.1.3.1).

4.1.4 Exploitation rates in Canadian and USA fisheries

In Newfoundland, exploitation rates were available for 12 rivers in 2001. For those rivers with retention of small salmon, exploitation rates ranged from 7% to 47% with a mean value of 13%.

In Québec, exploitation rates were available for 35 rivers. Exploitation rates of small salmon ranged from 4% to 57% with a mean value of 33%. Retention of large salmon was permitted on 21 of those rivers; exploitation rate for large salmon ranged from 3% to 31% with a mean value of 22%. Global exploitation rates using mid-point estimates of returns and recreational landings were 17% for small salmon and 12% for large salmon.

In previous years, overall Canadian exploitation rates were calculated as the harvest of salmon divided by the estimated returns to North America. No estimates of returns to Labrador are possible for 1998 - 2001, as there was no commercial fishery and there was insufficient information collected on freshwater escapements to extrapolate to other Labrador rivers. For this reason, exploitation rates cannot be calculated for 1998 - 2001. Harvests in 2001 of 48,760 small and 12,102 large salmon were less than those of 1997, substantially in the case of large salmon. Exploitation rates in 1997 were estimated to be between 0.14 and 0.26 for small and 0.15 and 0.25 for large salmon.

There was no exploitation of USA salmon in homewaters, and no salmon of USA origin were reported in Canadian fisheries in 2001.

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 for various reasons :

1) they compose significant fractions of the salmon resource;
2) they are indicators of patterns within a region;
3) at the requests of user groups;
4) as a result of requests for biological advice from fisheries management.

The status was evaluated by examining trends in returns and escapement relative to the conservation limits, expressed as spawners or eggs.

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 75 rivers were assessed in eastern Canada in 2001. Estimates of total returns of small and large salmon were obtained using various techniques: 38 were derived from counts at fishways and counting fences; 2 were obtained using mark and recapture experiments; 31 using visual counts by snorkelling or from shore; and 4 from angling catches, and redd counts.

2001 compared to 2000 adult returns: Of the 75 stocks for which returns of salmon were determined in 2001, comparable data were available for 72 of these in 2000. For 52 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 2001 were less than 50% of the 2000 returns in ten of the rivers assessed (14%), between 50% and 90% of 2000 returns in 28 (39%) of the rivers, and were 90% or greater than 2000 returns in 34 (47%) of the rivers. The southern Gulf of St. Lawrence and Québec rivers showed the highest number of improvements in returns.

Large salmon returns in 2001 decreased from 2000 in rivers, particularly for Newfoundland and Labrador (68%). Lower proportions of the rivers were down or improved in the other regions (20%) (Table 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 2001 relative to 2000 were generally reduced throughout eastern Canada in the majority of the monitored rivers (73%) (Table 4.2.1.1). Returns were similar to or improved (>90% in 2001 relative to 2000) in about one quarter (27%) of the assessed rivers.

1985-2001 patterns of adult returns: Annual returns of salmon by size group are available for 22 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 4.2.1.1). The returns during the Newfoundland commercial fishery moratorium years (1992 to 2001) 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 seven Newfoundland rivers doubled during 1993 to 2001 from the low levels observed during 1989 to 1991 (Figure 4.2.1.1).

The returns for 2001 of large salmon in all areas except Newfoundland were among the lowest observed during the last 15 years, although a slight increase was noted in all regions (Table 4.2.1.1, Figure 4.2.1.1). The returns of large salmon in 2001 were the fourth lowest of the time-series for the Nova Scotia and Bay of Fundy, but show an increase of 109% relative to 2000. Returns of small salmon in Québec, Gulf, Nova Scotia, and Bay of Fundy rivers in 2001 decreased from 2000. Returns of small salmon to the rivers of Newfoundland in 2001 were approximately the same as 2000.

Smolt and juvenile abundance: Counts of smolts provide direct measurements of the outputs from the freshwater habitat. Previous reports have documented the high annual variability in the annual smolt output: in tributaries, smolt output can vary by five times, but in the counts for entire rivers, annual smolt output has generally varied by a factor of three. Wild smolt production was estimated in 12 rivers of eastern Canada; the Highlands River was not operated in 2001. Of these, nine rivers have several years of data (Figure 4.2.1.2). In numerous other rivers, juvenile abundance surveys have been conducted.

In 2001, smolt production improved from the previous year in four of five monitored rivers in Newfoundland and in both rivers of Quebec, but in only one of three rivers in the Maritime Provinces (Figure 4.2.1.2). In Newfoundland, smolt production in 2001 was below the previous five-year mean in four of five rivers.

Juvenile salmon abundance has been monitored annually since 1971 in the Miramichi (SFA 16) and Restigouche (SFA 15) rivers, and for shorter and variable time periods in other rivers (Figure 4.2.1.3). In the rivers of the southern Gulf, densities of young-of-the-year (fry) and parr (juveniles of one or more years old) have increased since 1985 in response to increased spawning escapements (Figure 4.2.1.3). Densities of parr in 2001 increased to record values in the

Northwest Miramichi and remained at high values in the Southwest Miramichi. In the Restigouche River, both fry and parr densities remained high and at average values since 1986. 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). Rivers of SFAs 20 and 21 along the Atlantic coast of Nova Scotia are generally organic stained, of lower productivity, and, when combined with acid precipitation, can result in acidic conditions toxic to salmon. Prognoses for salmon populations in 47 of 65 of these rivers indicate that 40 populations are likely to be extirpated if the trend in low annual marine survival of salmon persists. In the low-acidified St. Mary's River, fry (age 0^+) densities remain at moderate abundance and older parr (age-1^+ and 2^+) densities remain low, but somewhat improved in 2001 (Figure 4.2.1.3). Trends in densities of age-1^+ and older parr in the outer Bay of Fundy (SFA 23) have varied since 1980. Parr densities in the Nashwaak River and Saint John River above Mactaquac Dam have declined in accordance with reduced spawning escapements. However, parr densities did increase in the Nashwaak and Saint John River upstream of Mactaquac Dam in 2001. During the same period, densities in the Hammond River have periodically increased since 1984 but remain below normal densities previously observed in New Brunswick rivers.

The salmon stock in 33 rivers of the inner Bay of Fundy (SFA 22 and a portion of SFA 23) was listed as *Endangered* by the Committee on the Status of Endangered Wildlife in Canada in 2000 (see Section 2.4.5). Juvenile densities remained critically low in 2001, such as noted in the Stewiacke River (Figure 4.2.1.3).

It is not possible to measure the total smolt production from the rivers of Atlantic Canada for any given year. However, juvenile abundance indices were considered as surrogates of smolt production from eastern Canada. Smolt estimates are absolute values, whereas juvenile indices are presented as densities (fish per 100 m^2 of surveyed habitat). To allow for the combined analysis of smolt counts and juvenile abundance surveys from all the rivers, the individual river abundance indices were standardized to the size of the river using the egg conservation requirement as the scaling factor (Figure 4.2.1.2). This differs from the previous year's analysis when series were standardized by dividing each annual observation by the mean of 1995 to 1998 (period corresponding to the largest geographic coverage).

Ind_{ij} = $Abund_{ij}$ / Conservation egg $requirement_j$

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*

Conservation egg $requirement_j$ = Egg requirement for conservation for river j (O'Connell et al. 1997)

This adjustment places all the juvenile and smolt indices on a common scale, in units of juveniles (parr or smolts) per egg and retains the measure of the temporal variability. Juvenile measures were age 1 and older parr and were lagged forward one year to correspond to the smolt migration year.

The index of smolts or juveniles from geographic regions of North America was obtained by weighting the individual river indices by the egg requirement for the salmon fishing area to which they belong (SFA_{WT}). For the index of production of interest to the forecasting of 2SW salmon abundance in the Northwest Atlantic, an alternative weighting incorporated the relative contribution to the 2SW spawner requirements of the areas or zones within North America. This allows indices of smolt production from all areas of North America to be used, but attributes weights to the area indices according to the expected contribution to 2SW abundance.

Indices were natural log transformed before analysis using a general linear model to obtain an adjusted annual mean. Variables that were considered to explain the variation in the smolt indices included: year, salmon fishing area, stage (parr or smolt).

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 more than 25 rivers since 1995.

Estimates of the relative smolt index in the four geographic areas correspond to the previously documented status of rivers (Figure 4.2.1.4). Smolt production from Newfoundland rivers was increasing into the late 1980s when the overall index declined as more rivers were monitored in less productive areas such as the south shore of Newfoundland (Figure 4.2.1.2, 4.2.1.4). The Gulf smolt index is at its highest level in the 1990s (Figure 4.2.1.4). The Quebec smolt index increased into the 1990s but has since declined, driven by the River Trinite production. The relative index for Scotia-Fundy was at its highest in the early 1990s but has since declined. The indices based on parr are of a different order of magnitude than those derived from smolts. The Gulf index, derived from parr, ranges between 0.02 and 0.15 juveniles per egg in contrast to the lower producing Scotia-Fundy region with an index of less than 0.06 juveniles per egg (Figure 4.2.1.4). Both are still higher than the smolt-derived indices from Newfoundland and Quebec which are less than 0.02 and 0.03 smolts per egg, respectively (Figure 4.2.1.4).

The translation of parr into smolts is not direct. On three monitored rivers in the Maritimes provinces in which juvenile indices and smolt production estimates are generated, parr indices are much higher than smolt indices when these are compared, lagged one year. No correction for this was done in the present analyses.

The relative index of smolt production, weighted by the area-specific 2SW spawner contributions, suggests three levels of increasing freshwater production since 1971 (Figure 4.2.1.5). Relative freshwater production which would contribute to 2SW recruitment has been fairly stable since 1992, at about twice the level observed during the late 1970s and early 1980s.

USA

The documented return in 2001 of Atlantic salmon to rivers in USA was 1,063. Returns of 1SW salmon in 2001 were 266, comparable to last year (270), while MSW returns were 779, an increase from 533 in 2000. Total salmon returns to the rivers of New England continued the downward trend that began in the mid-1980s, and were lower than the previous 5-year and 10-year averages (Figure 4.2.1.6). These are minimal estimates of the total return, since many rivers in Maine do not contain fish counting facilities, and where counting facilities exist they do not count 100% of the returns.

For five of the eight rivers that comprise the federally endangered Gulf of Maine Distinct Population Segment (DPS), redd counts were used in a linear regression model to estimate returns because traps or weirs were not present. The total estimated returns for the entire DPS was 98 (95% CI = 81-122), with two rivers having an estimate of zero.

The majority of the returns were recorded in the rivers of Maine, with the Penobscot River accounting for nearly 73% of the total New England returns. The Connecticut River returns accounted for 3.7% of the total and 25% of the adult returns outside Maine. Overall, 25% of the adult returns were 1SW salmon and 75% were MSW salmon. Most returns (79%) originated from hatchery smolts and the balance (21%) originated from either natural spawning or hatchery fry.

4.2.2 Estimates of total abundance by geographic area

For assessment purposes, the following regions were considered: Labrador (SFA 1, 2, & 14B), Newfoundland (SFA 3–14A), Québec (Q1-Q11), Gulf of St. Lawrence (SFA 15-18), Scotia-Fundy (SFA 19-23), and USA. Returns of 1SW and 2SW salmon to each region (Tables 4.2.2.1 and 4.2.2.2; Figures 4.2.2.1 and 4.2.2.2; and Appendix 5) were estimated by updating the methods and variables used by Rago *et al.* (1993b) and reported in ICES 1993/Assess:10. The returns for both sea-age groups were derived by applying a variety of methods to data available for individual river systems and management areas. These methods included counts of salmon at monitoring facilities, population estimates from mark-recapture studies, and the application of angling and commercial catch statistics, angling exploitation rates, and measurements of freshwater habitat (Appendix 5). The 2SW component of the MSW returns was determined using the sea-age composition of one or more indicator stocks.

In the context used here "returns" are the number of salmon that returned to the geographic region, including homewater commercial fisheries, except in the case of Newfoundland and Labrador regions where returns do not include commercial fisheries. This was done to avoid double counting of fish when commercial catches in Newfoundland and Labrador are added to returns of all geographic areas in North America to create the PFA of North American salmon.

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 1998-2001, there was no commercial fishery in Labrador and although counting projects took place in 2001 on two Labrador rivers, out of about 100 salmon rivers that exist, it is not possible to extrapolate from these rivers to unsurveyed ones. For Labrador, returns were previously estimated from commercial catches and exploitation rates. As there was no commercial fishery since 1998, it was not possible to estimate the returns or spawners to Labrador for these years.

Newfoundland: The estimates of 1SW and 2SW returns and spawners for insular Newfoundland (SFAs 3–12 & 14A) are updated for the entire time-series. Prior to 1999, they 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 1997, for SFAs 3−14A, angling catch data was derived from the license 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.

Beginning in 1999, the method used in previous years was modified to take into consideration the changes implemented in the 1999-2001 Salmon Management Plan. The Management Plan introduced, for the first time, a river classification scheme with different season limits for each of classes I-IV and, in addition, some other rivers were placed in a special class with a different management plan for each river. The 95th confidence intervals of bootstrap estimates of unweighted exploitation rates and ratios of large:small salmon were generated from the assessment rivers with retention angling fisheries. The unweighted averages were used as large rivers are now being dealt with independently. Population estimates for all rivers with counting facilities were included from their assessment information. In order to avoid double counting, the catches of rivers whose populations were included from assessments were subtracted from the total catch. In 1999, most of the Class IV rivers were in the Bay St. George area of SFA 13 and the entire area returns and spawners were estimated based on assessments for 8 rivers expanded to the total drainage based on their proportionate contribution. In 2000-2001, the rivers in Bay St. George were in three separate classes and were dealt with independently. Catches in 2000 and the calculated exploitation rates were updated and catches in 2001 and exploitation rates were calculated.

The mid-point of the estimated returns (179,600) of 1SW salmon to Newfoundland rivers in 2001 is 13% lower than in 2000 and 15% lower than the average 1SW returns (210,700) for the period 1992–95 (Figure 4.2.2.1, Appendix 5). The 1992–95 1SW returns are higher than the returns in 1989-91, but similar to the returns to the rivers between 1971 and 1988. The mid-point (8,000) of the estimated 2SW returns to Newfoundland rivers in 2001 was 17% lower than in 2000 and 7% lower than the recent 5-year average of 8700 (Figure 4.2.2.2, Appendix 5).

Québec: The mid-point (23,900) of the estimated returns of 1SW salmon to Québec in 2001 was 29% lower than that observed in 2000 and was the lowest since 1983 (Figure 4.2.2.1, Appendix 5).

The mid-point (30,900) of the estimated returns of 2SW salmon in Québec in 2001 is about the same as the returns observed for 2000 and in the previous three years (Figure 4.2.2.2). Within the 1971-2001 time-series, the 2001 value is the fourth lowest estimated and a substantial decline from the high of 98,000 2SW salmon in 1980.

Gulf of St. Lawrence, SFAs 15–18: The mid-point (45,500) of the estimated returns in 2001 of 1SW salmon returning to the Gulf of St. Lawrence was a 12% decrease from 2000 and it is the third lowest value since 1984. The low values noted in 1997 through 2001 are low relative to the high value of about 189,000 in 1992 (Figure 4.2.2.1, Appendix 5).

The mid-point (25,600) of the estimate of 2SW returns in 2001 is 49% higher than the estimate for 2000 and the fifth lowest of the time-series (Figure 4.2.2.2, Appendix 5), the lowest being 1979 at 11,500. Returns of 2SW salmon have declined since 1995 with only slight improvement shown in 2001, relative to the years prior to 1995.

Scotia-Fundy, SFAs 19-23: The mid-point (9,200) of the estimate of the 1SW returns in 2001 to the Scotia-Fundy Region was a 37% decrease from the 2000 estimate, and the second lowest value in the time-series, 1971-2001. Returns have generally been low since 1990 (Figure 4.2.2.1, Appendix 5).

The mid-point (5,000) of the 2SW returns in 2001 is 41% higher than the returns in 2000 and still the fourth lowest value in the time-series, 1971–2001 (Figure 4.2.2.2, Appendix 5). A declining trend in returns has been observed from 1985 to 2001.

USA

For 2001 the number of USA spawners was considered to be the sum of documented returns and pre-spawn adults stocked into rivers above head of tide. Total salmon returns for USA rivers in 2001 were based on trap and weir catches (documented returns). Because many of the Maine rivers do not have fish counting facilities the total abundance continues to be underestimated. The 1SW returns and spawners to USA rivers in 2001 were 266 fish. This was comparable to the 2000 estimate but less than the previous 5-year and 10-year averages. The 2SW returns in 2001 to USA rivers were 788 fish, augmented by 703 spawners. There were only 9 3SW and repeat spawners compared to 18 in 2000.

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 2001/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 peoples' food fisheries in Canada [NC2(i+1)], and catches in year i from fisheries on non-maturing 1SW salmon in Canada [NC1(i)] and Greenland [NG1(i)]. In Labrador, Aboriginal peoples' food harvests of small (AH_s) and large salmon (AH_l) were included in the reported catches for 1999-2001. Because harvests occurred in both Lake Melville and coastal areas of northern Labrador, the fraction of these catches that are immature was labeled as af_imm. This was necessary because non-maturing salmon do not occur in Lake Melville where approximately half the catch originated. However, non-maturing salmon may occur in coastal marine areas in the remainder of northern Labrador. Consequently, af_imm for the fraction of Aboriginal peoples' harvests that were non-maturing was set at 0.05 to 0.1 which is half of f_imm from commercial fishery samples. The equations used to calculate NC1 and NC2 are as follows:

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

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

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

Similar to 1998-2000, the commercial fishery in Labrador remained closed in 2001. 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 1998-2001. Consequently, a raising factor was developed by dividing pre-fishery abundance without Labrador into pre-fishery abundance with Labrador based on the time-series of Labrador recruit estimates and pre-fishery abundance data from 1971-97. The raising factor (RFL2) to estimate returns to Labrador for 1998-2000 for 2SW salmon was set to the low and high range of values in the time-series which was 1.05 to 1.27. An assumed natural mortality rate [M] of 0.03 per month (see Section 2.3) is used to adjust the numbers between the salmon fisheries on the 1SW and 2SW salmon (10 months) and between the fishery on 2SW salmon and returns to the rivers (1 month) as shown below:

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

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

This estimated pre-fishery abundance represents the extant population and does not account for the fraction of the population present in a given fishery area. The model does not take into account non-catch fishing mortality in any of the fisheries. This is because rates for non-catch fishing mortality are not available on an annual basis and are not well described for some of the fisheries harvesting potential or actual 2SW salmon. Commercial catches were not included in the run-reconstruction model for the West Greenland fishery (1993 and 1994), Newfoundland fishery (1992–2001), and Labrador fishery (1998-2001), as these fisheries were closed.

As the pre-fishery abundance estimates for potential 2SW salmon requires estimates of returns to rivers, the most recent year for which an estimate is available is 2000. This is because pre-fishery abundance estimates for 2001 require 2SW returns to rivers in North America in the year 2002, which of course are as of yet unavailable. The minimum and maximum values of the catches and returns for the 2SW cohort are summarized in Table 4.2.3.3. The 2000 abundance estimates ranged between 81,470 and 169,954 salmon. The mid-point of this range (125,712) is 16% higher than the 1999 value (108,451) and is the 4th lowest in the 29-year time-series (Figure 4.2.3.1). The most recent four years are shown with hollow symbols as no Labrador values were estimated for these years and the raising factor described previously was used. The results indicate an increase from the general decline in recent years, but still much lower than the 917,300 in 1975. The Working Group expressed concern that pre-fishery abundance still remains considerably lower than the conservation limits.

Maturing 1SW salmon

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

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

Similar to calculations to determine non-maturing 1SW salmon, a raising factor was also required to include Labrador returns in the maturing component of pre-fishery abundance necessitated by the closure of the commercial fishery in Labrador in 1998. Consequently, a raising factor was developed by dividing pre-fishery abundance without Labrador into pre-fishery abundance with Labrador based on the time-series of Labrador recruit estimates and pre-fishery abundance data from 1971-97. The raising factor (RFL1) to estimate returns to Labrador for 1998-2000 for 1SW salmon was set to the low and high range of values in the time-series, which were 1.04 to 1.59.

The maturing 1SW component is represented by the pre-fishery abundance estimator for year i [MN1(i)]. It is constructed by summing maturing 1SW returns in year i [MR1(i)] in Canada and the USA and catches in year i from commercial and food fisheries on maturing 1SW salmon in Newfoundland and Labrador [MC1(i)]. An assumed natural mortality rate [M] of 0.03 per month is used to adjust the numbers between the fishery on 1SW salmon and returns to the rivers (1 month) as shown below:

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

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

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

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 1992–2001 and for Labrador for 1998-2001 to remain consistent with catches used in other years in these areas (see Section 4.1.1).

The minimum and maximum values of the catches and returns for the 1SW cohort are summarized in Table 4.2.3.4 and the mid-point values are shown in Figure 4.2.3.1. The most recent three years are shown with hollow symbols as no Labrador values were estimated for these years and the raising factor described previously was used. The mid-point of the range of pre-fishery abundance estimates for 2001 (376,132) is 15% higher than in 2000 (442,029) which had increased considerably from the low 1997 value of 331,815, which was the lowest, estimated in the time-series 1971-2001. The reduced values observed in 1978 and 1983–84 and 1994 were followed by large increases in pre-fishery abundance.

Total 1SW recruits (maturing and non-maturing)

Figure 4.2.3.1 shows the pre-fishery abundance of 1SW maturing for the 1971-2001 and 1SW non-maturing salmon from North America for 1971-2000. Figure 4.2.3.2 shows these data combined to give the total 1SW recruits. While maturing 1SW salmon in 1998-2001 have increased over the lowest value achieved in 1997, the non-maturing portion of these cohorts remained unchanged since 1997. As the prefishery abundance of the non-maturing portion (potential 2SW salmon) has been consistently well below the Spawning Escapement Reserve (derived from S_{lim}) since 1993, this situation is considered to be very serious. The decline in recruits in the time-series is alarming. Although the declining trend appears common to both maturing and non-maturing portions of the cohort, non-maturing 1SW salmon have declined further. The Working Group expressed concerns about these stock trends and recommended further investigation into their causes.

4.2.4 Spawning escapement and egg deposition

4.2.4.1 Egg depositions in rivers

Egg depositions in 2001 exceeded or equaled the river-specific conservation limits (S_{lim} for eggs) in 30 of the 85 assessed rivers (35%) and were less than 50% of conservation (S_{lim}) in 32 other rivers (38%) (Figure 4.2.4.1). Large deficiencies in egg depositions were noted in the Bay of Fundy and Atlantic coast of Nova Scotia where 6 of the 7 rivers assessed (85%) had egg depositions that were less than 50% of conservation limits (S_{lim}). Proportionally fewer rivers in Gulf (14%) and Québec (27%) had egg depositions less than 50% of conservation (S_{lim}). Only 57% of the Gulf rivers and 43% of the Québec rivers had egg depositions that equaled or exceeded conservation (Figure 4.2.4.1). In Newfoundland, 28% of the rivers assessed met or exceeded the conservation egg limits, and 39% had egg depositions that were less than 50% of limits. The deficits occurred in the east and southwest rivers of Newfoundland (SFA 13) and in Labrador. All USA rivers had egg depositions less than 5% of conservation limits (Figure 4.2.4.1).

Escapements over time relative to conservation limits (S_{lim}) have improved in 2001 in Bay of Fundy/Atlantic coast of Nova Scotia and the Gulf areas, whereas Newfoundland and Québec regions decreased in 2001(Figure 4.2.4.2). The status of three Bay of Fundy/Atlantic coast of Nova Scotia rivers has severely declined, especially since 1989. The proportion of the conservation limits achieved in 2001 was the highest of the time-series in this area since 1997. For the Québec rivers, spawning escapements declined continually from a peak median value in 1988 with two slight recoveries in 1995 and 1999. In almost all years in Québec, the median proportion of conservation requirements achieved has exceeded the requirements. However, in 2001, the median proportion was the lowest value of the time-series at 81% of the conservation limit. The rivers of the Gulf of St. Lawrence have also been quite consistent in equalling or exceeding the conservation limits. The median escapements were below conservation requirements in 2000, but recovered to above the limit in 2001. Newfoundland rivers in 2001 have shown the lowest level in the proportion of the limit achieved since 1992, although still above it. This occurred as a direct result of the high proportion of 1SW salmon in their stocks and the poor returns of the 1SW observed for all the areas in 2001. The exceeding of limits encountered in Newfoundland from 1992 to 2000 corresponded to the commercial salmon and groundfish moratoria initiated in 1992.

4.2.4.2 Run-reconstruction estimates of spawning escapement

Updated estimates for 2SW spawners were derived for the six geographic regions referenced in Section 4.2.2 (Table 4.2.4.1). Estimates of 1SW spawners, 1971-2001 are provided in Table 4.2.4.2. These estimates were derived by subtracting the in-river removals from the estimates of returns to rivers. A comparison between the numbers of spawners, returns, and conservation limits (S_{lim}) for 1SW and 2SW salmon are shown in Figures 4.2.2.1 and 4.2.2.2 respectively (there are no spawning requirements defined specifically for 1SW salmon).

<u>Labrador:</u> As previously explained, it was not possible to estimate spawners in Labrador in 1998 - 2001 due to lack of assessment information.

<u>Newfoundland:</u> The mid-point of the estimated numbers of 2SW spawners (7,800) in 2001 is 17% below that estimated in 1999 (9,300) and is 193% of the total 2SW conservation limit (S_{lim}) for all rivers. The 2SW spawner limit has been met or exceeded in eight years since 1984 (Figure 4.2.2.2). The 1SW spawners (156,300) in 2001 were 14% less than the 182,300 1SW spawners in 2000. The 1SW spawners since 1992 are higher than the spawners in 1989–91 and similar to levels in the late 1970s and 1980s (Figure 4.2.2.1), although in 1995-1996 they were unusually high. There had been a general increase in both 2SW and 1SW spawners during the period 1992–96 and 1998-2001, and this is consistent with the closure of the commercial fisheries in Newfoundland. For 1997, decreases occurred most strongly in the 1SW spawners.

<u>Québec:</u> The mid-point of the estimated numbers of 2SW spawners (20,800) in 2001 is about the same as in 2000 and is about 71% of the total 2SW conservation limit (S_{lim}) for all rivers (Figure 4.2.2.2). The spawning escapement in 2001 is the eighth lowest in the time-series (1971-2001). Estimates of the numbers of spawners approximated the spawner limit from 1971 to 1990; however, they have been below the limits since 1990. The mid-point of the estimated 1SW

spawners in 2001 (17,100) was about 32% lower than in 2000 (Figure 4.2.2.1) and has only been lower once since 1978.

Gulf of St. Lawrence: The mid-point of the estimated numbers of 2SW spawners (23,600) in 2001 is about 56% higher than estimated in 2000 (15,100) and is about 77% of the total 2SW conservation limits (S_{lim}) for all rivers in this region (Figure 4.2.2.2). This is the sixth time in ten years that these rivers have not exceeded their 2SW spawner limits. The mid-point of the estimated spawning escapement of 1SW salmon (29,800) decreased by 14% from 2000 and is the seventh lowest in the time-series, 1971–2001. The abundance remains low relative to the peak observed in 1992 (Figure 4.2.2.1). Spawning escapement has on average been higher in the mid-1980s than it was before and after this period.

Scotia-Fundy: The mid-point of the estimated numbers of 2SW spawners (4,700) in 2001 is a 41% increase from 2000 and is about 19% of the total 2SW conservation limits (S_{lim}) for rivers in this region (Figure 4.2.2.2). Neither the spawner estimates nor the conservation limits include rivers of the inner Bay of Fundy (SFA 22 and part of SFA 23) as these rivers do not contribute to distant water fisheries and spawning escapements are extremely low. The 2SW spawning escapement in the rest of the area has been generally declining since 1985 and the last five years are the lowest estimated since 1984. The mid-point of the estimated 1SW spawners (8,900) in 2001 is a 38% decrease from 2000 and is the fifth lowest in the time-series, 1971-2001. There has been a general downward trend in 1SW spawners since 1990 (Figure 4.2.2.1).

USA: Returns of 2SW fish were only 2.7% of the conservation limit (S_{lim}) in USA rivers. To augment spawners, Maine stocked 703 2SW river-specific pre-spawning adults reared by aquaculture in three rivers. With these stocked adults, the USA achieved 5% of the 2SW conservation limits in 2001. As a result, spawners have exceeded returns in the last two years (Figure 4.2.2.2). Spawning 2SW salmon, expressed as the percentage of conservation limit (S_{lim}) was: 11% in the Pleasant, 8% in the Penobscot, 6% in the Narraguagus, 3% in the Merrimack, and less than 1% in the Connecticut and Pawcatuck rivers.

4.2.4.3 Escapement variability in North America

The projected numbers of potential 2SW spawners that could have returned to North America in the absence of fisheries can be computed from estimates of the pre-fishery abundance taking into consideration the 11 months of natural mortality at 3% per month. These values, termed potential 2SW recruits, along with total North American 2SW returns, spawners, and conservation limits (S_{lim}) are shown in Figure 4.2.4.3 and indicate that the overall North American conservation limit could have been met, in the absence of all fisheries prior to, but not since 1994. The difference between the potential 2SW recruits and actual 2SW returns reflect the extent to which mixed stock fisheries at West Greenland and in SFAs 1–14 have reduced the populations.

Similarly, the impact of the Greenland fishery can be considered by subtracting the non-maturing 1SW salmon (accounting for natural mortality) harvested there from the total potential 2SW recruits. These values, termed 2SW recruits to North America, are also shown in Figure 4.2.4.3. The difference between the 2SW recruits to North America and the 2SW returns reflects the impact of removals by the commercial fisheries of Newfoundland and Labrador when they were open and the Labrador food fisheries since reports began in 1998. The 2SW recruits to North America indicate that, even if there had not been a West Greenland commercial fishery, conservation limits could not have been met since 1992. The difference between the actual 2SW returns and the spawner numbers reflects in-river removals throughout North America and coastal removals in Québec, Gulf, and Scotia Fundy regions.

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

Except for Labrador, the 2SW spawners to North America have been estimated to 2001. In Labrador, the spawning stock is only known to 1997 and therefore lagged spawners contributing to the pre-fishery abundance can only be completely assembled to the 2002 pre-fishery abundance (Figure 4.2.4.4, Table 4.2.4.4). In Labrador, age-3 smolts contribute about 7% to 2SW returns six years later or five years later to the pre-fishery abundance.

Spawning escapement of 2SW salmon to several stock complexes has been below S_{lim} (Labrador, Québec, Scotia-Fundy, USA) since at least the 1980s (Figure 4.2.4.4). In the last four years, lagged spawner abundance has been increasing in Labrador and Newfoundland, but decreasing in all other areas.

The relative contributions of the stocks from these six geographic areas to the total spawning escapement of 2SW salmon has varied over time (Figure 4.2.4.5). The reduced potential contribution of Scotia-Fundy stocks and the initial increased proportion of the spawning stock from the Gulf of St. Lawrence and, more recently, from Labrador rivers to future recruitment is most noticeable. Only the Newfoundland stock complex has received spawning escapements that have exceeded the area requirements, all other complexes were below requirement, and some declined further in 2001.

4.2.5 Survival Indices

Counts of smolts and adult salmon returns enable the estimation of indices of natural survival at sea, particularly following the closure of most northwest Atlantic commercial salmon fisheries in 1992. These estimates are potentially influenced by annual variation in size, age, and sex composition of smolts leaving freshwater and, possibly, by annual variation in sea-age at maturity. There is information from 18 rivers in North America with smolt counts and corresponding adult counts. Data available in 2001 were from 11 wild and three hatchery populations distributed between Newfoundland (SFAs 4, 9, 11, 13, and 14a), Québec (Q2 and Q7), Nova Scotia (SFAs 20 and 21), New Brunswick (SFA 23), and Maine (USA).

Plots of survival rates over time (Figures 4.2.5.1 to 4.2.5.4) provide insight into the impact of changes in management measures and possible changes in marine survival of wild and hatchery 1SW and 2SW stocks. In general the plots suggest:

- survival of North America stocks to home waters has not increased as expected after closure of the commercial fisheries in 1984 and 1992,
- 1SW survival greatly exceeds that of 2SW fish (except for Maine, where survival of 2SW exceeds 1SW), and
- survival of wild stocks exceeds that of hatchery stocks.

Survival indices for 3 of 14 stocks returning 1SW fish in 2001 exceeded indices for 1SW fish in 2000. Nine indices for 1SW fish decreased from 2000. Three of the survival indices for five stocks returning 2SW fish in 2001 decreased from values in 2000. There have been no significant increasing trends ($p \leq 0.05$) in survival indices of any of the stock components since commercial closures in 1992.

		Number of stocks					
Sea-age		Relative to 2000			9-Year Trend		
&stock	Province/region	⇧	⇔	⇩	⇧	⇔	⇩
1SW Wild	West & North Nfld	1	1	1		3	
	South Nfld			3		3	
	Québec	1		1		2	
	NS/NB	1		2			
Hatchery	Québec					1	
	NS			2		1	1
	NB					1	
	Maine		1			1	
	Total	3	2	9	0	12	1
2SW Wild	West & North Nfld			1			
	Québec	1		1		1	1
Hatchery	Québec					1	
	NS		1			1	1

NB					1	
Maine			1			1
Total	1	1	3	0	4	3

The 2SW survival of hatchery-reared smolts released in the Penobscot River drainage in 1999 was 0.08%. This was the second lowest survival observed in the time-series (Figure 4.2.5.4). Marine survival for this cohort of Penobscot River hatchery-reared smolts slowed the downward trend that began in the mid-1980s.

4.2.6 Evaluation of the potential bias involved by including fish farm escapees in stock assessments

Catch advice is based on estimates of returns and spawners in home rivers and harvests in commercial fisheries (see Sections 4.2.2, 4.2.3, and 4.2.4). Escaped-farmed salmon have been most frequently found close to the principal salmon farming area of Passamaquoddy and Cobscook bays of the Bay of Fundy, although a few other farm sites occur in Nova Scotia and Newfoundland.

The principal salmon farming industry in the Bay of Fundy has grown extensively since 1984 since the closure of local commercial salmon fisheries. Estimates of returns and spawners in this area are based on assessments of wild and hatchery fish at counting facilities where escapes are identified on the basis of external characteristics and scale analysis and excluded from both the assessment and from ascending the rivers. Counts of wild/hatchery salmon in all the principal impacted rivers (Table 4.1.3.1) generally total less than 200 fish in any year since 1990. Misclassification of many of the hatchery fish would be of little consequence to catch advice at even a regional scale.

Catch advice is not provided for inner Bay of Fundy rivers where some escapes have been observed. The occasional escape noted in other rivers of Nova Scotia and Newfoundland allows the possibility that escapes could influence angler harvests used to derive returns in some Salmon Fishing Areas. However, the numbers of these fish must be of minor consequence to assessments. The occurrence of escapes in the West Greenland catch, the North American proportion of which is included in the total of North American production, has been investigated by Hansen et. al. (1997) and found to be less than one percent. Scale samples and other material from recent sampling at Greenland are currently being examined for estimating fish farm escapees and will be reported on next year.

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

Estimates of pre-fishery abundance suggest a continuing decline of North American adult salmon over the last 10 years. The total population of 1SW and 2SW Atlantic salmon in the northwest Atlantic has oscillated around a generally declining trend since the 1970s, and the abundance recorded in 1993–2001 was the lowest in the time-series (Figure 4.2.3.2). During 1993 to 2001, the total population of 1SW and 2SW Atlantic salmon was about 600,000 fish, about half 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.

In most regions the returns of 2SW fish are at or near the lower end of the 31-year time-series (1971-2001), except Newfoundland where they are at the sixth highest but are a minor age group component of the stocks in this area. Returns of 1SW salmon were at the lower end of the time-series in Gulf, Scotia-Fundy, and USA and at about at the mid-point in Québec and Newfoundland.

The rank of the estimated returns in 2001 in the 1971–2001 time-series for six regions in North America is shown below:

Region	**Rank of 2001 returns in 1971-2001 time-series (1=highest)**		**Mid-point estimate of 2SW spawners as proportion of conservation limit (S_{lim})**
	1SW	**2SW**	**(%)**
Labrador	Unknown	Unknown	unknown
Newfoundland	16	6	193
Québec	23	28	71
Gulf	26	26	77
Scotia-Fundy	30	28	19
USA	21	29	3

Trends in abundance of small salmon and large salmon within the geographic areas show a general synchronicity among the rivers. Returns of large salmon in North America were generally increased from 2000, while small salmon returns decreased. Any increases however in large salmon returns were from often record low values in 2000. For the rivers of Newfoundland, large salmon returns decreased from 2000, but remained high relative to the years before the closure of the commercial fisheries. Large salmon in Newfoundland are predominantly repeat-spawning 1SW salmon, while in other areas of eastern Canada, 2SW and 3SW salmon make up varying proportions of the returns.

Egg depositions in 2001 exceeded or equaled the river-specific conservation limits (S_{lim} for eggs) in 30 of the 85 assessed rivers (35%) and were less than 50% of conservation in 32 other rivers (38%). Large deficiencies in egg depositions were noted in the Bay of Fundy and Atlantic coast of Nova Scotia where 6 of the 7 rivers assessed (85%) had egg depositions that were less than 50% of conservation limits. Proportionally fewer rivers in Gulf (14%) and Québec (27%) had egg depositions less than 50% of conservation. Only 57% of the Gulf rivers and 43% of the Québec rivers had egg depositions that equaled or exceeded conservation. In Newfoundland, 28% of the rivers assessed met or exceeded the conservation egg limits, and 39% had egg depositions that were less than 50% of limits. The deficits occurred in the east and southwest rivers of Newfoundland (SFA 13) and in Labrador. All USA rivers had egg depositions less than 5% of conservation limits.

In 2001, the overall conservation limit (S_{lim}) for 2SW salmon was not met in any area except Newfoundland. The overall 2SW conservation limit for Canada could have been met or exceeded in only nine (1974-78, 1980-82 and 1986) of the past 29 years (considering the mid-points of the estimates) by reduction of terminal fisheries (Figures 4.2.2.2 and 4.2.4.3). In the remaining years, conservation limits could not have been met even if all terminal harvests had been eliminated. It is only within the last decade that Québec and the Gulf areas have failed to achieve their overall 2SW salmon conservation limits.

Measures of marine survival rates over time indicate that survival of North America stocks to home waters has not increased as expected as a result of fisheries changes**.** There have been no significant increasing trends in survival indices of any of the stock components since commercial closures in 1992.

Substantive increases in spawning escapements in recent years in northeast coast Newfoundland rivers and high smolt and juvenile production in many rivers, in conjunction with suitable ocean climate indices, were suggestive of the potential for improved adult salmon returns for 1998 through 2001. Colder oceanic conditions both nearshore and in the Labrador Sea in the early 1990s are thought to have contributed to lower survival of salmon stocks in eastern Canada during that period.

Based on the genera1ly poor 1SW returns in 2001, no significant improvements in most areas, and further declines in some areas, are expected for large salmon in 2002. An additional concern is the low abundance levels that currently describe many salmon stocks in rivers in eastern Canada, particularly in the Bay of Fundy and Atlantic coast of Nova Scotia. USA salmon stocks exhibit these same downward trends. Most salmon rivers in the USA are hatchery-dependent and remain at low levels compared to conservation requirements. Despite major changes in fisheries management, returns have continued to decline in these areas and many populations are currently threatened with extirpation.

4.3 Effects on US and Canadian stocks and fisheries of quota management and closure after 1991 in Canadian commercial salmon fisheries, with special emphasis on the Newfoundland stocks

The Working Group previously considered the impact of the closure of the Newfoundland commercial fishery in 1992 on the Newfoundland stocks (ICES 1997/Assess:10).

Dempson *et al.* (1997) developed an index of salmon returns to illustrate the impact of the commercial salmon fishery moratorium on Newfoundland stocks. It was based on the difference between the returns prior to the moratorium (1984-91) when there was a commercial fishery to those in the years since the commercial fishery closed (1992-97). By averaging among rivers with counting facilities this provides an estimate of commercial fishing mortality which can then be used to estimate what returns would have been if the commercial fishery had not closed. The method assumes that natural mortality during the commercial fishery years remained at the same levels on average after the commercial fishery was closed. Average commercial fishing exploitation rate was 44% on small salmon and 75% on large. These exploitation rates should be regarded as minimum values because it is evident that the natural component of marine survival has declined in recent years.

For 2SW salmon, if the commercial fishery had remained open during this period then, on average, from 1,942 to 6,821 fewer 2SW fish would have spawned. For 1SW salmon, had the commercial fishery remained open then, on average, from 37,672 to 96,655 fewer 1SW salmon would have spawned. For 2SW salmon, in the years since the moratorium, spawner requirements have never been achieved if one uses the minimum estimates, or have always been achieved using the maximum estimate. If the commercial fishery had not closed, then 2SW spawners would never have achieved spawning requirements even at maximum estimates.

Within Newfoundland, the commercial fishery closure has resulted in increased escapements of both small and large salmon to rivers, higher catches of large salmon (which were subsequently released) in the recreational fishery, and increased spawning escapements of both size groups. These increased spawning escapements have not however always resulted in increased smolt production. Some areas of Newfoundland, particularly the south coast, did not see increases in escapement as was expected from the closure of the commercial fishery.

4.4 Update of age-specific stock conservation limits

There are no changes recommended in the 2SW salmon conservation limits (S_{lim}) from those recommended previously. Conservation limits for 2SW salmon for Canada now total 123,349 and for the USA, 29,199 for a combined total of 152,548 (Table 4.4.1). The Working Group again recommends that these requirements be refined as additional information on sea-age composition of spawners becomes available and as further understanding of life history strategies is gained.

4.5 Sensitivity analyses of the PFA estimates

The Working Group was asked to characterize the reliability of input data used to estimate the lagged spawner variable, with special emphasis on the Labrador region, and evaluate sensitivity of resulting pre-fishery abundance estimates. In Figure 4.2.4.4, estimates of 2SW spawners and 2SW lagged spawners are plotted for Labrador along with other geographic areas in North America. This information can be used to characterize trends and compare spawner numbers among regions. The spawner estimates are derived from a run reconstruction model described below, while the lagged spawners are calculated by applying proportions by river age to the spawner estimates and then ascribing them to the year in which their offspring will be available as 1SW non-maturing adults (pre-fishery abundance). If the run reconstruction model for Labrador is inappropriate for characterizing Labrador returns and spawners or has directional biases, and/or if the river ages of Labrador salmon are biased for any reason, then lagged spawners will also be either incorrect and/or biased. In general, if the Labrador spawners are over-estimated then the forecasted pre-fishery abundance will also be over-estimated by the proportionate contribution made by the Labrador spawners to the total of Labrador, Newfoundland, Scotia-Fundy, and Quebec, which is then used as a variable in the forecast model (Figure 4.5.1). Labrador has increased as a proportion of the lagged spawner variable in recent years. In 2002, lagged spawners for Labrador made the highest proportionate contribution of any individual area (greater than 40%).

The spawner estimates declined after 1987 reaching a record low in 1991 and then increased to a record high in 1995, declining thereafter (Figure 4.2.2.4 in Section 4.2.2.4). The increases occurred at a time when licenses and fishing seasons in Labrador were being reduced to lower exploitation. The estimation process for Labrador returns and spawners resulted in higher numbers relative to the known catch as exploitation declined, due to reductions in fishing effort. The commercial fishery was closed completely in 1998. On the other hand, the lagged spawner estimates for Labrador began to increase in 1998 from a record low in 1997, due to reductions in commercial fishing licenses and seasons. The proportionate contribution of Labrador lagged spawners to the total for North America increased considerably after 1997 from about 5% to a record high of almost 30% by 2002 as Labrador spawners increased. Thus, the contribution that Labrador spawners made to the lagged spawner variable also increased considerably (Figure 4.5.2).

The model that was used to derive the number of annual spawners and then the lagged spawners was based on commercial catches and exploitation rates from a tagging study conducted in 1969-73 at Sand Hill River in Labrador. The exploitation rates were adjusted annually after 1991 due to reductions in active licenced effort and season reductions from early closures due to a quota system (Appendix 5(ii)). Prior to 1992, exploitation rates were kept constant at 0.70 – 0.90 for large salmon and in following years, they were: 1992 - 0.58 to 0.83, 1993 - 0.38 to 0.62, 1994 - 0.29 to 0.50, 1995 – 0.15 to 0.26, 1996 – 0.13 to 0.23, 1997 – 0.22 to 0.40 (SFA 1), and 0.16 to 0.28 (SFA 2). The estimates of returns to freshwater in Labrador are highly dependent on the annual exploitation rates and small changes can result in a large change in estimated stock size. River age distribution used to apportion lagged spawners for Labrador was for river age 3 spawners – 7.68%, 4 – 54.2%, 5 – 34.1%, and 6 – 4.01%. The reliability of this distribution for annually characterising lagged spawners is unknown but is also fixed and unchanged in other regions. Furthermore, as the commercial fishery was closed in SFA 14B in 1997, the estimated numbers of small and large salmon returns and spawners were based on the results of assessments in Forteau Brook and Pinware River expanded to the total watershed area in SFA 14B.

As shown in Section 5.6 the forecast of pre-fishery abundance is highly dependent on the estimate of lagged spawners. In the present year forecast, based on the sum of squares about 12% of the forecast is determined by thermal habitat and 75% by lagged spawners. Thus, it was decided to examine the relationship between the forecasts of pre-fishery abundance with varying estimates of lagged spawners. Lagged spawners were set at ±10% and ±50% of the present estimated values for the Labrador portion and predictions were made for pre-fishery abundance in each year. A varying Labrador component can in some years make a big change in pre-fishery abundance forecasts (Figure 4.5.3). This was true in earlier years when pre-fishery abundance was high but is also the case in 2000 when pre-fishery abundance is relatively low. This is because lagged spawners were high in 2000. Clearly lagged spawners make an important contribution to the forecasts in 2002 and the Labrador component of lagged spawners is an important part of it. Errors in the Labrador lagged spawner numbers will have a big impact on the pre-fishery abundance forecasts. However, because we do not know the actual number of Labrador spawners the degree of potential mis-forecasting is unknown. Also, this was the only technique possible for deriving lagged spawners because of a lack of an alternate data series for Labrador, i.e. counting fences and other assessment techniques.

4.6 Catch options or alternative management advice and assessment of risks relative to the objective of exceeding stock conservation limits

Overview

Catch options are only provided for the non-maturing 1SW and maturing 2SW components as the maturing 1SW component is not fished outside of home waters, and in the absence of significant marine interceptory fisheries, is managed in homewaters by the producing nations.

Catch histories of salmon which could have been available to the Greenland fishery, 1972-2001, are provided in Tables 4.6.1 and 4.6.2. and expressed as 2SW salmon equivalents. The Newfoundland-Labrador commercial fisheries historically was a mixed stock fishery and harvested both maturing and non-maturing 1SW salmon as well as 2SW maturing salmon. The harvest in these fisheries of repeat spawners and older sea-ages was not considered in the run reconstructions. Harvests of 1SW non-maturing salmon in Newfoundland-Labrador commercial fisheries have been adjusted by natural mortalities of 3 % per month for 13 months, and 2SW harvests in these same fisheries have been adjusted by one month to express all harvests as 2SW equivalents in the year and time they would reach rivers of origin. Starting in 1998, the Labrador commercial fishery was closed. An Aboriginal Peoples' fishery occurred in 1998 - 2001 that may have harvested, to some degree, mixed stocks, and catches for this fishery have been included in Tables 4.6.1 and 4.6.2. As well, a resident's food fishery in Labrador is included for the first time in 2000. Mortalities (principally in fisheries) in mixed stock and terminal fisheries areas in Canada are summed with those of USA to estimate total 2SW equivalent mortalities in North America (Table 4.5.1). The terminal fisheries areas included coastal and river catches of all areas, except Newfoundland and Labrador where only river catches were included. Mortalities within North America peaked at about 365,000 in 1976 and are now about 15,200 2SW salmon equivalents. In the most recent three years estimated (that is those since the closure of the Labrador commercial fishery), those taken as non-maturing fish in Labrador comprise 2%, or less, of the total in North America.

Of the North American fisheries on the cohort destined to be 2SW salmon, 85 % of the catch comes from terminal fisheries in the most recent year. This value has ranged from as low as 20% in 1973, 1976 and 1987 to values of 77-91% in 1996-2001 fisheries (Table 4.6.1). The percentage increased significantly with the reduction and closures of the Newfoundland and Labrador commercial mixed stock fisheries, particularly since 1992.

Table 4.6.2 shows the mortalities expressed as 2SW equivalents in Canada, USA, and Greenland for 1972–2001, by applying a mortality of 3 % per month for 11 months to the estimates of harvests of 1SW non-maturing North American salmon in the Greenland fishery. Harvests within the USA of the total within North America approached 0.6% on a few occasions in the time-series and as recently as in 1990. As well as these harvests in the USA, USA-origin salmon were also harvested in Canada during the time period indicated. The percentage of the total 2SW equivalents that have been harvested in North American waters has ranged from 48-100%, with the most recent year estimated at 79%. 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 2001 for 2SW maturing fish is based on a new forecast of the 2001 pre-fishery abundance and accounting for fish which were already removed from the cohort by fisheries in Greenland and Labrador in 2001 as 1SW non-maturing fish. The second is a new estimate for 2002 based on the pre-fishery abundance forecast for 2001 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.

4.6.1 Catch advice for 2002 fisheries on 2SW maturing salmon

A revised forecast of the pre-fishery abundance for 2001 is provided in Table 4.6.1.1**.** This value of 332,455 is higher than the value forecast last year at this time of 295,678 (See Section 5.2 for more detailed derivation of the models used, and Section 2.3 on the impact of the changed mortality parameter used, etc.). A pre-fishery abundance of 332,455 in 2001 can be expressed as 2SW equivalents by considering natural mortality of 3% per month for 11 months (a factor of 0.718924), resulting in 239,010 2SW salmon equivalents. There have already been harvests of this cohort as 1SW non-maturing salmon in 2001 for both the Labrador (268) and Greenland (7,053) fisheries (Tables 4.6.1 and 4.6.2) for a total of 7,321 2SW salmon equivalents already harvested, when the mortality factor is considered.

Table 4.6.1.1 uses the probability density projections for the revised pre-fishery abundance estimate of 332,455 (at 50% probability), converts them to 2SW salmon equivalents and subtracts the 2SW conservation limit (S_{lim}) of 152,548 and the harvests in Greenland and Labrador of 1SW non-maturing salmon that have been converted to 2SW salmon equivalents (from Tables 4.6.1 and 4.6.2). The calculation is as follows:

[(PFA_i – harvest in Greenland in 2001 of 1SW non-maturing fish] x exp - (0.03 *11 months)]

minus

[harvest in Labrador in 2001 of 1SW non-maturing fish x exp –(0.03*13 months)]

minus

the conservation limit

where PFA_i = values from 25–50%

conservation limit = 152,548

From Table 4.6.1.1, there are harvest possibilities at forecasted levels considered risk-neutral or risk-averse, that is, at probability levels of 50% and below down to about 7,000 fish at the 30% probability level. Any probability levels below this would suggest no harvest. The numbers provided for catch options refer to the composite North American fisheries. As the biological objective is to have all rivers reaching their conservation requirements, river-by-river management is necessary. On individual rivers, where spawning requirements are being achieved, there are no biological reasons to restrict the harvest.

Regional assessments in some areas of eastern North America provide a more detailed consideration of expectations for 2002, taking into consideration the contribution of all sea ages of salmon to the spawning population. By area, these are:

Labrador: As there has been a lack of long-term monitoring facilities in Labrador, there is little information available to comment on expectations for 2002 and beyond.

Newfoundland: Stock-specific quantitative forecast for salmon returns in 2002 have not been done. With the exception of Northeast Brook (Trepassey), smolt output from all other monitored rivers increased in 2001. Thus, if there is no decrease in marine survival rates, returns of 1SW salmon in 2002 could be somewhat improved.

Québec: There were 29% fewer 1SW returns in 2001 than in 2000, and the 2001 value was 25%, lower than the 1996-2000 mean. Returns of large salmon in 2002 are expected to be insufficient for attainment of conservation requirement on 39 rivers; consequently, only retention of small salmon will be permitted on those rivers.

Gulf: Returns in 2002 to the Restigouche and area rivers should be similar to the last five years, approximately at the conservation limits before fisheries. The outlook for the Miramichi River for 2002 is for a return of large salmon equal to 2000 and 2001 with a 13% chance of meeting the conservation limit in the Miramichi River overall, 26% for the Southwest Miramichi, and 19% for the Northwest Miramichi River. Adult returns to the southern Gulf of St. Lawrence rivers in 2001 were not assessed; however, juvenile densities were equal to or exceeded the conservation limit parr levels in all surveyed rivers. Adult salmon return to the Margaree River (western Cape Breton Island) was again above the conservation limit in 2001, but lower than in the recent decade. Juvenile densities in the Margaree River were above the conservation limit parr levels, but the fry densities showed a sharp decrease in 2001 compared with previous years.

Scotia-Fundy: With the exception of a few rivers in northern Cape Breton Island, Nova Scotia, returns of salmon to rivers of the Atlantic coast and Bay of Fundy of the Maritime Provinces in 2002 are not expected to be sufficient to meet conservation limits in 2002.

USA: Salmon returns (both large and small) in 2002 are not expected to be sufficient to meet conservation limits in any river, including those receiving hatchery stocking.

4.6.2 Catch advice for 2003 fisheries on 2SW maturing salmon

Most catches (91%) in North America now take place in rivers or in estuaries. The commercial fisheries are now closed and the remaining coastal food fisheries in Labrador are mainly located close to river mouths and likely harvest few salmon from other than local rivers. Fisheries are principally managed on a river-by-river basis and in areas where retention of large salmon is allowed, it is closely controlled.

Catch options which could be derived from the prefishery abundance forecast for 2002 (329,552 at the 50% probability level – see Section 5.6.2) would apply principally to North American fisheries in 2003 and hence the level of fisheries in 2002 need to be accounted for before finalizing these catch options. Catch options were calculated by assuming probability values between 25 and 50%, accounting for mortality and the conservation limits and considering an allocation of 60% of the surplus to North America. Catches of about 6600 2SW salmon equivalents would be available at a probability value of 30%; below this probability value, there are no salmon expected to be surplus to limits. The catch at the risk neutral point (50% probability) would be about 50,600 fish. The numbers provided for catch options refer to the composite North American fisheries. As the biological objective is to have all rivers reaching their conservation requirements, river-by-river management will be necessary. On individual rivers, where spawning requirements are being achieved, there are no biological reasons to restrict the harvest.

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

Some progress was made on research needs identified last year. The Working Group reiterates many of last year's recommendations and suggests some further ones. Relevant Sections of this year's report are identified in parentheses.

1. **Estimates of total returns to Labrador no longer exist. There is a critical need to develop alternate methods to derive estimates of salmon returns and develop habitat-based spawner requirements in Labrador, and to monitor salmon returns in the Ungava regions of Québec. (4.2.2; 4.2.4)**

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 of Canadian and US rivers, and the harvest in food fisheries in Labrador. These data and new information on measures of habitat and stock recruitment are necessary to re-evaluate existing estimates of spawner requirements in Canada and USA and for use in the run reconstruction model. (4.2.2; 4.2.3; 4.4)**

3. **There is a requirement for additional smolt-to-adult survival rates for wild salmon. As well, sea survival rates of wild salmon from rivers stocked with hatchery smolts should be examined to determine if hatchery return rates can be used as an index of sea survival of wild salmon elsewhere. (4.2.5)**

4. **Further basic research is needed on the spatial and temporal distribution of salmon and their predators at sea to assist in explaining variability in survival rates. (4.2.3; 4.2.5)**

5. **Return estimates for the few rivers (Annapolis, Cornwallis and Gaspareau) in SFA 22 that contribute to distant fisheries should be developed and when these are available, the SFA 22 spawning requirements for these rivers (476 fish) should be included in the total. (4.4)**

6. **A consistent approach to estimating returns is needed for instances in which offspring from broodstock are stocked back into the management area from which their parents originated. (4.1.3)**

7. **Scale analysis of salmon captured at West Greenland indicated an infrequent appearance of escaped-farmed salmon. To substantiate this conclusion, farmed salmon need to be genetically characterized and included as baseline populations in continent-of-origin analysis of samples collected from West Greenland (4.2.6)**

8. **The risk associated with being under or over S_{lim} needs to be determined (4.4).**

The Working Group recommends that an ad Hoc modelling group be formed and that prior to the next WG meeting, the ad Hoc group develops a new model(s) for estimation of pre-fishery abundance (4.2.3).

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 2001.

	% of Provincial Harvest			% of	
	Native peoples' food fisheries	**Recreational fisheries**	**Resident food fisheries**	**eastern Canada**	**Number of fish**
Small salmon					
Newfoundland / Labrador	12.4	81.3	6.3	51.8	25,260
Québec	18.6	81.4	0.0	10.4	5,073
New Brunswick	11.6	88.4	0.0	37.0	18,028
P.E.I.	14.8	87.1	0.0	0.4	217
Nova Scotia	12.1	87.9	0.0	0.4	182
Large salmon					
Newfoundland / Labrador	69.4	12.3	18.3	22.0	2,660
Québec	42.2	57.8	0.0	73.9	8,945
New Brunswick	100.0	0.0	0.0	3.9	470
P.E.I.	-	-	-	0.0	0
Nova Scotia	100.0	0.0	0.0	0.2	27
Eastern Canada		**% by User Group**			
Small salmon	12.8	84.0	3.3		48,760
Large salmon	50.5	45.4	4.0		12,102

Table 4.1.2.2. Hook-and-released Atlantic salmon caught by recreational fishermen in Canada, 1984 – 2001.

Year	Newfoundland			Nova Scotia			New Brunswick					Prince Edward Island			Quebec			CANADA*		
	Small	Large	Total	Small	Large	Total	Small Kelt	Small Bright	Large Kelt	Large Bright	Total	Small	Large	Total	Small	Large	Total	**SMALL**	**LARGE**	**TOTAL**
1984				939	1,655	2,594	661	851	1,020	14,479	17,011							**2,451**	**17,154**	**19,605**
1985		315	315	1,323	6,346	7,669	1,098	3,963	3,809	17,815	26,685			67				**6,384**	**28,285**	**34,669**
1986		798	798	1,463	10,750	12,213	5,217	9,333	6,941	25,316	46,807							**16,013**	**43,805**	**59,818**
1987		410	410	1,311	6,339	7,650	7,269	10,597	5,723	20,295	43,884							**19,177**	**32,767**	**51,944**
1988		600	600	1,146	6,795	7,941	6,703	10,503	7,182	19,442	43,830	767	256	1,023				**19,119**	**34,275**	**53,394**
1989		183	183	1,562	6,960	8,522	9,566	8,518	7,756	22,127	47,967							**19,646**	**37,026**	**56,672**
1990		503	503	1,782	5,504	7,286	4,435	7,346	6,067	16,231	34,079			1,066				**13,563**	**28,305**	**41,868**
1991		336	336	908	5,482	6,390	3,161	3,501	3,169	10,650	20,481	1,103	187	1,290				**8,673**	**19,824**	**28,497**
1992	5,893	1,423	7,316	737	5,093	5,830	2,966	8,349	5,681	16,308	33,304			1,250				**17,945**	**28,505**	**46,450**
1993	18,196	1,731	19,927	1,076	3,998	5,074	4,422	7,276	4,624	12,526	28,848							**30,970**	**22,879**	**53,849**
1994	11,105	2,343	13,448	796	2,894	3,690	4,153	7,443	4,790	11,556	27,942	577	147	724				**24,074**	**21,730**	**45,804**
1995	12,383	2,588	14,971	979	2,861	3,840	770	4,260	880	5,220	11,130	209	139	348		922	922	**18,601**	**12,610**	**31,211**
1996	22,227	3,092	25,319	3,526	5,661	9,187						472	238	710		1,718	1,718	**26,225**	**10,709**	**36,934**
1997	17,362	3,810	21,172	717	3,358	4,075	3,457	4,870	3,786	8,874	20,987	210	118	328	182	1,643	1,825	**26,798**	**21,589**	**48,387**
1998	25,314	4,351	29,665	687	2,520	3,207	3,154	5,760	3,452	8,298	20,664	233	114	347	297	2,680	2,977	**35,445**	**21,415**	**56,860**
1999	18,119	4,534	22,653	591	2,161	2,752	3,155	5,631	3,456	8,281	20,523	192	157	349	298	2,693	2,991	**27,986**	**21,282**	**49,268**
2000	27,778	6,030	33,808	407	1,303	1,710	3,154	6,689	3,455	8,690	21,988	101	46	147	445	4,008	4,453	**38,574**	**23,532**	**62,106**
2001	20,660	4,470	25,130	418	1,058	1,476	3,094	6,166	3,829	11,252	24,341	81	86	167	809	4,674	5,483	**31,228**	**25,369**	**56,597**

* 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 rivers of eastern 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
1999	74	74	29	83	103	77
2000	41	68	3	67	44	68
2001	128	94	13	31	141	88

Rivers of eastern Maine								
Year	Union		St. Croix		Dennys		Narraguagus	
	Total Run	% Aqua'	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
1999	72	91	36	64	-	-	35	8
2000	5	40	50	60	30	97	23	0
2001	2[2]	100	77	73	82	79	32	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 2001 relative to returns in 2000 and to returns in 1991 to 2001.

	Number of rivers in each category			
		Returns in 2001 relative to returns in 2000		
Size group	Total	<50%	50% to 90%	>= 90%
Bay of Fundy and Atlantic Coast of Nova Scotia (SFA 19 to 23)				
Small	10	3	4	3
Large	10	1	2	7
Small & Large	10	0	6	4
Southern Gulf of St. Lawrence (SFA 15 to 18)				
Small	5	0	3	2
Large	5	0	0	5
Small & Large	5	0	1	4
Quebec (Zones Q1 to Q11)				
Small	15	4	8	3
Large	15	0	3	12
Small & Large	35	3	12	20
Newfoundland and Labrador (SFA 1 to 14)				
Small	22	6	10	6
Large	22	6	9	7
Small & Large	22	7	9	6

		Rank of 2001 within the 1991 to 2001 period (Rank 1 = highest)		
Size group	Number of rivers	Best	Median	Worst
Bay of Fundy and Atlantic coast of Nova Scotia (SFA 19 to 23)				
Small	3	9	10	11
Large	4	8	8,5	10
Small & Large	4	8	10,5	11
Southern Gulf of St. Lawrence (SFA 15 to 18)				
Small	3	6	9	10
Large	3	5	7	10
Small & Large	3	4	8	10
Quebec (Zones Q1 to Q11)				
Small	11	1	9	11
Large	11	5	8	11
Small & Large	26	4	8	11
Newfoundland and Labrador (SFA 1 to 14)				
Small	11	4	9	11
Large	12	4	7	11
Small & Large	11	5	9	10

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

	Labrador		Newfoundland		Quebec		Gulf of St. Lawrence		Scotia-Fundy		USA	North America		
Year	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max		Min	Max	Mid-points
1971	32,966	115,382	112,644	226,129	14,969	22,453	33,118	57,973	11,515	19,525	32	205,245	441,495	323,370
1972	24,675	86,362	109,282	219,412	12,470	18,704	42,202	73,711	9,522	16,915	18	198,169	415,122	306,645
1973	5,399	18,897	144,267	289,447	16,585	24,877	43,681	77,102	14,766	24,823	23	224,721	435,169	329,945
1974	27,034	94,619	85,216	170,748	16,791	25,186	65,673	114,083	26,723	44,336	55	221,491	449,026	335,259
1975	53,660	187,809	112,272	225,165	18,071	27,106	58,613	101,887	25,940	36,316	84	268,639	578,367	423,503
1976	37,540	131,391	115,034	230,595	19,959	29,938	90,308	155,693	36,931	55,937	186	299,958	603,740	451,849
1977	33,409	116,931	110,114	220,501	18,190	27,285	31,322	56,088	30,860	48,387	75	223,971	469,268	346,619
1978	16,155	56,542	97,375	195,048	16,971	25,456	26,008	45,413	12,457	16,587	155	169,121	339,201	254,161
1979	21,943	76,800	107,402	215,160	21,683	32,524	50,872	93,340	30,875	49,052	250	233,025	467,126	350,075
1980	49,670	173,845	121,038	242,499	29,791	44,686	45,716	81,737	49,925	73,560	818	296,958	617,145	457,051
1981	55,046	192,662	157,425	315,347	41,667	62,501	70,238	128,658	37,371	62,083	1,130	362,877	762,381	562,629
1982	38,136	133,474	141,247	283,002	23,699	35,549	79,874	143,543	23,839	38,208	334	307,129	634,111	470,620
1983	23,732	83,061	109,934	220,216	17,987	26,981	25,337	43,922	15,553	23,775	295	192,838	398,250	295,544
1984	12,283	42,991	130,836	262,061	21,566	30,894	37,696	63,943	27,954	47,493	598	230,933	447,980	339,456
1985	22,732	79,563	121,731	243,727	22,771	33,262	61,255	110,580	29,410	51,983	392	258,290	519,507	388,899
1986	34,270	119,945	125,329	251,033	33,758	46,937	114,718	204,455	30,935	54,678	758	339,768	677,807	508,787
1987	42,938	150,283	128,578	257,473	37,816	54,034	86,564	156,086	31,746	55,564	1,128	328,770	674,567	501,668
1988	39,892	139,623	133,237	266,895	43,943	62,193	123,578	223,368	32,992	56,935	992	374,635	750,007	562,321
1989	27,113	94,896	60,260	120,661	34,568	48,407	72,944	129,515	34,957	59,662	1,258	231,101	454,400	342,750
1990	15,853	55,485	99,543	199,416	39,962	54,792	83,670	159,455	33,939	60,828	687	273,654	530,664	402,159
1991	12,849	44,970	64,552	129,308	31,488	42,755	59,721	113,722	19,759	31,555	310	188,679	362,619	275,649
1992	17,993	62,094	118,778	237,811	35,257	48,742	146,539	231,291	22,832	37,340	1,194	342,594	618,473	480,533
1993	25,186	80,938	134,150	268,550	30,645	42,156	89,934	146,977	16,714	27,539	466	297,095	566,627	431,861
1994	18,159	56,888	95,981	192,138	29,667	40,170	55,639	117,549	8,216	11,583	436	208,098	418,763	313,430
1995	25,022	76,453	202,739	435,153	23,851	32,368	26,019	96,871	14,239	21,822	213	292,082	662,880	477,481
1996	51,867	153,553	257,215	559,079	32,008	42,558	50,313	99,615	22,795	36,047	651	414,848	891,504	653,176
1997	66,812	155,963	99,029	146,050	24,300	33,018	27,515	54,511	7,173	10,467	365	225,194	400,374	312,784
1998	-	-	146,371	247,035	24,495	34,301	38,029	69,155	16,770	26,481	403	-	-	-
1999	-	-	156,740	224,959	25,880	36,679	28,867	53,244	10,556	16,901	419	-	-	-
2000	-	-	151,313	260,251	27,212	40,208	40,215	63,624	10,997	18,343	270	-	-	-
2001	-	-	125,893	233,376	19,346	28,463	32,588	58,406	6,752	11,746	266	-	-	-

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

Table 4.2.2.2 Estimated numbers of 2SW returns in North America by geographic regions, 1971 – 2000.

	Labrador		Newfoundland		Quebec		Gulf of St. Lawrence		Scotia-Fundy		USA	North America		
Year	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max		Min	Max	Mid-points
1971	4,312	29,279	2,388	8,923	34,568	51,852	29,483	46,831	11,187	16,410	653	81,937	153,295	117,616
1972	3,706	25,168	2,511	9,003	45,094	67,642	35,640	59,937	14,028	19,731	1,383	102,364	182,865	142,614
1973	5,183	35,196	2,995	11,527	49,765	74,647	34,911	59,550	10,359	14,793	1,427	104,641	197,140	150,890
1974	5,003	34,148	1,940	6,596	66,762	100,143	49,081	83,402	21,902	29,071	1,394	146,082	254,754	200,418
1975	4,772	32,392	2,305	7,725	56,695	85,042	31,175	51,864	23,944	31,496	2,331	121,222	210,851	166,036
1976	5,519	37,401	2,334	7,698	56,365	84,547	29,266	51,427	21,768	29,837	1,317	116,569	212,228	164,398
1977	4,867	33,051	1,845	6,247	66,442	99,663	58,822	100,766	28,606	39,215	1,998	162,581	280,941	221,761
1978	3,864	26,147	1,991	6,396	59,826	89,739	30,465	51,481	16,946	22,561	4,208	117,301	200,531	158,916
1979	2,231	15,058	1,088	3,644	32,994	49,491	8,671	14,324	8,962	12,968	1,942	55,888	97,427	76,658
1980	5,190	35,259	2,432	7,778	78,447	117,670	43,407	73,841	31,897	44,823	5,796	167,169	285,167	226,168
1981	4,734	32,051	3,451	12,035	61,633	92,449	17,743	29,594	19,030	28,169	5,601	112,192	199,900	156,046
1982	3,491	23,662	2,914	9,012	54,655	81,982	31,652	51,128	17,516	24,182	6,056	116,284	196,022	156,153
1983	2,538	17,181	2,586	8,225	44,886	67,329	29,038	46,874	14,310	20,753	2,155	95,513	162,517	129,015
1984	1,806	12,252	2,233	7,060	44,661	59,160	20,478	34,131	17,938	27,899	3,222	90,339	143,724	117,031
1985	1,448	9,779	958	3,059	45,916	61,460	23,106	43,533	22,841	38,784	5,529	99,798	162,144	130,971
1986	2,470	16,720	1,606	5,245	55,159	72,560	36,214	70,921	18,102	33,101	6,176	119,727	204,723	162,225
1987	3,289	22,341	1,336	4,433	52,699	68,365	22,668	47,919	11,529	20,679	3,081	94,602	166,818	130,710
1988	2,068	14,037	1,563	5,068	56,870	75,387	26,140	49,956	10,370	19,830	3,286	100,297	167,564	133,930
1989	2,018	13,653	697	2,299	51,656	67,066	17,311	35,338	11,939	21,818	3,197	86,819	143,371	115,095
1990	1,148	7,790	1,347	4,401	50,261	66,352	24,616	53,110	10,248	18,871	5,051	92,671	155,576	124,123
1991	548	3,740	1,054	3,429	46,841	60,724	20,983	44,446	10,613	17,884	2,647	82,687	132,871	107,779
1992	2,515	15,548	3,111	10,554	46,917	61,285	30,026	62,660	9,777	16,456	2,459	94,805	168,964	131,884
1993	3,858	18,234	1,499	5,094	37,023	46,484	25,420	51,241	6,764	11,087	2,231	76,796	134,372	105,584
1994	5,653	24,396	1,902	6,174	37,703	47,180	22,666	58,519	4,379	6,908	1,346	73,649	144,522	109,086
1995	12,368	44,205	3,635	12,592	43,755	54,186	23,712	61,512	4,985	8,317	1,748	90,203	182,559	136,381
1996	9,113	32,759	4,457	14,159	39,413	49,846	20,416	43,032	7,227	12,054	2,407	83,033	154,256	118,644
1997	9,384	23,833	3,887	8,355	32,443	41,017	15,660	34,321	3,645	5,922	1,611	66,630	115,059	90,844
1998	-	-	5,322	12,453	24,358	31,832	7,541	18,300	2,728	6,003	1,526	-	-	-
1999	-	-	4,254	14,262	25,415	33,710	9,991	23,979	3,482	7,107	1,168	-	-	-
2000	-	-	3,176	16,144	24,847	34,874	11,041	23,322	2,038	5,079	533	-	-	-
2001	-	-	2,467	13,581	25,878	35,925	17,962	33,269	3,099	6,902	788	-	-	-

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

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

	{1}			{1-7, 14b}		{8-14a}		{1-7, 14b}
1SW Year (i)	AH_Small (i)	AH_Large (i+1)	AH_Large (i)	H_Small (i)	H_Large (i)	H_Small (i)	H_Large (i+1)	H_Large (i+1)
1971	0	0	0	158896	199176	70936	42861	144496
1972	0	0	0	143232	144496	111141	43627	227779
1973	0	0	0	188725	227779	176907	85714	196726
1974	0	0	0	192195	196726	153278	72814	215025
1975	0	0	0	302348	215025	91935	95714	210858
1976	0	0	0	221766	210858	118779	63449	231393
1977	0	0	0	220093	231393	57472	37653	155546
1978	0	0	0	102403	155546	38180	29122	82174
1979	0	0	0	186558	82174	62622	54307	211896
1980	0	0	0	290127	211896	94291	38663	211006
1981	0	0	0	288902	211006	60668	35055	129319
1982	0	0	0	222894	129319	77017	28215	108430
1983	0	0	0	166033	108430	55683	15135	87742
1984	0	0	0	123774	87742	52813	24383	70970
1985	0	0	0	178719	70970	79275	22036	107561
1986	0	0	0	222671	107561	91912	19241	146242
1987	0	0	0	281762	146242	82401	14763	86047
1988	0	0	0	198484	86047	74620	15577	85319
1989	0	0	0	172861	85319	60884	11639	59334
1990	0	0	0	104788	59334	46053	10259	39257
1991	0	0	0	89099	39257	42721	0	32341
1992	0	0	0	24249	32341	0	0	17096
1993	0	0	0	17074	17096	0	0	15377
1994	0	0	0	8640	15377	0	0	11176
1995	0	0	0	7980	11176	0	0	7272
1996	0	0	0	7849	7272	0	0	6943
1997	0	2269	0	9753	6943	0	0	0
1998	2988	1084	2269	0	0	0	0	0
1999	2739	1352	1084	0	0	0	0	0
2000	5323	2334	1352	0	0	0	0	0
2001	4730	0	2334	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 (0.03 per month)
t1	Time between the mid-point of the Canadian fishery and return to river = 1 months
S1	Survival of 1SW salmon between the homewater fishery and return to river {exp(-M t1)}
H_s(i)	Number of “Small” salmon caught in Canada in year i; fish <2.7 kg
H_l(i)	Number of “Large” salmon caught in Canada in year i; fish >=2.7 kg
AH_s	Aboriginal and resident food harvests of small salmon in northern Labrador
AH_l	Aboriginal and resident food harvest of large salmon in northern Labrador
f_imm	Fraction of 1SW salmon that are immature, i.e. non-maturing: range = 0.1 to 0.2
af_imm	Fraction of 1SW salmon that are immature in native and resident food fisheries in N 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 used to estimate pre-fishery abundance of non-maturing (NN1) 1SW salmon of North American origin (terms defined in Table 4.2.3.2).

1SW Year (i)	NG1 (i)	NC1 min (i)	max (i)	NC2 min (i+1)	max (i+1)	NR2 min (i+1)	max (i+1)	NN1 min (i)	max (i)	mid-point (i)
1971	287672	17881	43730	144008	172907	102364	182865	642329	819161	730745
1972	200784	15768	37316	203072	248628	104641	197140	636223	847929	742076
1973	241493	21150	51412	223422	262767	146082	254754	767427	1001959	884693
1974	220584	21187	50243	223332	266337	121222	210851	711852	923630	817741
1975	278839	32385	73371	243315	285486	116569	212228	801808	1032778	917293
1976	155896	24285	57005	225424	271703	162581	280941	710616	970441	840529
1977	189709	24323	57902	146535	177644	117301	200531	574996	766338	670667
1978	118853	11796	29813	86644	103079	55888	97427	325344	423326	374335
1979	200061	19478	42242	202634	245013	167169	285167	725593	969695	847644
1980	187999	31132	70739	186367	228568	112192	199900	626755	845327	736041
1981	227727	31000	70441	125578	151442	116284	196022	589988	775253	682620
1982	194715	23583	52338	104116	125802	95513	162517	491695	642923	567309
1983	33240	17688	39712	76554	94103	90339	143724	279924	399893	339909
1984	38916	13255	30019	74062	88256	99798	162144	290960	413606	352283
1985	139233	18582	40002	97329	118841	119727	204723	455731	624417	540074
1986	171745	23343	50988	121610	150859	94602	166818	490832	658410	574621
1987	173687	29639	65127	74996	92205	100297	167564	444070	596354	520212
1988	116767	20709	44860	75300	92364	86819	143371	359883	485729	422806
1989	60693	18139	39691	53173	65040	92671	155576	279510	404579	342045
1990	73109	11072	24518	37739	45590	82687	132871	250138	343986	297062
1991	110680	9302	20175	22639	29107	94805	168964	282412	405168	343790
1992	41855	2748	6790	11967	15386	76796	134372	167578	256321	211949
1993	0	1878	4441	10764	13839	73649	144522	118852	224147	171500
1994	0	1018	2651	7823	10058	90203	182559	137048	270162	203605
1995	21341	910	2267	5090	6545	83033	154256	144618	247008	195813
1996	21944	858	2006	4860	6249	66630	115059	122042	192428	157235
1997	16814	1045	2367	1588	2269	41476	70113	80686	146928	113807
1998	3026	161	367	759	1084	44310	80226	68977	146973	107975
1999	5374	142	306	946	1352	41635	79952	67666	149236	108451
2000	5571	273	573	1634	2334	50195	90465	81470	169954	125712
2001	9810	248	543	0	0	0	0	10058	10353	10206

Table 4.2.3.4 Run reconstruction data inputs and estimated pre-fishery abundance for maturing (MN1) 1SW salmon (grilse) of North American origin (terms defined in Table 4.2.3.2).

1SW Year (i)	MC1 min (i)	max (i)	MR1 min (i)	max (i)	MN1 min (i)	max (i)	mid-point (i)
1971	213987	267720	205245	441495	425482	722661	574071
1972	237286	279064	198169	415122	441490	706828	574159
1973	346109	408260	224721	435169	577675	856682	717178
1974	322772	379370	221491	449026	551009	842071	696540
1975	351015	422105	268639	578367	627836	1018086	822961
1976	313060	375300	299958	603740	622154	997427	809790
1977	252058	318032	223971	469268	482850	801591	642220
1978	132546	172340	169121	339201	306818	521872	414345
1979	218442	252711	233025	467126	458564	734063	596314
1980	343344	412617	296958	617145	649346	1048557	848951
1981	308670	377651	362877	762381	682598	1163250	922924
1982	265678	312538	307129	634111	582160	965960	774060
1983	197184	234389	192838	398250	395894	644767	520331
1984	158852	187900	230933	447980	396817	649523	523170
1985	227928	259284	258290	519507	494084	794613	644348
1986	278654	321357	339768	677807	628769	1019806	824288
1987	319510	375472	328770	674567	658292	1070583	864438
1988	240291	276488	374635	750007	626335	1049336	837836
1989	205998	239495	231101	454400	444137	707733	575935
1990	134630	156382	273654	530664	416618	703208	559913
1991	117141	133509	188679	362619	311566	507172	409369
1992	21986	30556	342594	618473	375014	667865	521439
1993	15027	19983	297095	566627	321169	603865	462517
1994	8142	11928	208098	418763	222577	443444	333011
1995	7278	10200	292082	662880	308256	693267	500761
1996	6861	9028	414848	891504	434343	927682	681012
1997	8358	10652	225194	400374	240410	423219	331815
1998	3054	3302	226069	377375	245448	621601	433524
1999	2705	2758	222462	332202	241219	547045	394132
2000	5185	5156	230007	382696	251885	632173	442029
2001	4715	4887	184846	332257	202998	549265	376132

Table 4.2.4.1. Estimated numbers of 2SW spawners in North America by geographic regions, 1971-2001.

	Labrador		Newfoundland		Quebec		Gulf of St. Lawrence		Scotia-Fundy		USA	North America		
Year	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max		Min	Max	Mid-points
1971	4,012	28,882	1,817	8,055	11,822	17,733	4,303	8,237	4,496	9,032	490	26,940	72,429	49,684
1972	3,435	24,812	2,008	8,240	23,160	34,741	17,803	32,996	7,459	12,699	1,038	54,903	114,525	84,714
1973	4,565	34,376	2,283	10,449	23,564	35,346	20,505	38,126	3,949	7,844	1,100	55,966	127,240	91,603
1974	4,490	33,475	1,510	5,942	28,657	42,985	31,702	57,923	9,526	15,979	1,147	77,032	157,451	117,242
1975	4,564	32,119	1,888	7,086	23,818	35,726	18,477	33,210	11,861	18,830	1,942	62,549	128,913	95,731
1976	4,984	36,701	2,011	7,198	22,653	33,980	14,821	29,694	11,045	18,337	1,126	56,641	127,035	91,838
1977	4,042	31,969	1,114	5,088	32,602	48,902	32,535	60,188	13,578	23,119	643	84,512	169,909	127,211
1978	3,361	25,490	1,557	5,712	29,889	44,834	11,511	22,829	6,517	11,428	3,314	56,150	113,608	84,879
1979	1,823	14,528	980	3,463	12,807	19,210	3,575	6,823	4,683	8,234	1,509	25,376	53,767	39,572
1980	4,633	34,525	1,888	6,925	35,594	53,390	19,947	37,645	14,270	25,628	4,263	80,596	162,375	121,486
1981	4,403	31,615	3,074	11,442	26,132	39,199	4,657	10,028	5,870	13,353	4,334	48,470	109,971	79,221
1982	3,081	23,127	2,579	8,481	26,492	39,738	11,036	20,330	5,656	11,335	4,643	53,486	107,655	80,571
1983	2,267	16,824	2,244	7,677	17,308	25,963	7,436	14,288	1,505	6,529	1,769	32,529	73,050	52,790
1984	1,478	11,822	2,063	6,800	22,345	32,659	15,332	27,195	14,245	23,650	2,547	58,011	104,673	81,342
1985	1,258	9,530	946	3,042	20,668	31,742	21,168	39,982	18,185	33,580	4,884	67,108	122,759	94,934
1986	2,177	16,334	1,575	5,198	24,088	35,939	32,991	64,980	15,435	30,120	5,570	81,836	158,141	119,988
1987	2,895	21,821	1,320	4,409	21,723	31,727	19,877	43,120	10,235	19,233	2,781	58,831	123,091	90,961
1988	1,625	13,452	1,540	5,033	25,390	38,343	23,392	44,859	9,074	18,381	3,038	64,059	123,106	93,582
1989	1,727	13,270	690	2,289	25,016	35,905	14,758	30,866	11,689	21,539	2,800	56,680	106,668	81,674
1990	923	7,493	1,327	4,372	24,422	36,219	22,554	49,478	9,688	18,245	4,356	63,269	120,163	91,716
1991	491	3,665	1,041	3,410	19,959	29,052	19,590	41,956	9,356	16,479	2,416	52,854	96,978	74,916
1992	2,012	14,889	3,057	10,474	19,337	28,833	28,364	55,499	8,725	15,280	2,292	63,786	127,267	95,527
1993	3,624	17,922	1,449	5,017	15,774	21,428	24,884	45,823	5,710	9,921	2,065	53,506	102,176	77,841
1994	5,339	23,981	1,840	6,077	15,631	21,147	20,870	55,551	3,682	6,093	1,344	48,706	114,192	81,449
1995	12,006	43,726	3,563	12,481	22,575	28,703	22,086	59,089	4,672	7,971	1,748	66,650	153,718	110,184
1996	8,838	32,395	4,372	14,028	19,010	25,421	18,451	39,823	6,507	11,242	2,407	59,585	125,316	92,451
1997	9,221	23,646	3,780	8,190	15,531	20,780	14,040	31,772	3,095	5,311	1,611	47,278	91,311	69,294
1998	-	-	5,222	12,295	14,240	19,439	5,799	15,460	2,424	5,663	1,526	-	-	-
1999	-	-	4,169	14,126	17,250	23,811	9,047	22,149	3,041	6,648	1,168	-	-	-
2000	-	-	2,873	15,704	16,657	24,213	9,342	20,905	1,855	4,877	1,587	-	-	-
2001	-	-	2,251	13,269	17,013	24,584	16,405	30,715	2,860	6,631	1,491	-	-	-

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

Table 4.2.4.2 Estimated numbers of 1SW spawners in North America by geographic regions, 1971-2001.

	Labrador		Newfoundland		Quebec		Gulf of St. Lawrence		Scotia-Fundy		USA	North America		
Year	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max		Min	Max	Mid-points
1971	29,032	111,448	85,978	199,463	9,338	14,007	19,874	35,534	4,800	12,810	29	149,051	373,291	261,171
1972	21,728	83,415	84,880	195,010	8,213	12,320	24,319	43,318	2,992	10,385	17	142,149	344,465	243,307
1973	0	11,405	108,785	253,965	10,987	16,480	28,105	51,257	8,658	18,715	13	156,548	351,834	254,191
1974	24,533	92,118	58,731	144,263	10,067	15,100	48,343	84,685	16,209	33,822	40	157,922	370,028	263,975
1975	49,688	183,837	78,882	191,775	11,606	17,409	42,668	74,920	18,232	28,608	67	201,143	496,615	348,879
1976	31,814	125,665	80,571	196,132	12,979	19,469	56,021	99,810	24,589	43,595	151	206,125	484,822	345,474
1977	28,815	112,337	75,762	186,149	12,004	18,006	14,045	27,585	16,704	34,231	54	147,385	378,364	262,874
1978	13,464	53,851	68,756	166,429	11,447	17,170	13,768	25,474	5,678	9,808	127	113,240	272,859	193,049
1979	17,825	72,682	76,233	183,991	15,863	23,795	29,764	57,382	18,577	36,754	247	158,508	374,850	266,679
1980	45,870	170,045	85,189	206,650	20,817	31,226	26,450	50,297	28,878	52,513	722	207,926	511,453	359,690
1981	49,855	187,471	110,755	268,677	30,952	46,428	39,421	77,501	18,236	42,948	1,009	250,228	624,035	437,132
1982	34,032	129,370	99,376	241,131	16,877	25,316	52,020	97,071	12,179	26,548	290	214,774	519,727	367,250
1983	19,360	78,689	77,514	187,796	12,030	18,045	13,611	24,683	7,747	15,969	255	130,517	325,436	227,976
1984	9,348	40,056	91,505	222,730	16,316	24,957	17,990	33,657	17,964	37,503	540	153,663	359,444	256,554
1985	19,631	76,462	85,179	207,175	15,608	25,140	39,514	73,906	18,158	40,731	363	178,454	423,778	301,116
1986	30,806	116,481	87,833	213,537	22,230	33,855	82,122	149,587	21,204	44,947	660	244,854	559,067	401,960
1987	37,572	144,917	104,096	232,991	25,789	40,481	59,330	110,335	21,589	45,407	1,087	249,463	575,217	412,340
1988	34,369	134,100	93,396	227,054	28,582	44,815	85,644	159,916	23,288	47,231	923	266,203	614,039	440,121
1989	22,429	90,212	41,798	102,199	24,710	37,319	44,715	81,719	23,873	48,578	1,080	158,605	361,108	259,857
1990	12,544	52,176	69,576	169,449	26,594	39,826	56,161	113,442	22,753	49,642	617	188,245	425,153	306,699
1991	10,526	42,647	44,023	108,779	20,582	30,433	44,350	87,876	13,814	25,610	235	133,530	295,580	214,555
1992	15,229	59,331	95,096	214,129	21,754	33,583	118,723	189,260	15,125	29,633	1,124	267,051	527,060	397,056
1993	22,499	78,251	107,816	242,217	17,493	27,444	70,969	118,119	11,539	22,252	444	230,760	488,726	359,743
1994	15,228	53,958	66,185	162,342	16,758	25,642	32,651	90,339	6,918	10,218	427	138,167	342,925	240,546
1995	22,144	73,575	172,727	405,141	14,409	21,548	15,407	61,251	12,114	19,697	213	237,014	581,424	409,219
1996	48,362	150,048	218,639	520,504	18,923	27,805	24,411	70,260	19,253	32,472	651	330,240	801,740	565,990
1997	64,049	153,200	80,096	127,116	14,724	22,210	12,699	36,748	6,143	9,428	365	178,076	349,068	263,572
1998	-	-	124,551	225,216	16,743	25,730	23,580	46,609	16,342	26,028	403	-	-	-
1999	-	-	135,561	203,780	18,969	28,808	18,212	36,304	10,177	16,516	419	-	-	-
2000	-	-	127,839	236,777	19,527	31,003	25,968	43,558	10,656	17,977	270	-	-	-
2001	-	-	102,560	210,044	13,244	21,000	20,218	39,351	6,449	11,414	266	-	-	-

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

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

	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 prefishery abundance.

	North America		Prefishery	Recruits/	Labrador (L)		Newfoundland (N)		Quebec (Q)		Gulf of St. Lawrence (G)		Scotia-Fundy (S)		USA (US)	
	Total 2SW	Lagged 2SW	abundance	2SW lagged												
Year	spawners	spawners	recruits	spawner	Total	Lagged	Total	Lagged	Total	Lagged	Total	Lagged	Total	Lagged	Total	Lagged
1971	49684		652798		16447		4936		14777		6270		6764		490	
1972	84714		645365		14124		5124		28951		25399		10079		1038	
1973	91603		770157		19470		6366		29455		29316		5896		1100	
1974	117242		712224		18982		3726		35821		44813		12752		1147	
1975	95731		807439		18341		4487		29772		25844		15345		1942	
1976	91838		718793		20842		4605		28316		22258		14691		1126	
1977	127211		587353		18006		3101		40752		46361		18348		643	
1978	84879	95423	330067	3.46	14425	14759	3635	5802	37362	28016	17170	35371	8973	10034	3314	1442
1979	39572	107023	730751	6.83	8175	17486	2221	4664	16008	32232	5199	36818	6459	14270	1509	1553
1980	121486	96095	642412	6.69	19579	18903	4406	4316	44492	31940	28796	24971	19949	14937	4263	1029
1981	79221	104076	605835	5.82	18009	18795	7258	4472	32666	30266	7342	31955	9612	16888	4334	1699
1982	80571	107284	503741	4.70	13104	19695	5530	3661	33115	34821	15683	34049	8496	12699	4643	2358
1983	52790	82182	286882	3.49	9546	18710	4961	3440	21636	36526	10862	13258	4017	7514	1769	2733
1984	81342	79799	296448	3.71	6650	15422	4432	2801	27502	28065	21264	14937	18947	14569	2547	4006
1985	94934	85408	469065	5.49	5394	11576	1994	3786	26205	32359	30575	19576	25882	13668	4884	4443
1986	119988	80977	505381	6.24	9255	15361	3386	6075	30013	35728	48985	11286	22777	8998	5570	3528
1987	90961	78610	462966	5.89	12358	17772	2865	6023	26725	33119	31498	13524	14734	5813	2781	2359
1988	93582	79001	370678	4.69	7538	14762	3287	5209	31866	27538	34125	15142	13728	13002	3038	3347
1989	81674	93776	293487	3.13	7498	10875	1490	4544	30461	25762	22812	24668	16614	23026	2800	4901
1990	91716	103388	257262	2.49	4208	7799	2850	2951	30320	26580	36016	37632	13966	23978	4356	4449
1991	74916	99937	301232	3.01	2078	6285	2225	2953	24506	28072	30773	41497	12917	17965	2416	3166
1992	95527	89467	179600	2.01	8451	8072	6765	3018	24085	28227	41931	33056	12002	14173	2292	2922
1993	77841	91771	138525	1.51	10773	10649	3233	3080	18601	29616	35354	29551	7816	15464	2065	3410
1994	81449	88940	163955	1.84	14660	9247	3958	2178	18389	30646	38210	28397	4888	15007	1344	3464
1995	110184	89461	161799	1.81	27866	7453	8022	2400	25639	30138	40587	33549	6322	13350	1748	2570
1996	92451	85133	130922	1.54	20617	5299	9200	2585	22216	27289	29137	35369	8875	12373	2407	2219
1997	69294	83369	95039	1.14	16434	3511	5985	5004	18155	24550	22906	38994	4203	9493	1611	1817
1998		76301	87325	1.14		6285	8758	4368	16839	21312	10629	36685	4044	6080	1526	1571
1999		80178	88169	1.10		9930	9148	3994	20531	19459	15598	39077	4845	5764	1168	1954
2000		88577	102130	1.15		14098	9289	6574	20435	22055	15123	35966	3366	7845	1587	2039
2001		88216				22118	7760	8490	20798	22898	23560	26994	4746	6056	1491	1661
2002		73764				22527		7215		20286		18205		4133		1400
2003								7892		18121		12965		4525		1363
2004								8908		18934		15266		3952		1508

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	2,532	
		Q2	1,797	
		Q3	1,788	
		Q5	948	
		Q6	818	
		Q7	2,021	
		Q8	11,195	
		Q9	3,378	
		Q10	1,582	
		Q11	3,387	
	Subtotal			29,446
	Scotia-Fundy	SFA 19	3,138	
		SFA 20	2,691	
		SFA 21	5,817	
		SFA 22	0	
		SFA 23	13,059	
	Subtotal			24,705
Total				123,349
USA	Connecticut		9,727	
	Merrimack		2,599	
	Penobscot		6,838	
	Other Maine rivers		9,668	
	Paucatuck		367	
Total				29,199
North American Total				152,548

Table 4.6.1 Fishing mortalities of 2SW salmon equivalents by North American fisheries, 1972-2001.
Only mid-points of the estimated values have been used.

Year	CANADA: MIXED STOCK: NF-LAB Comm 1SW (Yr i-1) (b)	% 1SW of total 2SW equivalents	NF-LAB Comm 2SW (Yr i) (b)	NF-Lab comm total	TERMINAL FISHERIES IN YEAR i: Labrador rivers (a)	Nfld rivers (a)	Quebec Region	Gulf Region	Scotia - Fundy Region	Canadian total	USA Year i	Total	Terminal Fisheries as a % of Total
1972	20,857	9	153,775	174,632	314	633	27,417	22,389	6,801	232,187	346	232,532	25
1973	17,971	6	219,175	237,146	719	895	32,751	17,915	6,680	296,107	327	296,434	20
1974	24,564	7	235,910	260,475	593	542	47,631	21,429	12,734	343,404	247	343,651	24
1975	24,181	7	237,598	261,779	241	528	41,097	15,675	12,375	331,694	389	332,084	21
1976	35,801	10	256,586	292,388	618	412	42,139	18,088	11,111	364,757	191	364,948	20
1977	27,519	8	241,217	268,736	954	946	42,301	33,433	15,562	361,931	1,355	363,287	26
1978	27,836	11	157,299	185,135	580	559	37,421	23,803	10,781	258,278	894	259,172	29
1979	14,086	10	92,058	106,144	469	144	25,234	6,299	4,506	142,796	433	143,229	26
1980	20,894	6	217,209	238,103	646	699	53,567	29,828	18,411	341,253	1,533	342,785	31
1981	34,486	11	201,336	235,822	384	485	44,375	16,326	13,988	311,381	1,267	312,648	25
1982	34,341	14	134,417	168,757	473	433	35,204	25,707	12,353	242,927	1,413	244,339	31
1983	25,701	12	111,562	137,263	313	445	34,472	27,094	13,515	213,102	386	213,488	36
1984	19,432	14	82,807	102,238	379	215	24,408	6,041	3,971	137,253	675	137,928	26
1985	14,650	11	78,760	93,410	219	15	27,483	2,745	4,930	128,802	645	129,447	28
1986	19,832	12	104,890	124,723	340	39	33,846	4,582	2,824	166,354	606	166,959	25
1987	25,163	13	132,208	157,371	457	20	33,807	3,795	1,370	196,820	300	197,120	20
1988	32,081	21	81,130	113,211	514	29	34,262	3,922	1,373	153,311	248	153,559	26
1989	22,197	16	81,355	103,551	337	9	28,901	3,513	265	136,575	397	136,972	24
1990	19,577	18	57,359	76,937	261	24	27,986	2,847	593	108,649	696	109,344	30
1991	12,048	14	40,433	52,481	66	16	29,277	1,942	1,331	85,114	231	85,344	39
1992	9,979	14	25,108	35,087	581	67	30,016	4,412	1,114	71,278	167	71,445	51
1993	3,229	7	13,273	16,502	273	63	23,153	2,977	1,110	44,078	166	44,244	63
1994	2,139	5	11,938	14,077	365	80	24,052	2,382	756	41,712	1	41,714	66
1995	1,242	3	8,677	9,918	420	92	23,331	2,025	330	36,116	0	36,116	73
1996	1,075	3	5,646	6,721	320	108	22,413	2,587	766	32,915	0	32,915	80
1997	969	3	5,390	6,360	175	136	18,574	2,085	581	27,910	0	27,910	77
1998	1,155	7	1,872	3,027	268	129	11,256	2,291	322	17,292	0	17,292	82
1999	179	1	894	1,073	268	111	9,032	1,387	450	12,320	0	12,320	91
2000	152	1	1,115	1,267	268	372	9,425	2,058	193	13,583	0	13,583	91
2001	286	2	1,925	2,212	268	264	10,104	2,055	255	15,157	0	15,157	85
2002	268	-	-	-	-	-	-	-	-	-	-	-	-

NF-Lab comm as 1SW = NC1(mid-pt) * 0.677057 (M of 0.03 per month for 13 months to July for Canadian terminal fisheries)
NF-Lab comm as 2SW = NC2 (mid-pt) * 0.970446 (M of 0.03 per month for 1 month to July of Canadian terminal fisheries)
Terminal fisheries = 2SW returns (mid-pt) - 2SW spawners (mid-pt)
a - starting in 1993, includes estimated mortality of 10% on hook and released fish
b - starting in 1998, there was no commercial fishery in Labrador; numbers reflect size of aboriginal fish harvest in 1998-2001 and resident food fishery harvest in 2000-2001

Table 4.6.1.1. Catch options for 2002 North American fisheries

Catch Options for 2002 North American Fisheries (Probability levels refer to probability density function estimates of pre-fishery abundance)		
Probability Level	**Pre-fishery Abundance Forecast**	**Catch Options in 2SW Salmon Equivalents (no.)**
25	209,095	0
30	232,019	6,935
35	255,481	23,802
40	279,932	41,381
45	305,300	59,618
50	332,455	79,141

Table 4.6.2 History of fishing-related mortalities of North American salmon as 2SW equivalents, 1972-2001.

Year	Canadian total	USA total	North America Grand Total	% USA of Total North American	Greenland total	NW Atlantic Total	Harvest in homewaters as % of total NW Atlantic
1972	232,187	346	232,532	0.15	206,814	439,347	53
1973	296,107	327	296,434	0.11	144,348	440,782	67
1974	343,404	247	343,651	0.07	173,615	517,266	66
1975	331,694	389	332,084	0.12	158,583	490,667	68
1976	364,757	191	364,948	0.05	200,464	565,412	65
1977	361,931	1,355	363,287	0.37	112,077	475,364	76
1978	258,278	894	259,172	0.34	136,386	395,559	66
1979	142,796	433	143,229	0.30	85,446	228,676	63
1980	341,253	1,533	342,785	0.45	143,829	486,614	70
1981	311,381	1,267	312,648	0.41	135,157	447,805	70
1982	242,927	1,413	244,339	0.58	163,718	408,058	60
1983	213,102	386	213,488	0.18	139,985	353,473	60
1984	137,253	675	137,928	0.49	23,897	161,825	85
1985	128,802	645	129,447	0.50	27,978	157,425	82
1986	166,354	606	166,959	0.36	100,098	267,057	63
1987	196,820	300	197,120	0.15	123,472	320,592	61
1988	153,311	248	153,559	0.16	124,868	278,426	55
1989	136,575	397	136,972	0.29	83,947	220,919	62
1990	108,649	696	109,344	0.64	43,634	152,978	71
1991	85,114	231	85,344	0.27	52,560	137,904	62
1992	71,278	167	71,445	0.23	79,571	151,015	47
1993	44,078	166	44,244	0.38	30,091	74,335	60
1994	41,712	1	41,714	0.00	0	41,714	100
1995	36,116	0	36,116	0.00	0	36,116	100
1996	32,915	0	32,915	0.00	15,343	48,257	68
1997	27,910	0	27,910	0.00	15,776	43,686	64
1998	17,292	0	17,292	0.00	12,088	29,380	59
1999	12,320	0	12,320	0.00	2,175	14,495	85
2000	13,583	0	13,583	0.00	3,863	17,446	78
2001	15,157	0	15,157	0.00	4,005	19,162	79
2002	-	-	-	-	7,053	-	-

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

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

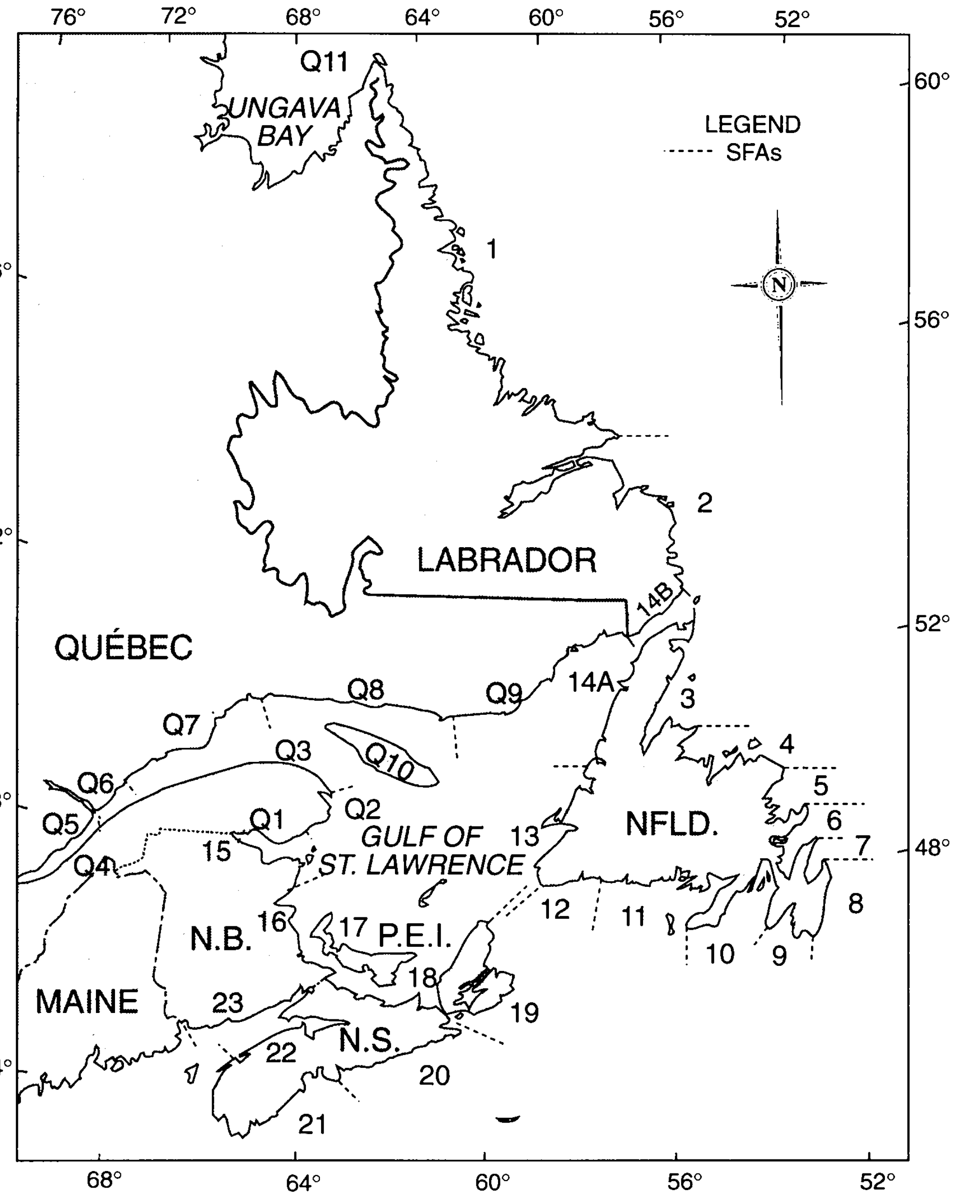


Figure 4.1.1.2. Summary of recreational fisheries management in eastern Canada and Maine (U.S.A.) during 2001.

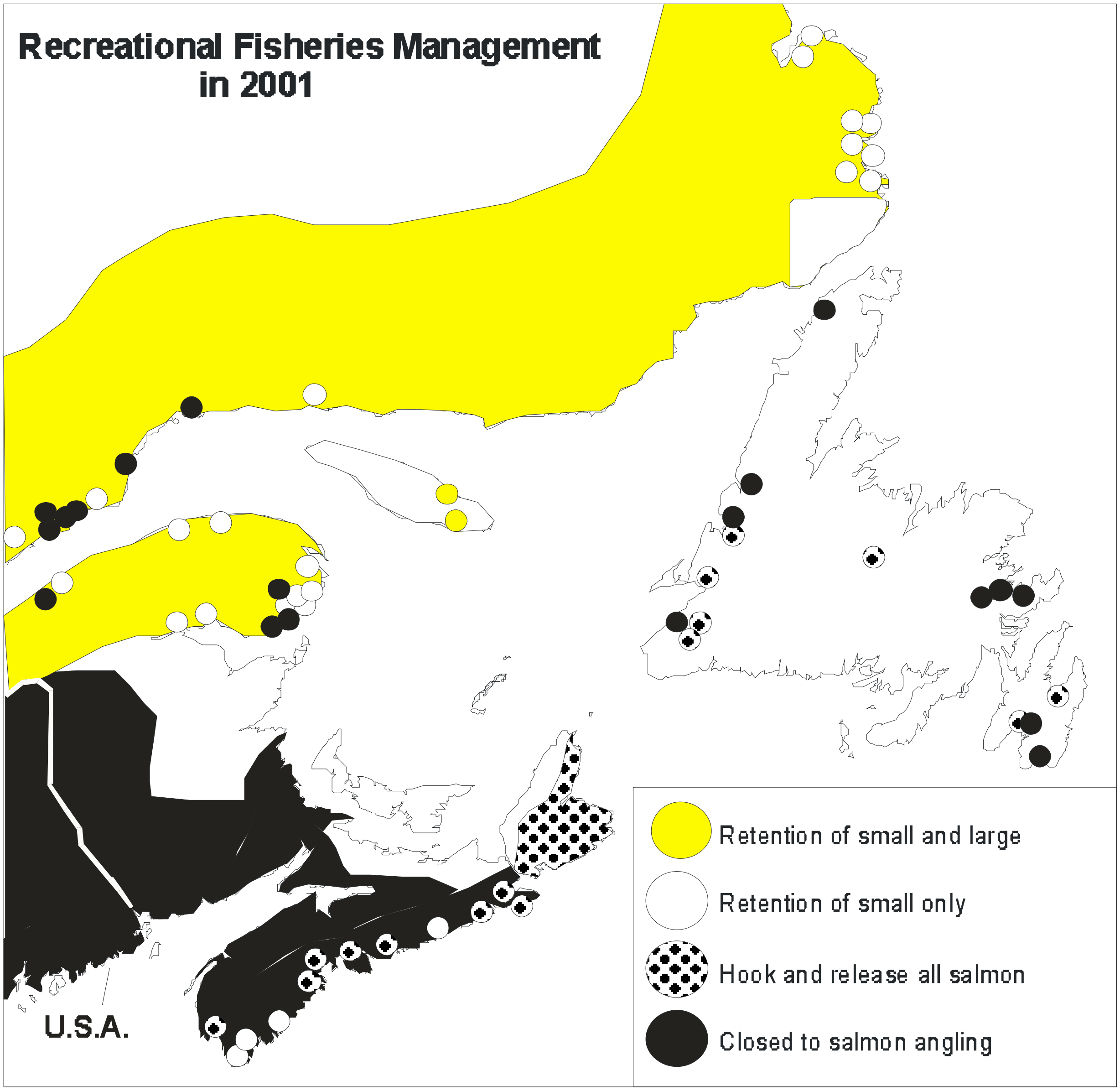


Figure 4.1.2.1. Harvest (t) of small salmon, large salmon, and combined in Canada, 1960-2001 by all users.

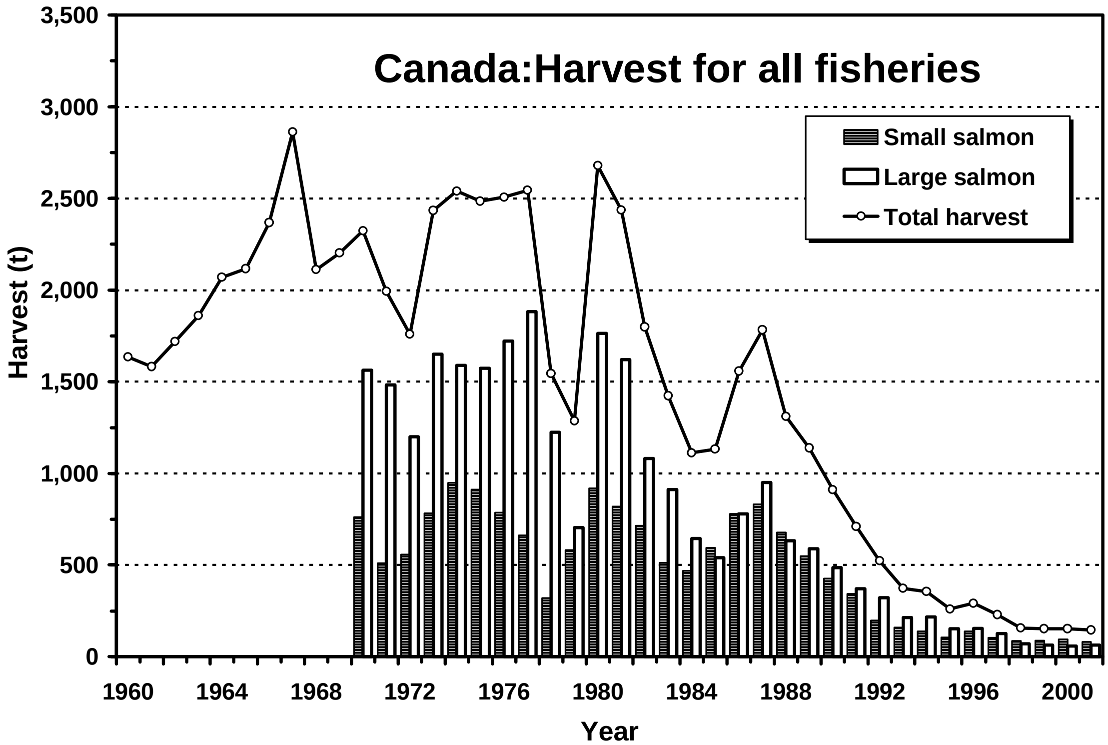


Figure 4.1.2.2. Harvest (number) of small and large salmon and both sizes combined in the recreational fisheries of Canada, 1974 to 2001.

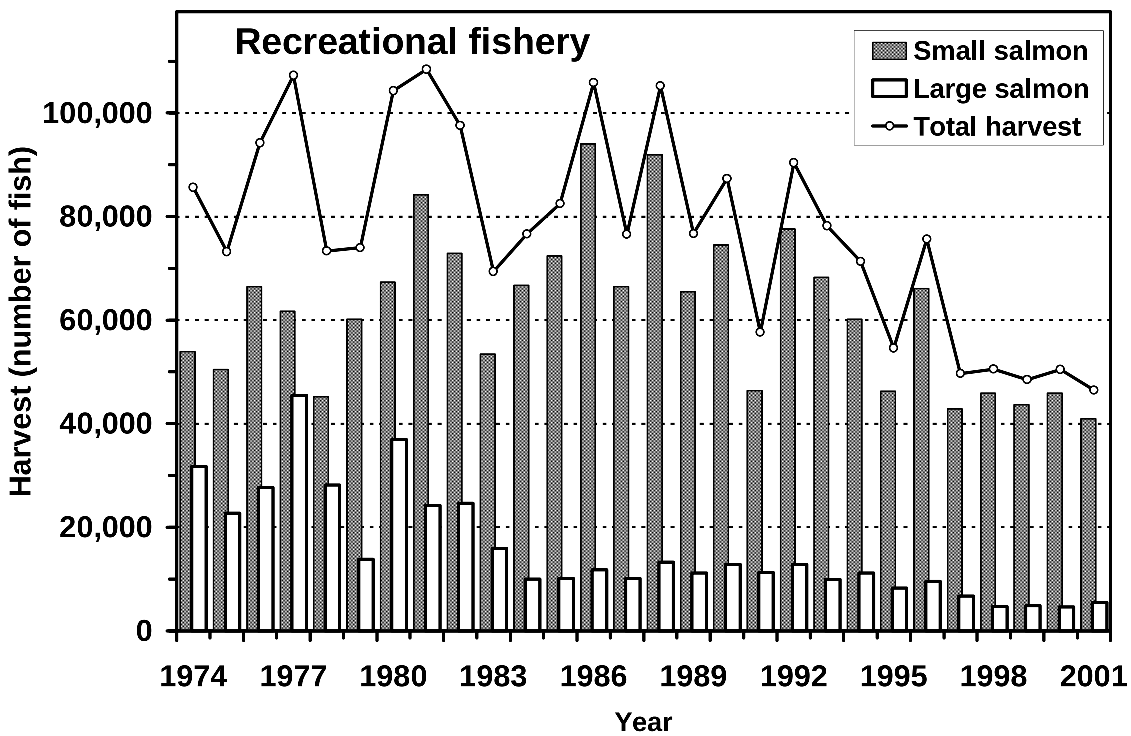
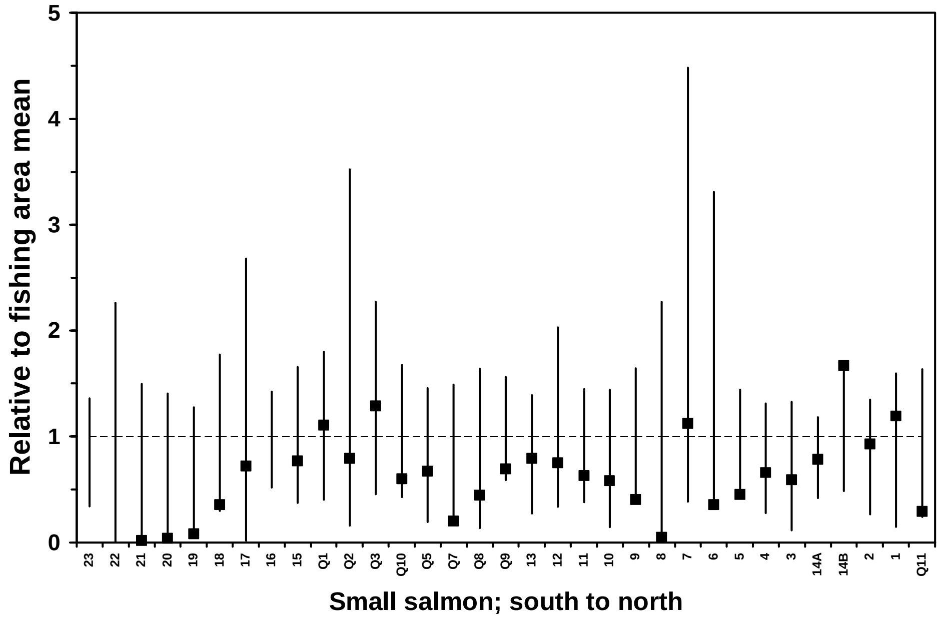


Figure 4.1.2.3. Angling catches (including kept and released fish) of small and large salmon by management area in 2001 (black square) expressed as a proportion of the average catches for the period 1984 to 1991, except for fishing areas 1 to 14B which are relative to the 1994 to 2000 period. The vertical 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 whereas the 1994 to 2000 period for Newfoundland and Labrador fishing areas 1 to 14A correspond to more complete accounting of angling catches after the salmon moratorium introduced in 1992.



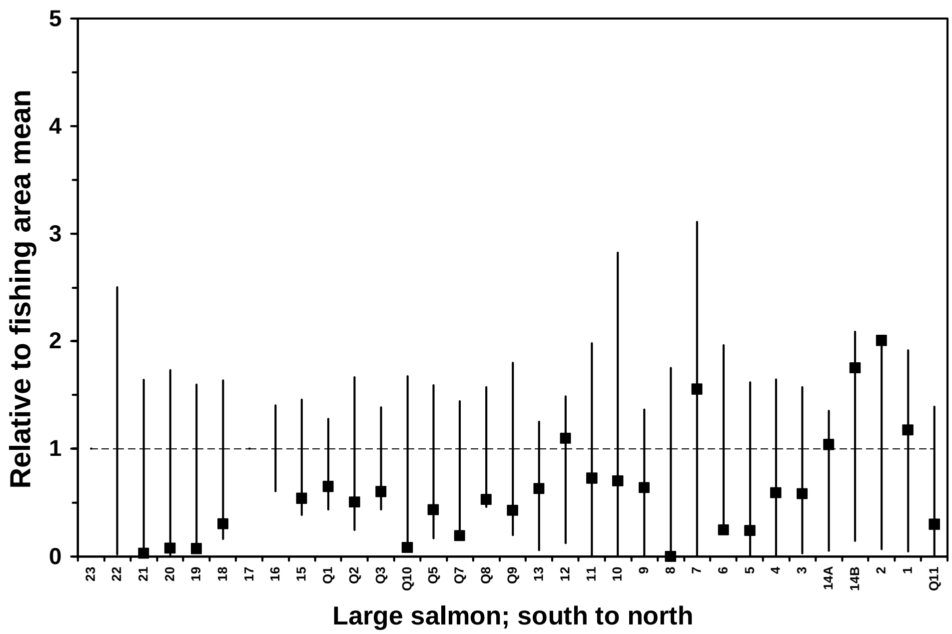


Figure 4.1.2.4. Harvest (t) of small salmon and large salmon and both size groups combined in the commercial fisheries of Canada, 1974 to 2001. All commercial fisheries were closed in 2000.

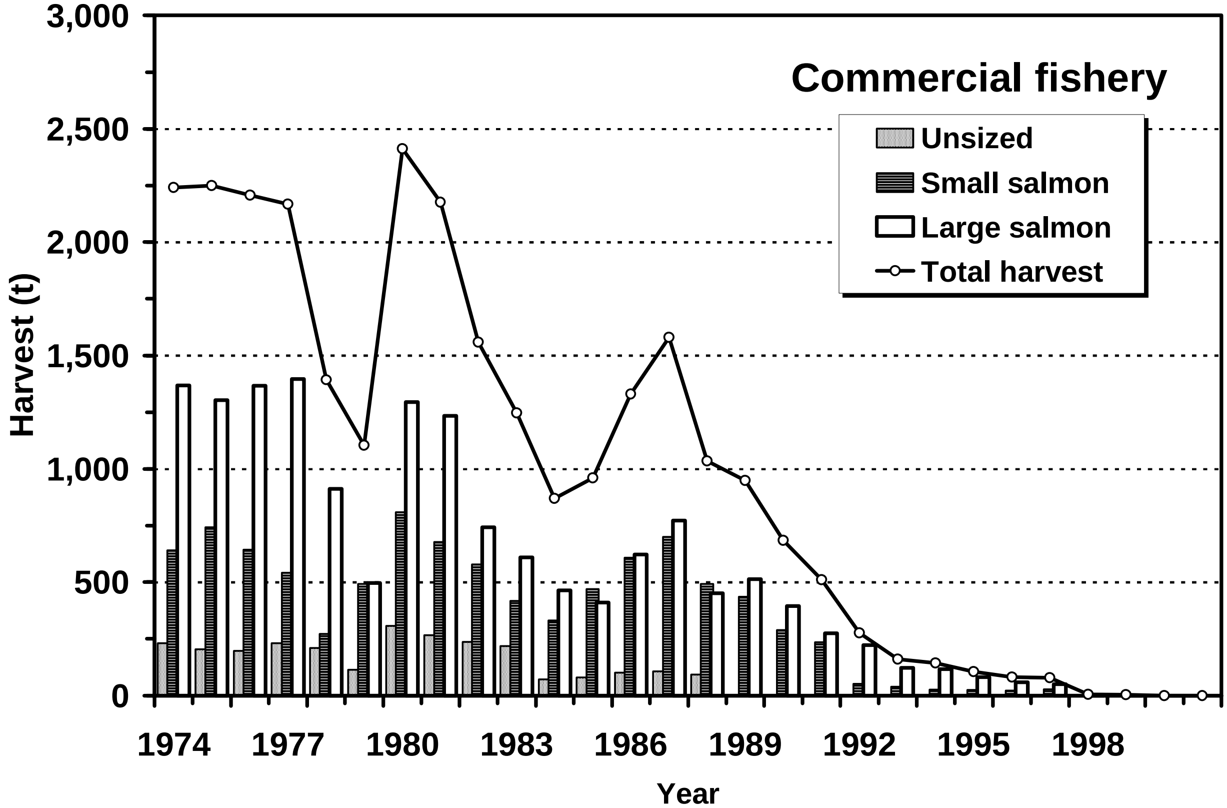


Figure 4.1.3.1. Origin (wild, hatchery, aquaculture) of Atlantic salmon returning to monitored rivers of eastern North America in 2001. Only rivers in which more than one origin type was expected are indicated.

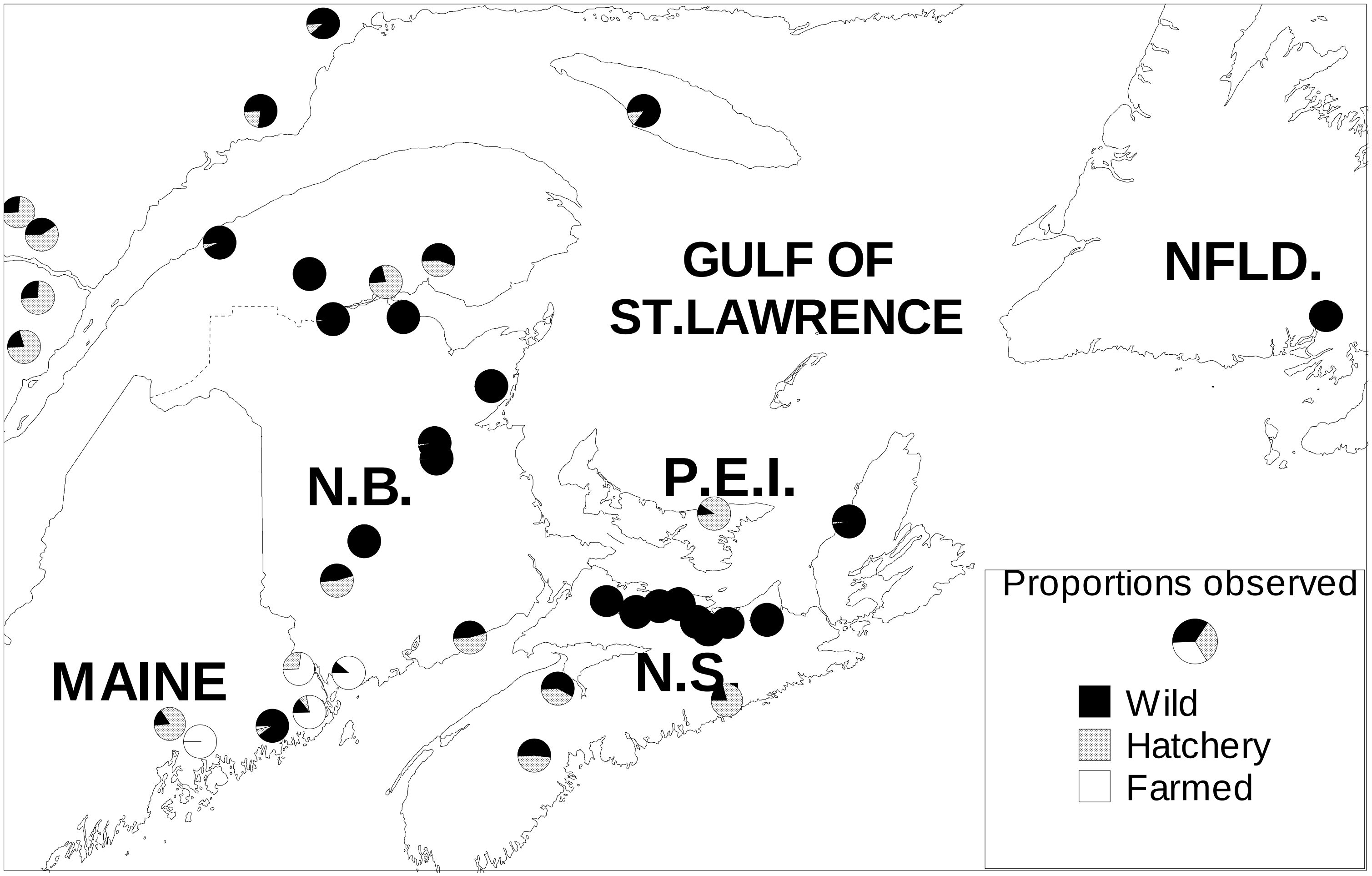


Figure 4.2.1.1. In-river returns of small salmon and large salmon for 26 monitored rivers in four geographic areas of eastern Canada from 1985 to 2000. The in-river returns do not account for removals in marine fisheries. Rivers by area are: Newfoundland (Conne, Exploits, Middle Brook, Northeast Trepassey, Northeast Brook, Torrent, Western Arm Brook), Québec (Bonaventure, Cascapédia, Port-Daniel Nord, Grande Rivière, St-Jean, York, Darmouth, Madeleine, Matane, de la Trinité), Gulf (Restigouche, Miramichi, Margaree), and Scotia-Fundy (LaHave, Saint John at Mactaquac).

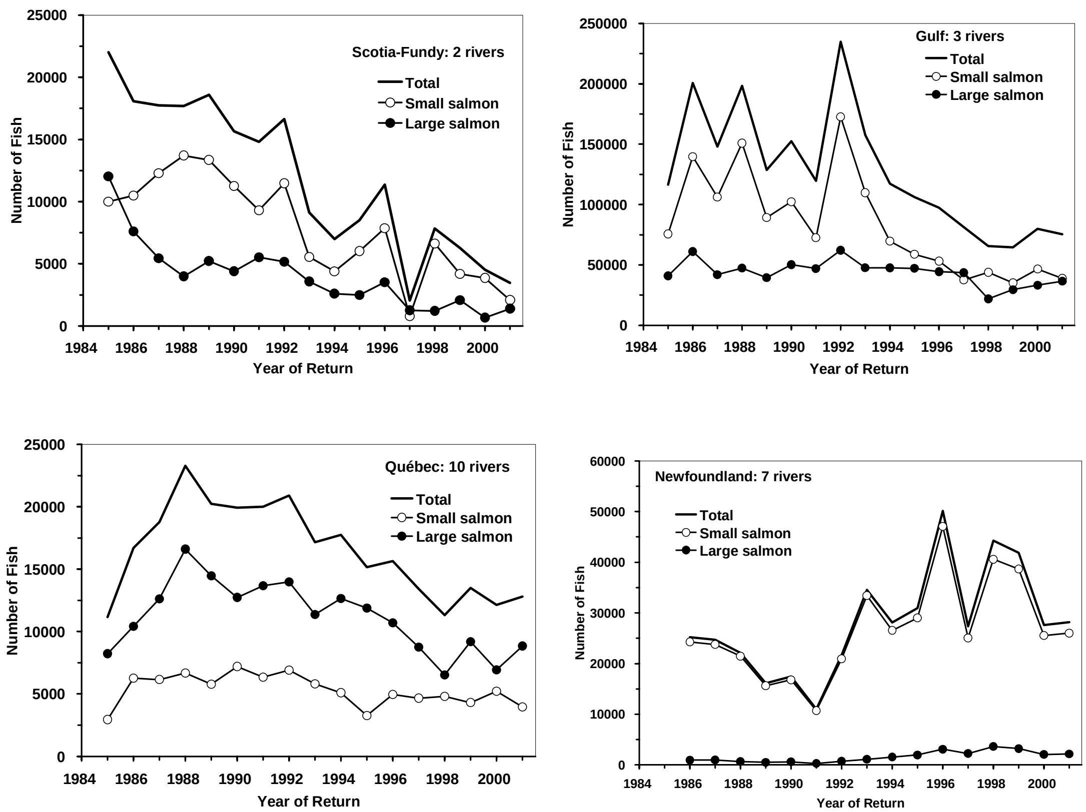


Figure 4.2.1.2. Wild smolt production from twelve rivers of eastern Canada, 1971 to 2001. Smolt production is expressed relative to the conservation egg requirements for each river (smolt output / conservation egg requirements).

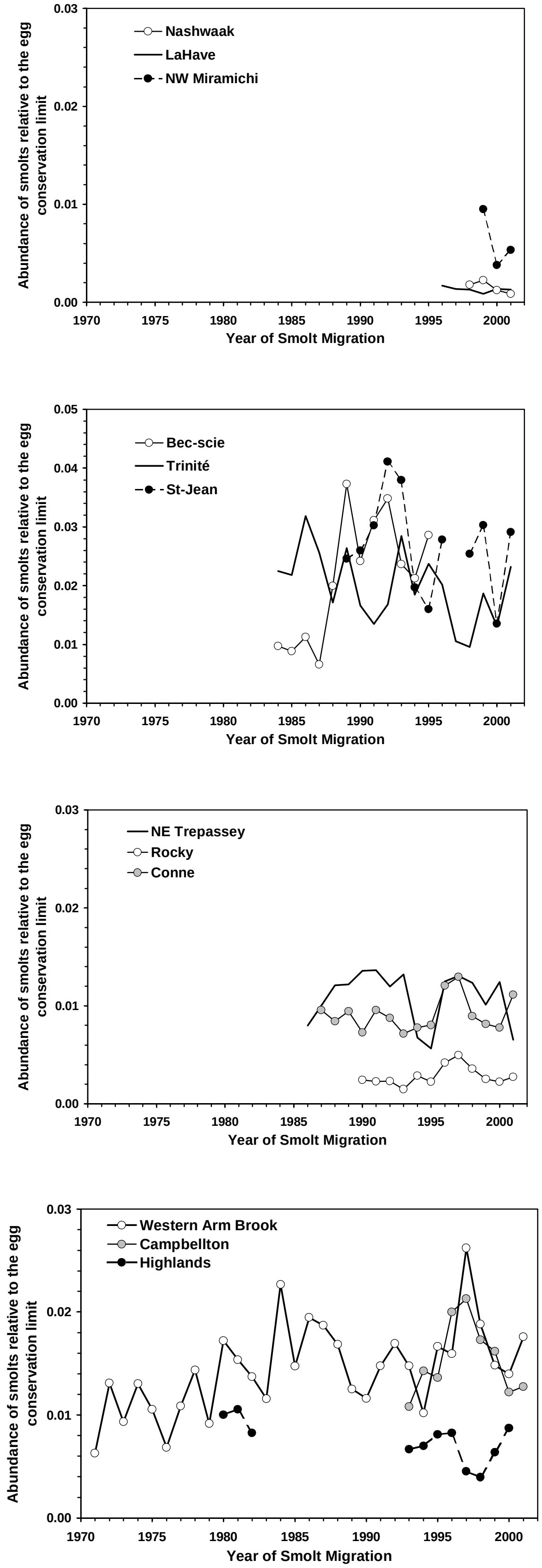
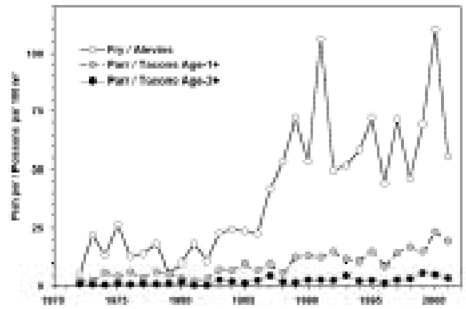
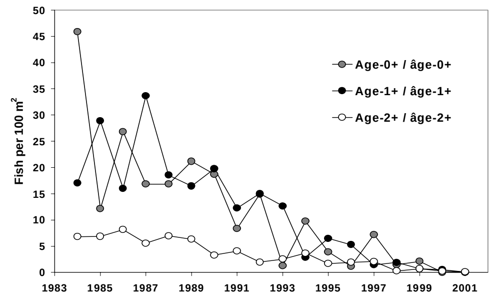


Figure 4.2.1.3 Atlantic salmon juvenile densities in eight rivers of the Maritime provinces (Restigouche, SFA 15; Miramichi,, SFA 16; St. Mary's, SFA 20; Stewiacke SFA 22; Nashwaak, Hammond and Upstream of Mactaquac Saint John River, SFA 23).

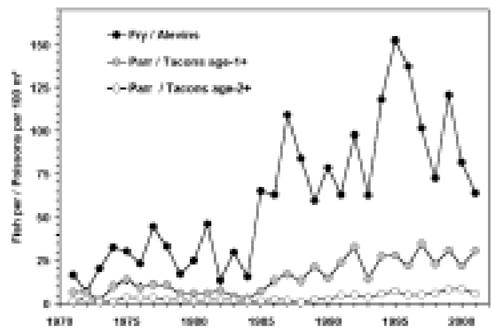
Restigouche (NB)



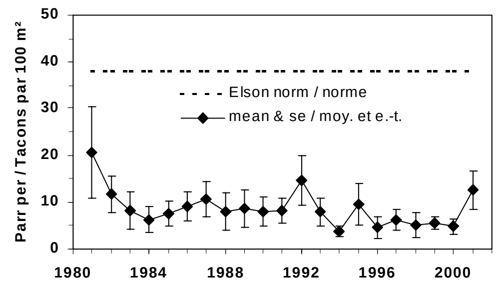
Stewiacke



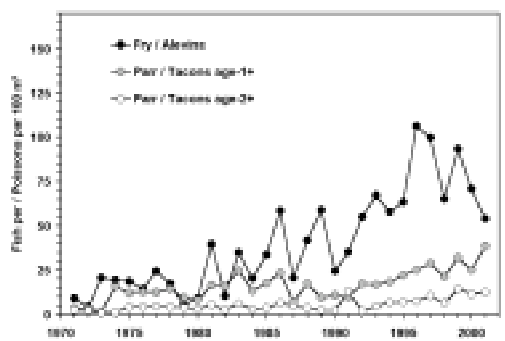
Southwest Miramichi



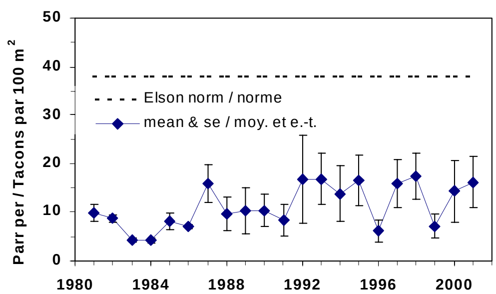
Nashwaak



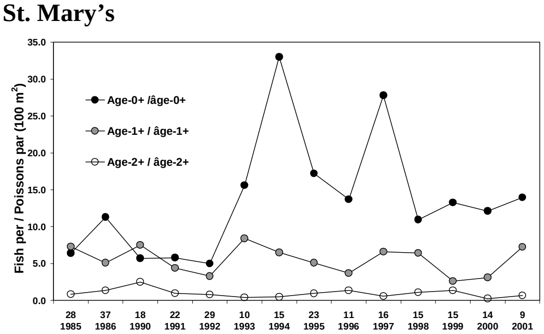
Northwest Miramichi



Hammond



St. Mary's



Upstream of Mactaquac

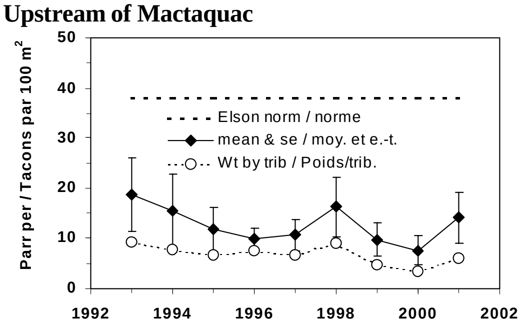


Figure 4.2.1.4. Relative index of smolt production in four areas of Canada. Relative indices are derived by weighting index river series by corresponding Salmon Fishing Area or Zone size (defined by conservation egg requirements). The Newfoundland and Quebec indices are derived from direct smolt counts. The Gulf and Scotia-Fundy estimates are based on juvenile abundances.

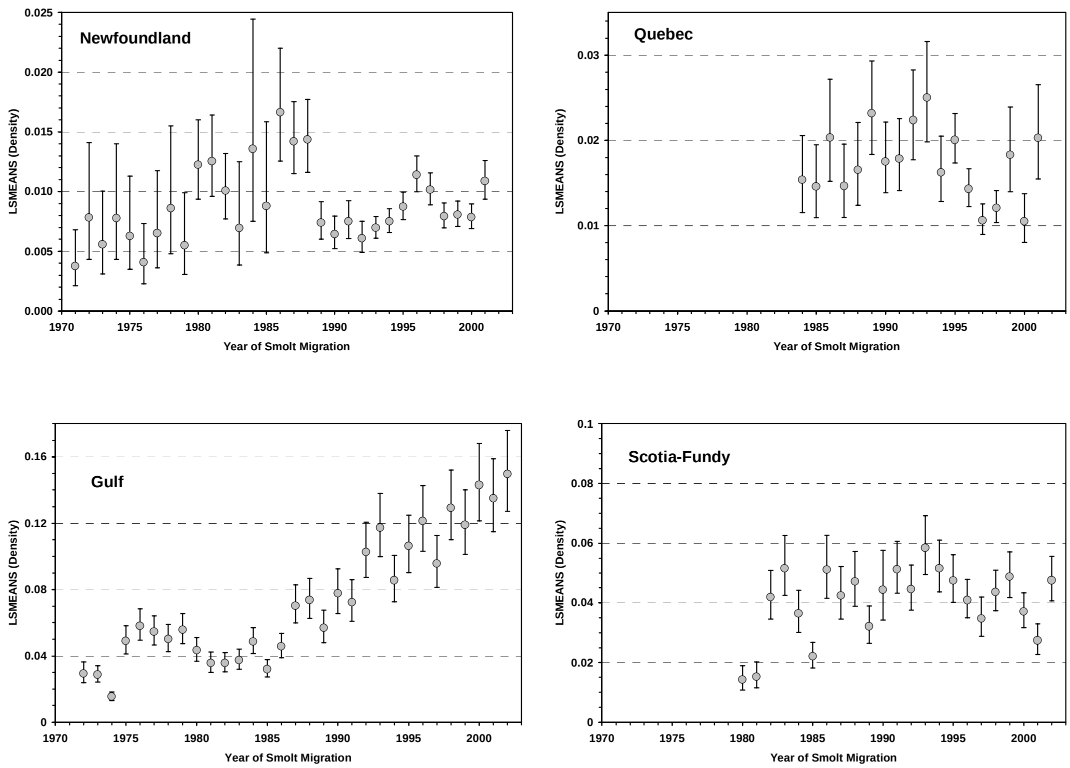


Figure 4.2.1.5. Relative index of smolt production in eastern North America. The index was derived from juvenile and smolt surveys in rivers of eastern Canada. The circle is the model adjusted mean (salmon fishing area factor) and the t-bars show one standard deviaton range. Juvenile and smolt data were natural ln transformed before analysis. The individual river indices were weighted by the 2SW spawner requirement for their respective salmon fishing areas.

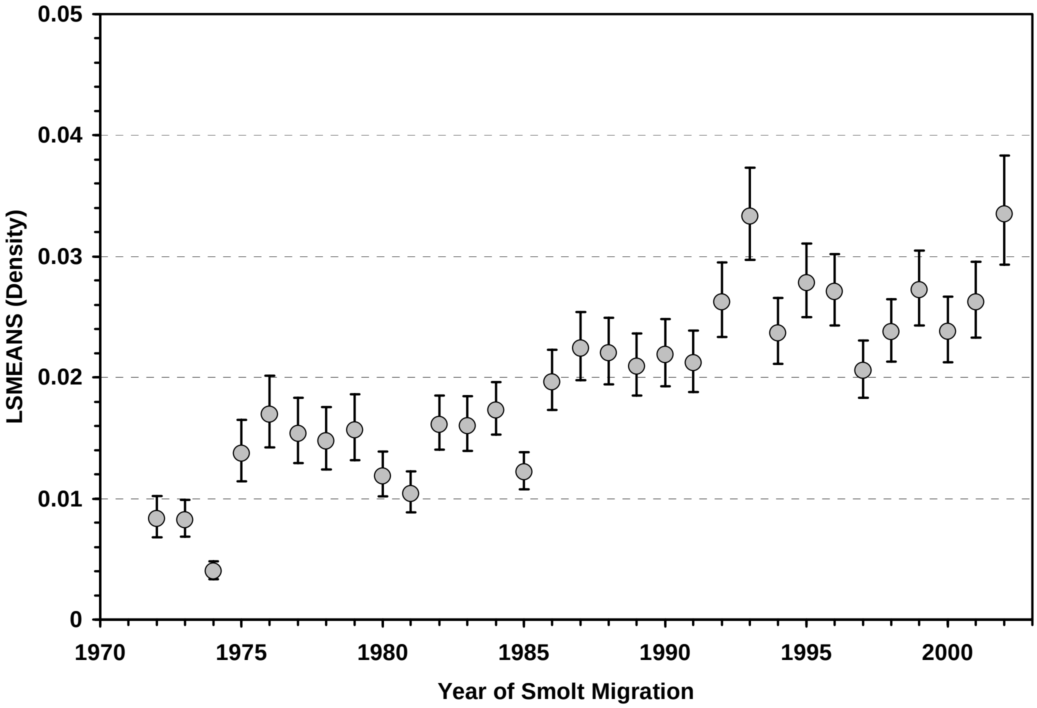


Figure 4.2.1.6. Documented returns of Atlantic salmon to USA rivers, 1967 to 2001.

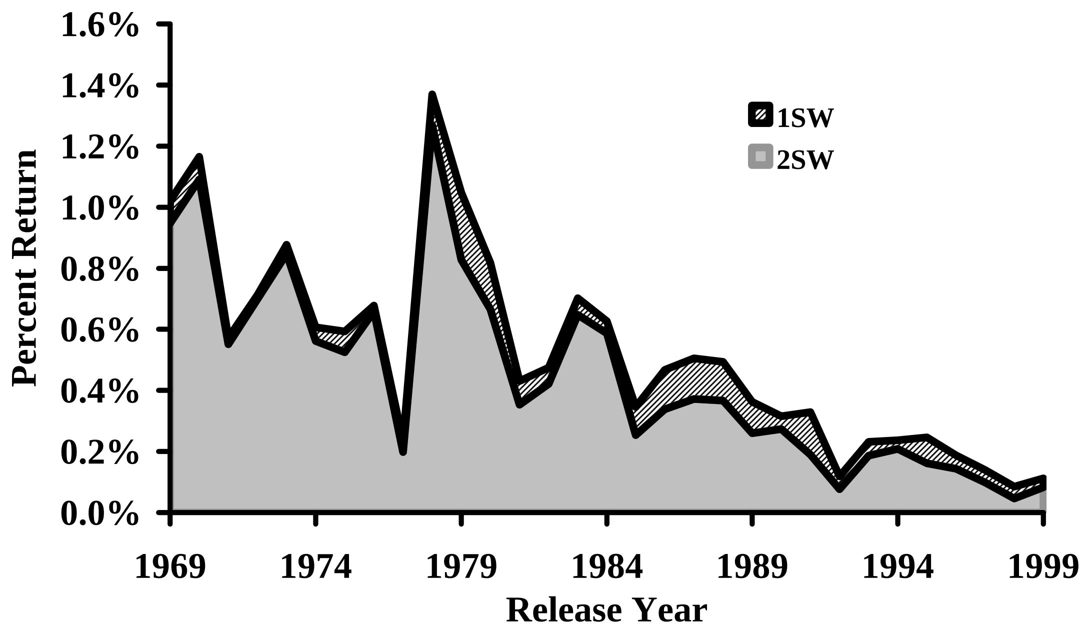


Figure 4.2.2.1 Comparison of estimated mid-points of 1SW returns to and 1SW spawners in rivers of six geographic areas in North America. Returns and spawners for Scotia-Fundy do not include those from SFA 22 and a portion of SFA 23.

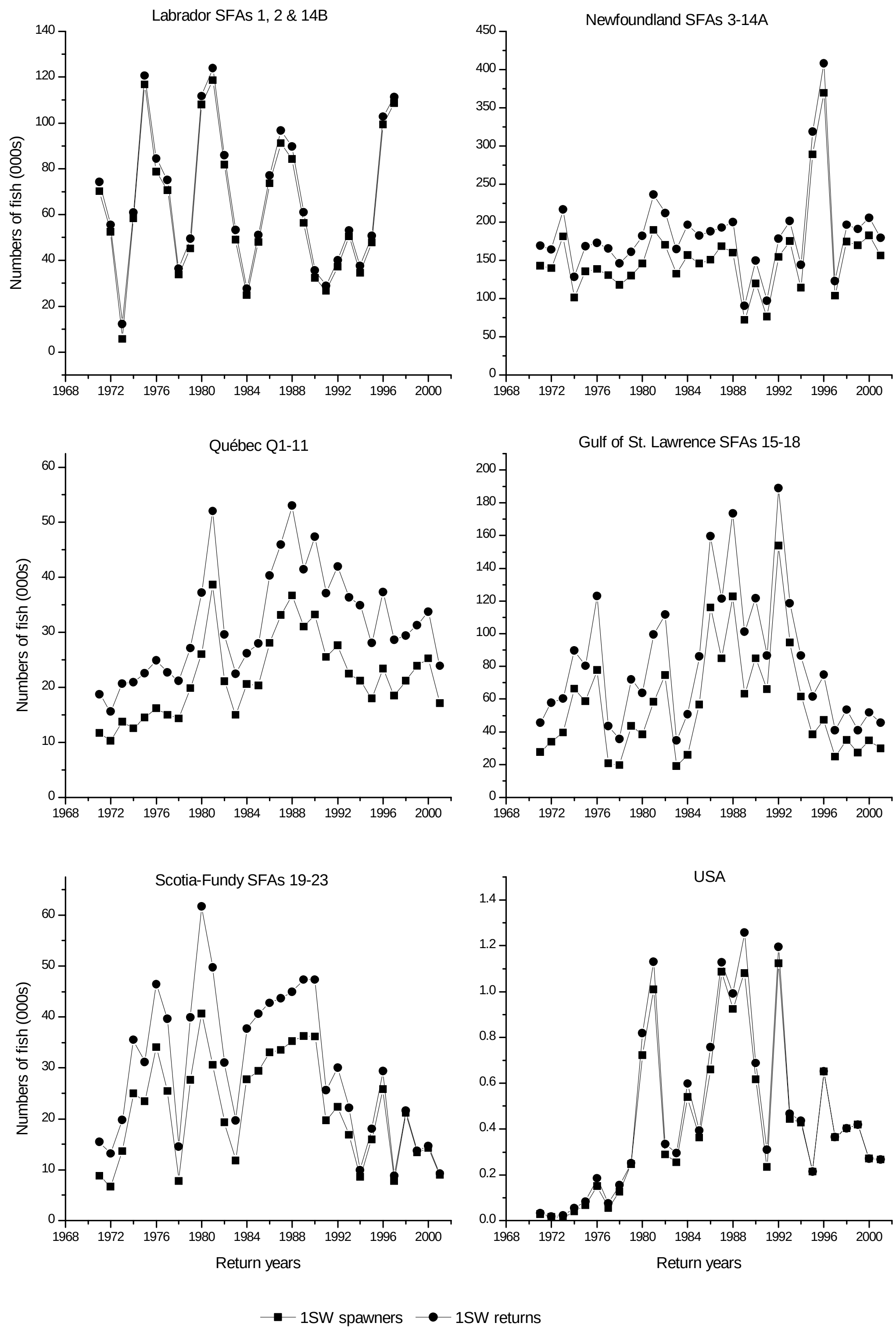


Figure 4.2.2.2 Comparison of estimated mid-points of 2SW returns, 2SW spawners, and 2SW conservation limits for six geographic areas in North America. Returns and spawners for Scotia-Fundy do not include those from SFA 22 and a portion of SFA 23.

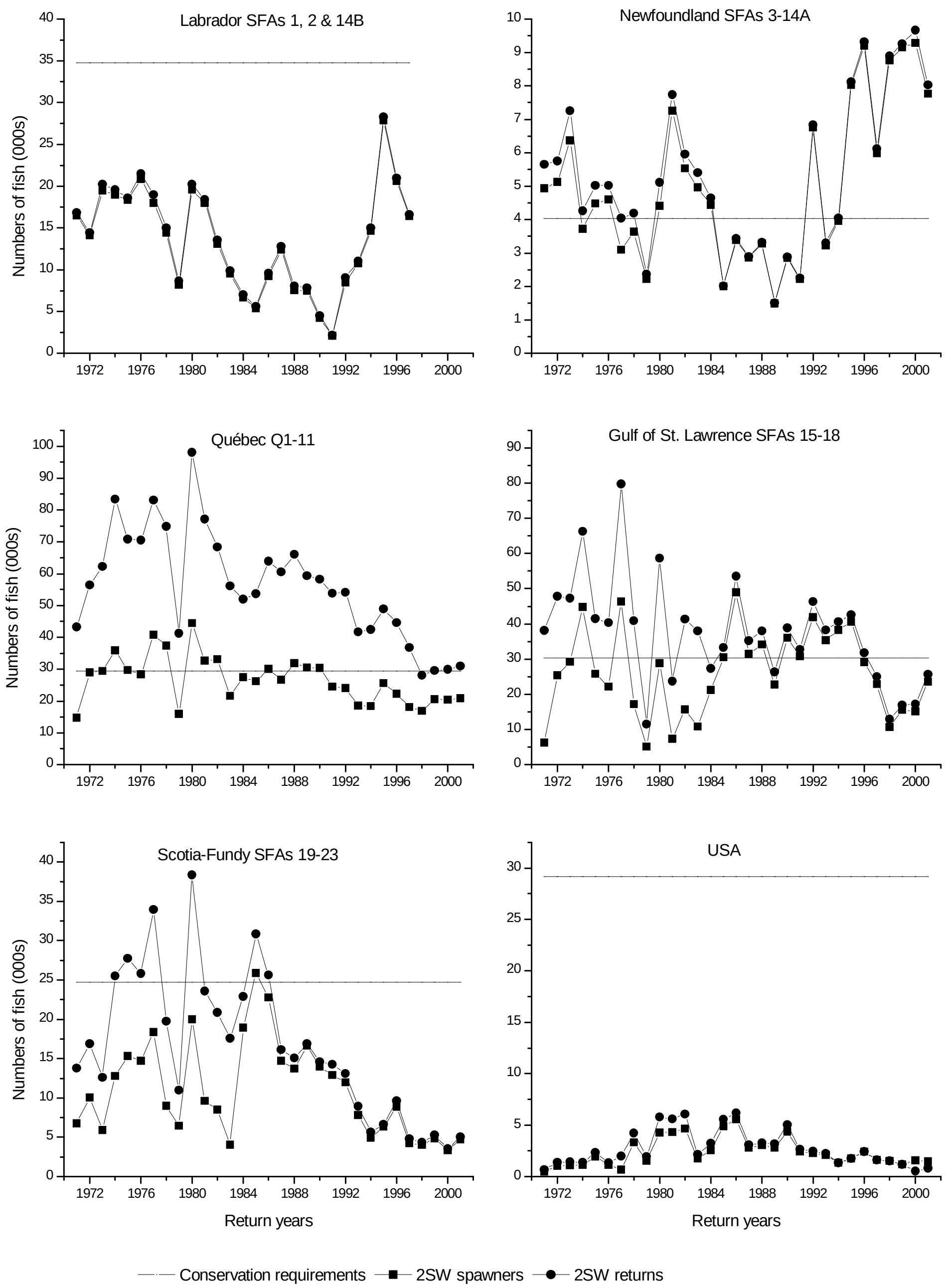


Fig. 4.2.3.1. Prefishery abundance estimate of maturing and non-maturing salmon in North America. Open circles are for the years that returns to Labrador were assumed as a proportion of returns to other areas in North America.

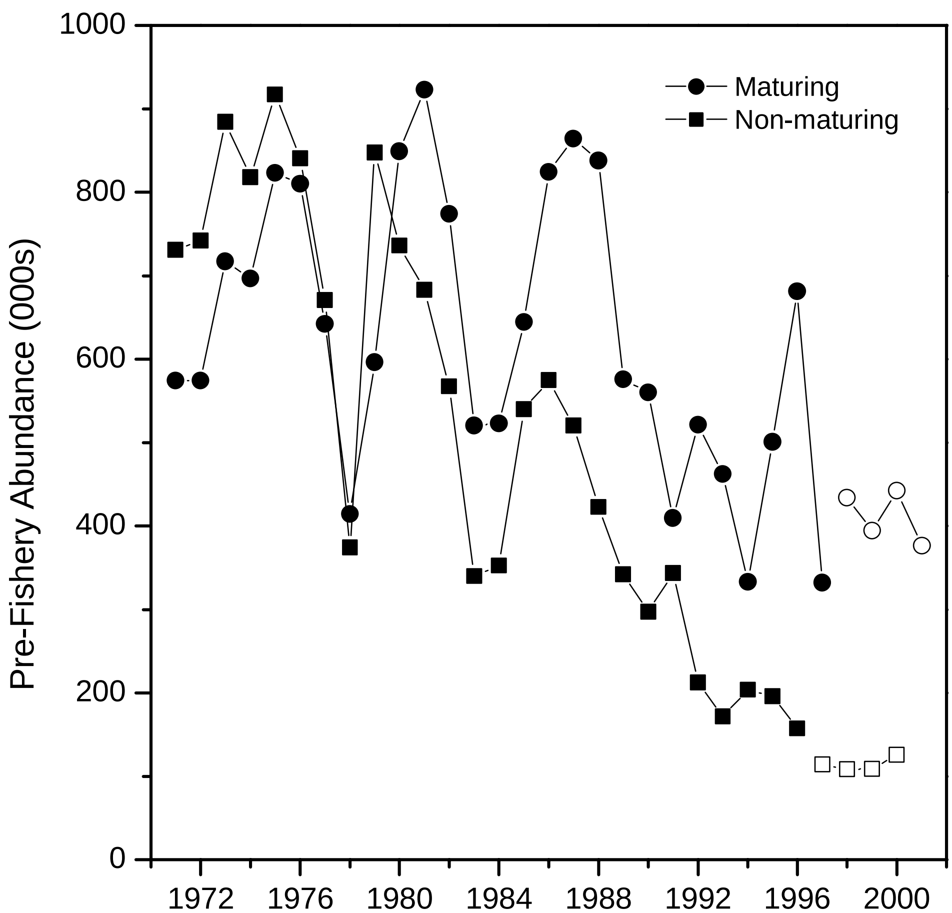


Fig. 4.2.3.2. Total 1SW recruits (non-maturing and maturing) originating in North America

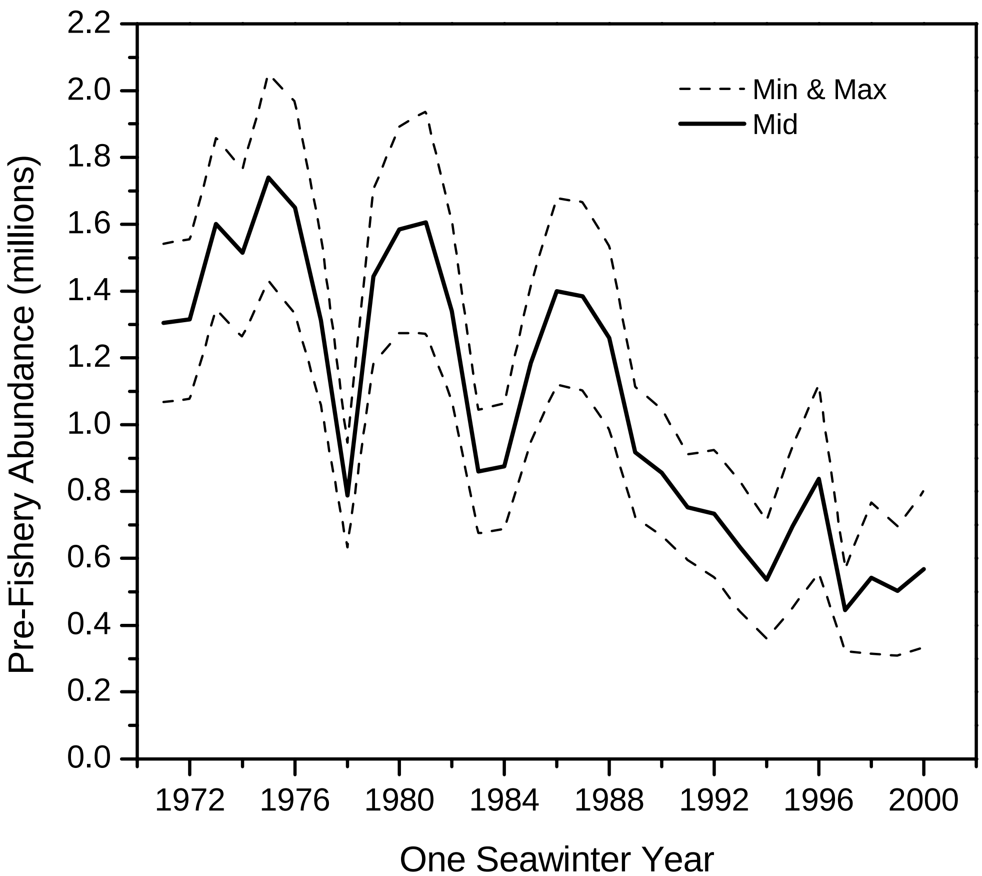
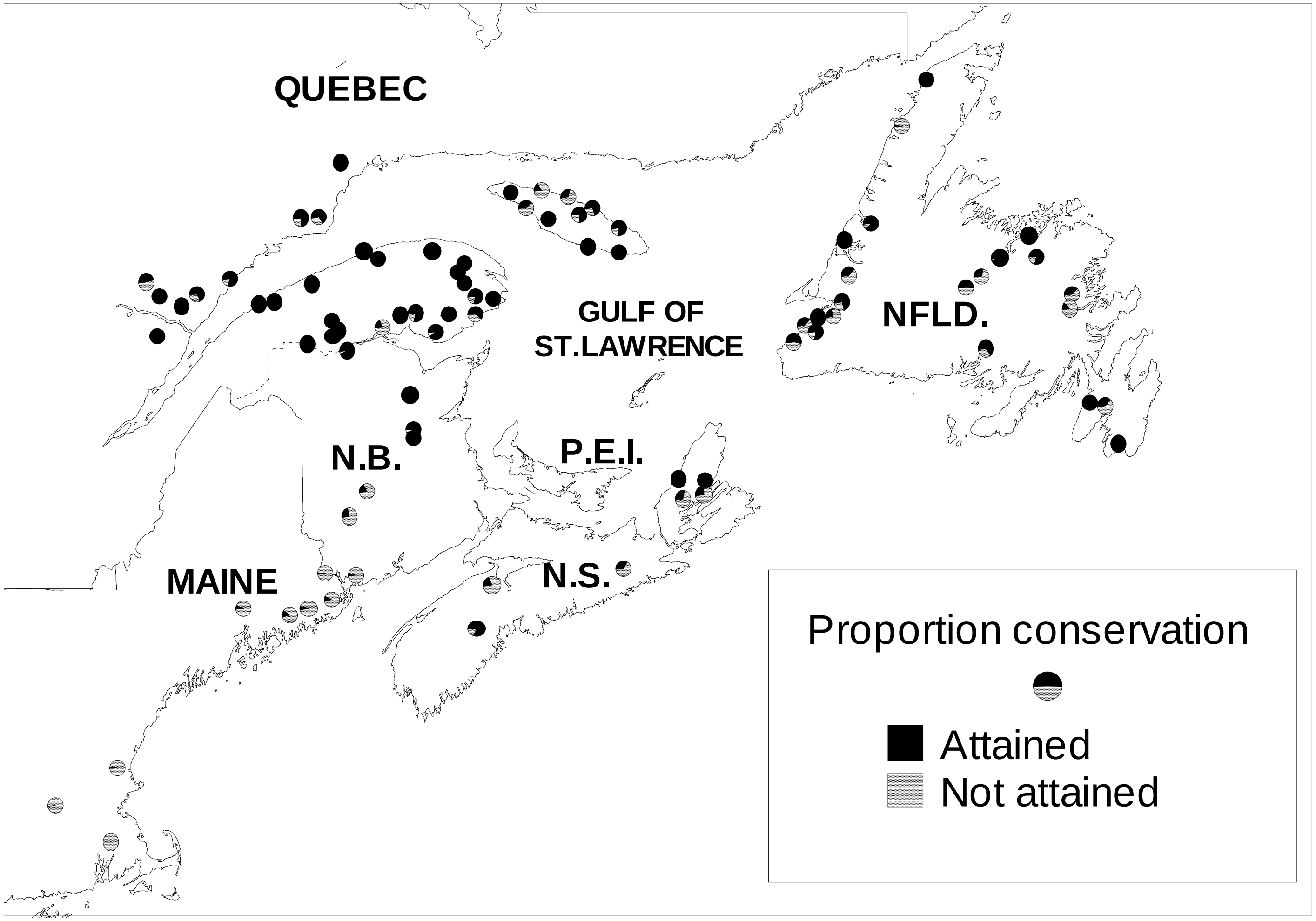


Figure 4.2.4.1. Egg depositions in 2001 relative to conservation requirements also known as the spawner limit (S_{lim}) in 85 rivers of North America in 2001. The black slice represents the proportion of the S_{lim} requirement achieved. A solid black circle indicates the egg deposition requirement was attained or exceeded.



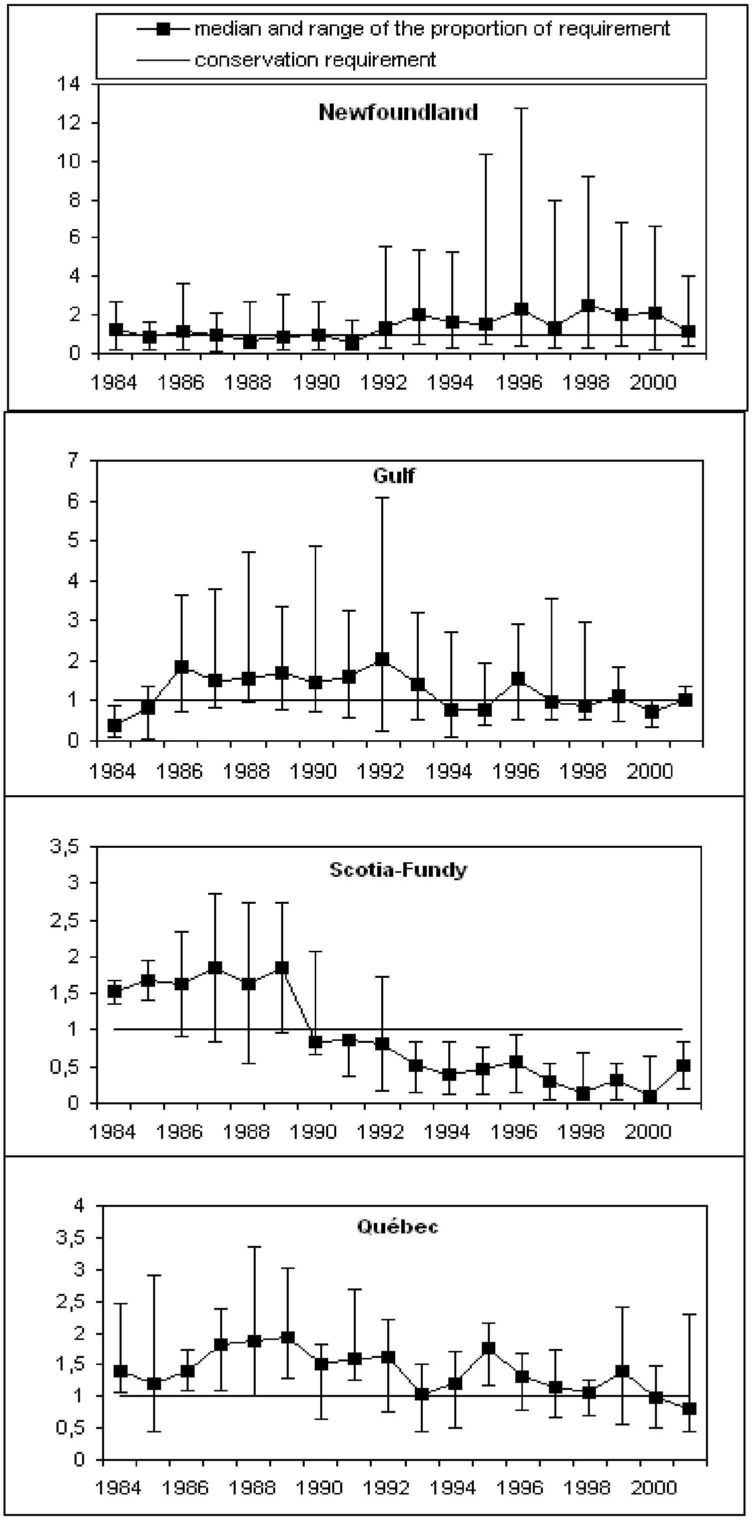


Figure 4.2.4.2. Proportion of the conservation limits met in monitored rivers in four geographic areas of eastern Canada, 1984 to 2001. The vertical line represents the minimum and maximum proportion achieved in individual rivers, the black square is the median proportion. The range of the number of rivers included in the annual summary was 7-8 for Newfoundland, 3-8 for the Gulf, 2-3 for Scotia-Fundy and 9 for Québec.

Figure 4.2.4.3 Top panel: comparison of estimated potential 2SW production prior to all fisheries, 2SW recruits available to North America, 1971-2001 and 2SW returns and spawners for 1971-97, as 1998-2001 data for Labrador are unavailable. The horizontal line indicates the 2SW conservation limits. Bottom panel: comparison of potential maturing 1SW recruits, 1971-2001 and returns and 1SW spawners for 1971-97 return years as Labrador data for 1998-2001 are unavailable.

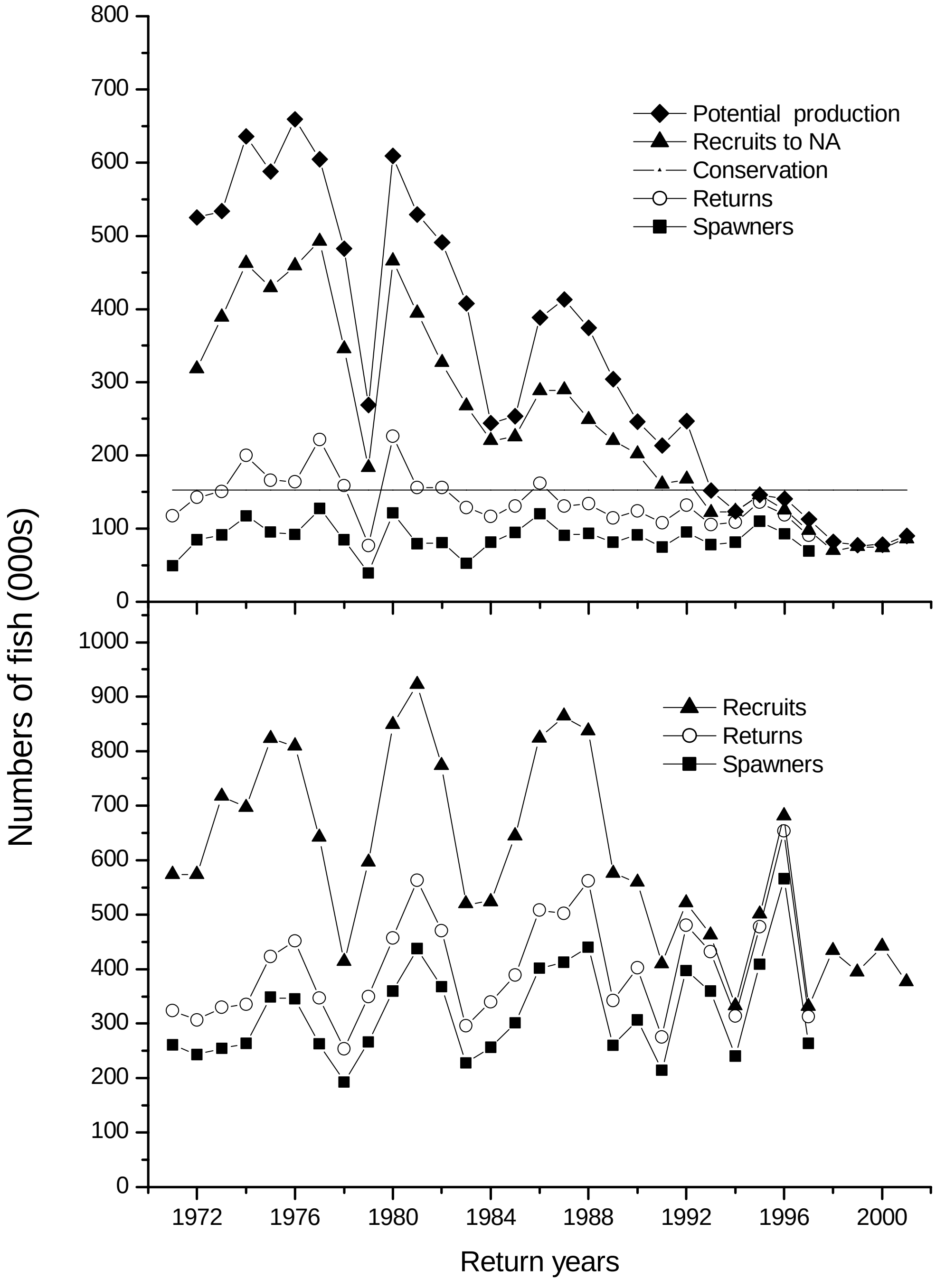


Fig. 4.2.4.4. Midpoints of lagged spawners (solid circles) and estimated annual spawners (open circles) as contribution to potential recruitment in the year of prefishery abundance (PFA) for six geographic areas of North America. The horizontal line represents the conservation limit (in terms of 2SW fish = S $_{lim}$) in each geographic area.

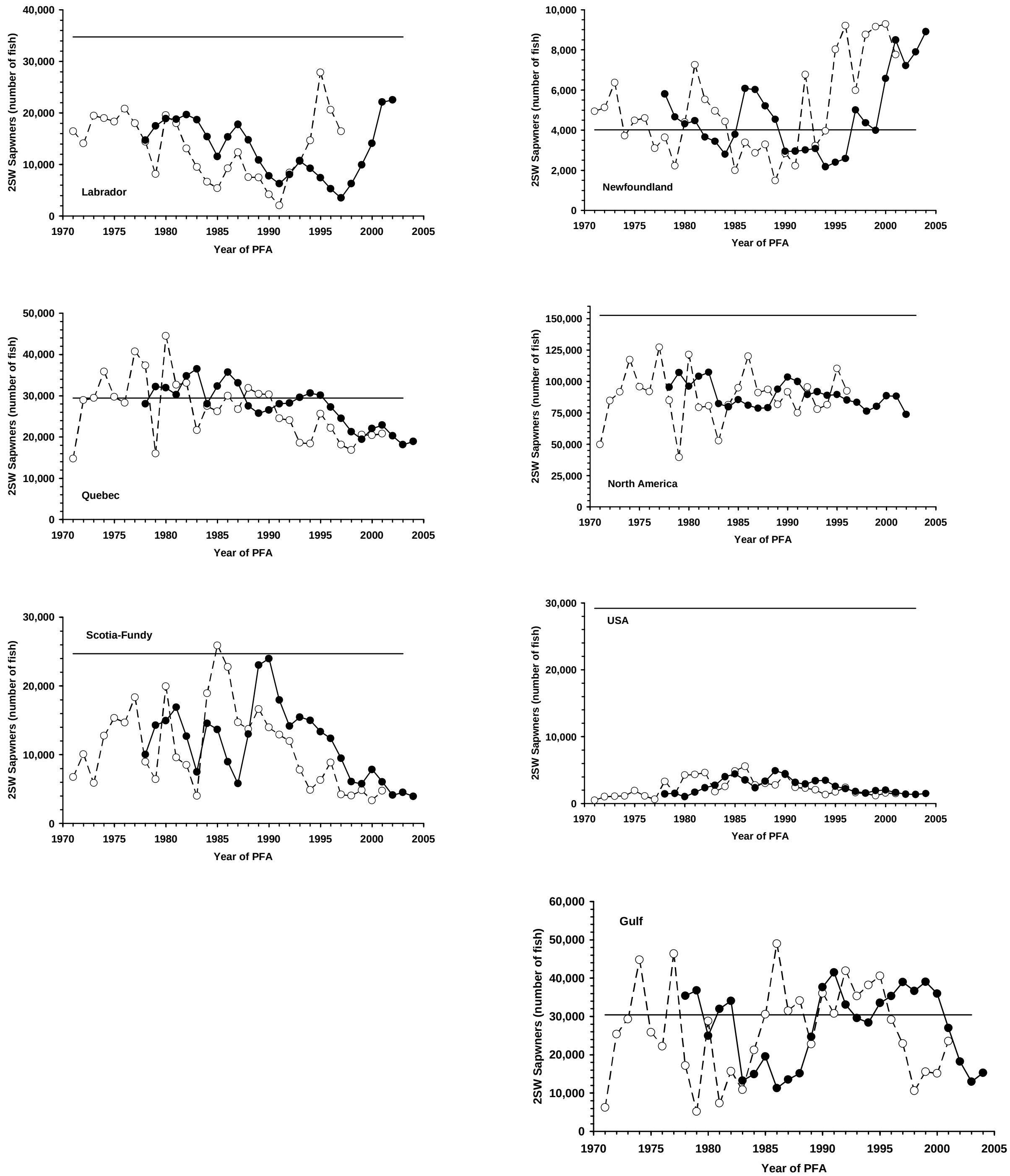
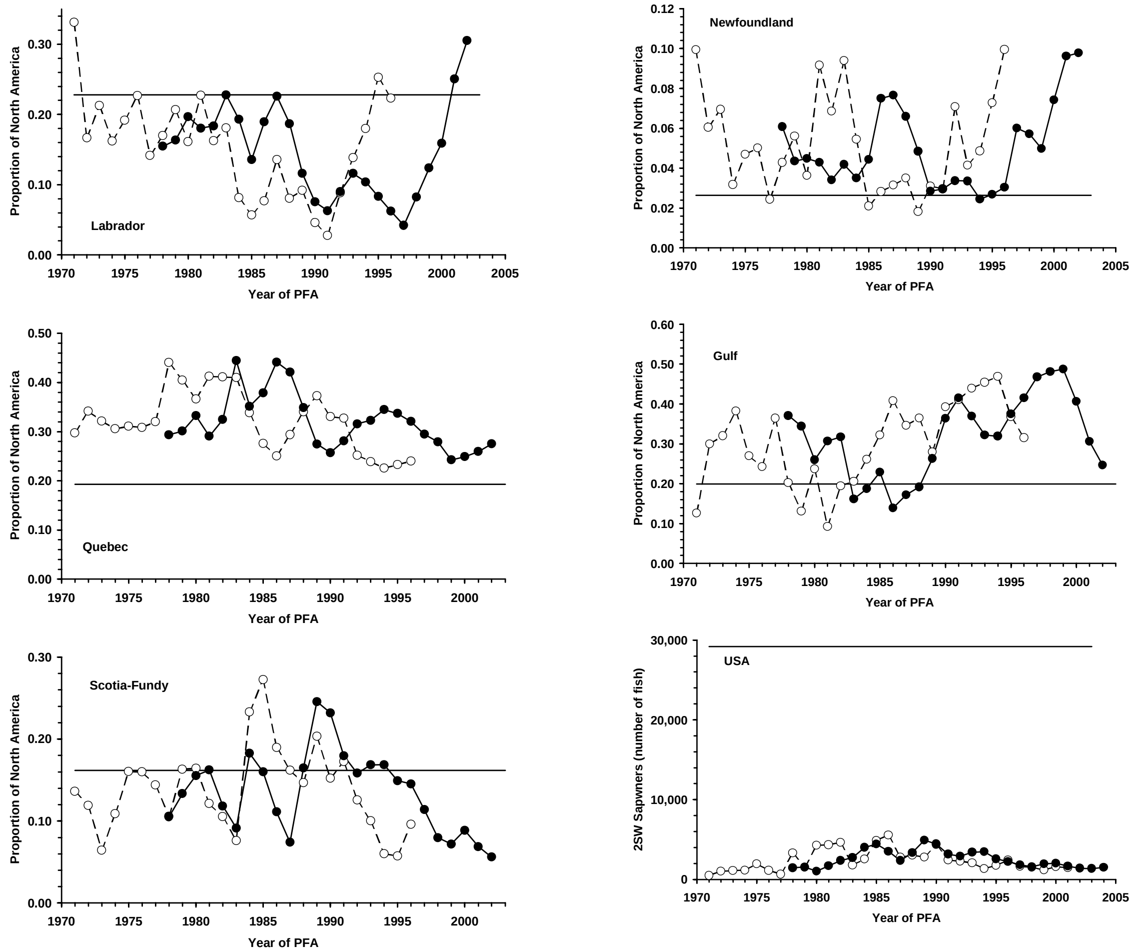


Fig. 4.2.4.5. Proportion of spawners (mid-points) lagged to year of PFA (solid circles) and as returns to rivers (open circles) in six geographic areas of North America relative to the total lagged spawner or annual spawning escapement to North America. The horizontal line represents the theoretical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



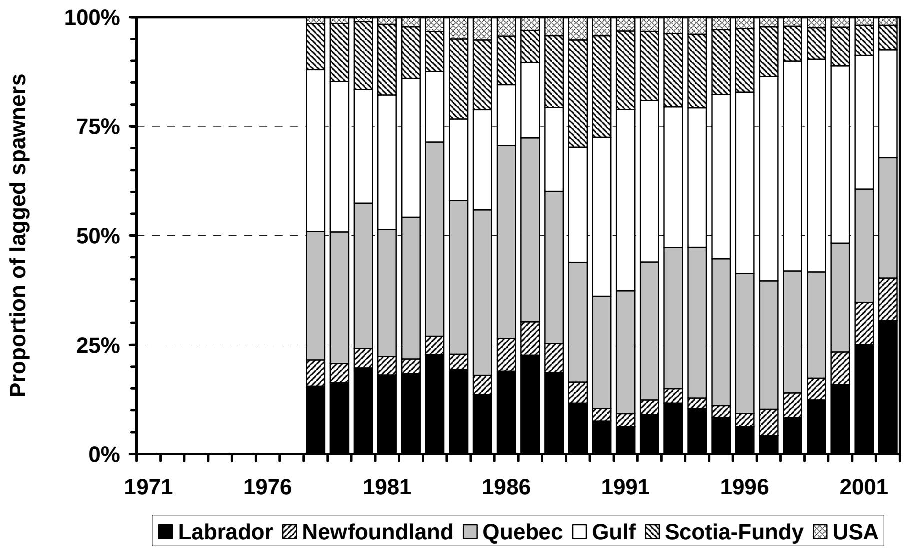
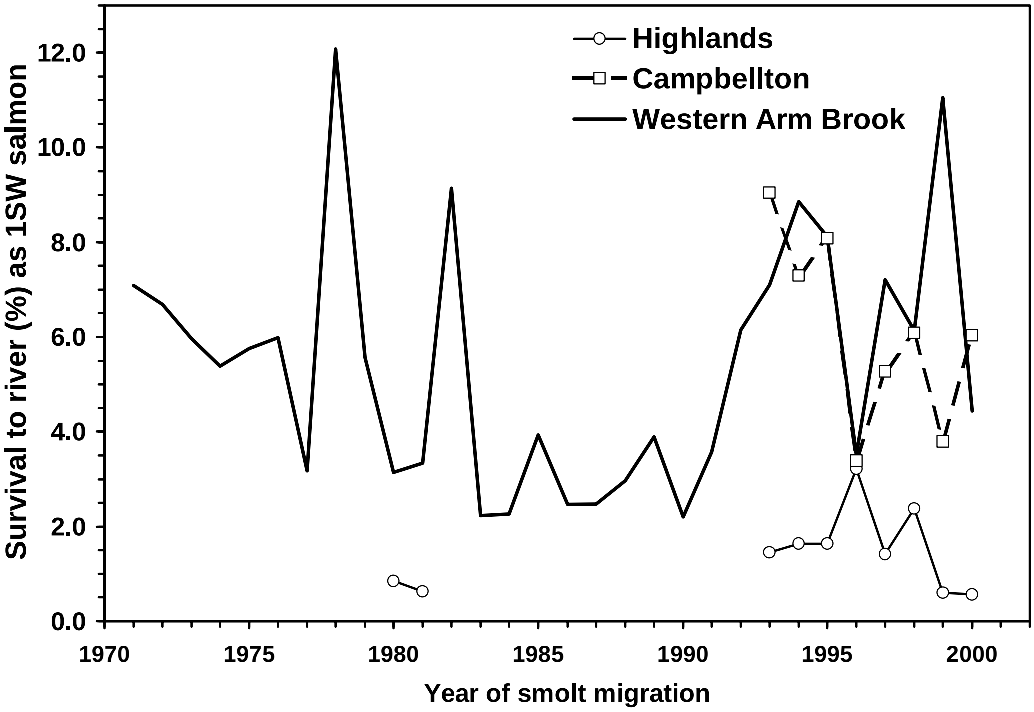


Figure 4.2.5.1. Survival rates (%) of wild smolts as 1SW salmon from the rivers in west and north Newfoundland (Highlands, SFA 13, Western Arm Brook, SFA 14A and Campbellton, SFA 4) and south Newfoundland (NE Trepassey, SFA 9; Rocky, SFA 9; and Conne, SFA 10).



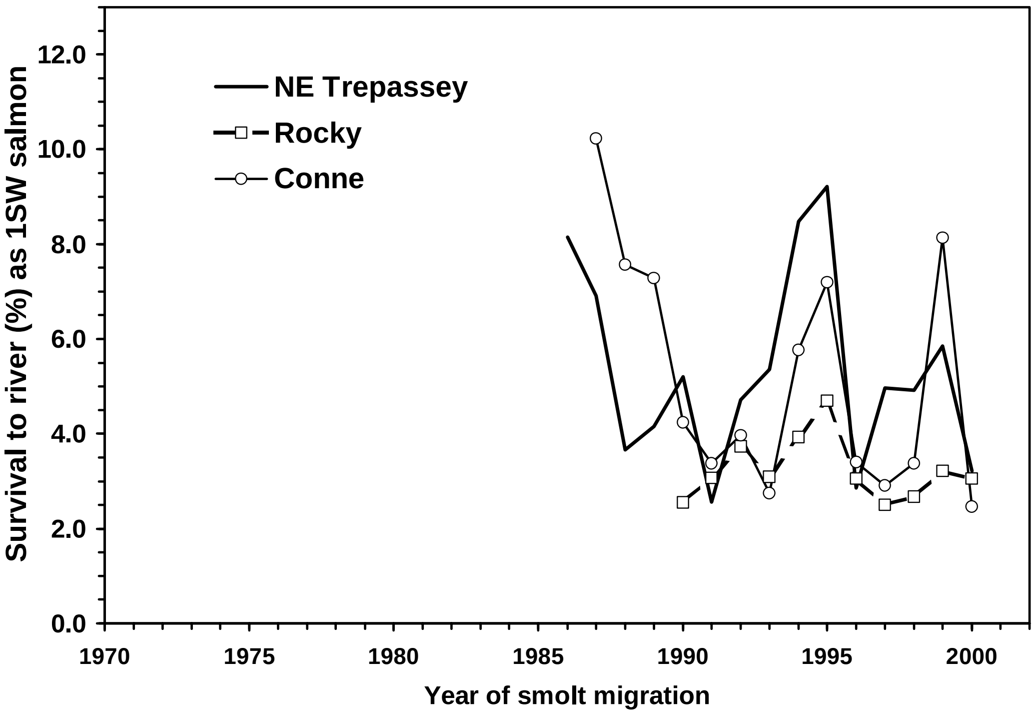


Figure 4.2.5.2. Survival rates (%) of wild smolts as 1SW (upper) and 2SW (middle) salmon from the rivers in Quebec (Bec-Scie Q10, de la Trinité, Q7 and Saint-Jean, Q2)., and from rivers in the Maritime provinces (lower panel) Northwest Miramichi SFA 16; LaHave, SFA 21; Nashwaak, SFA 23).

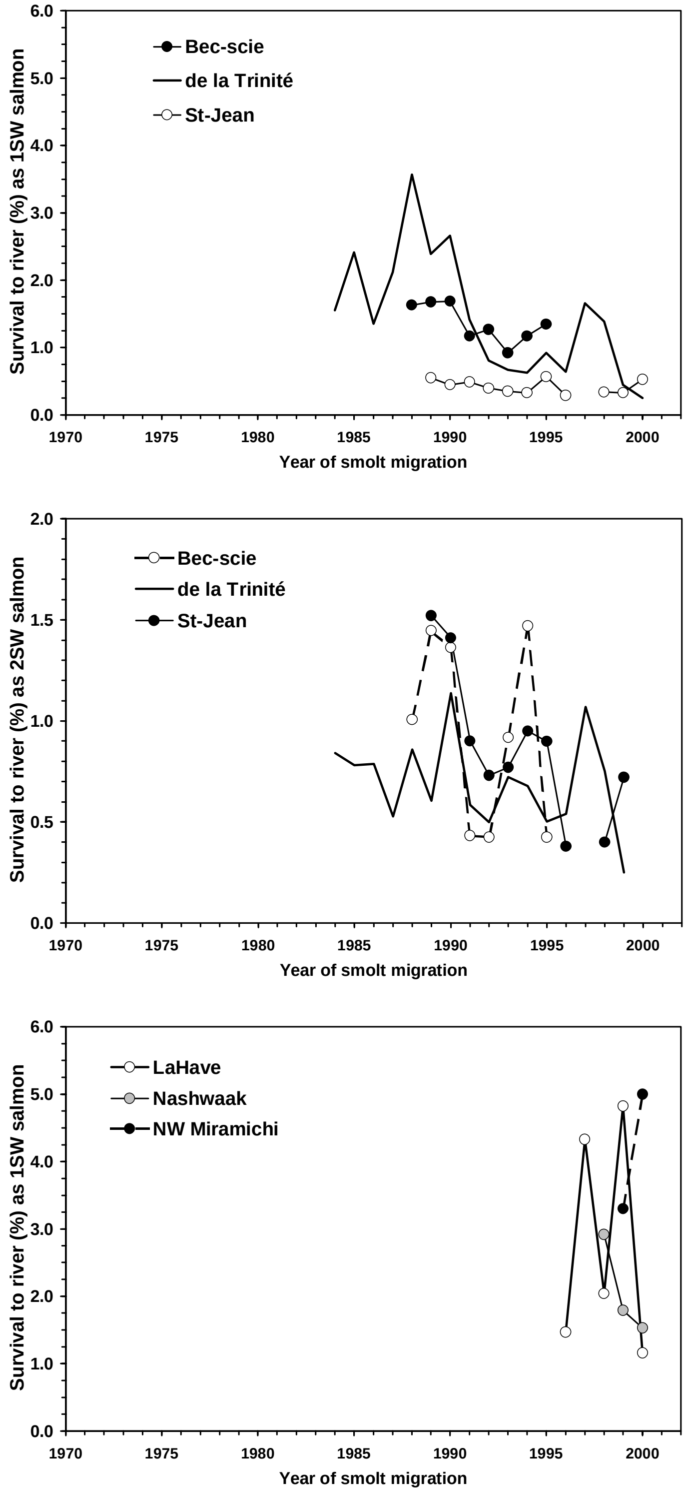
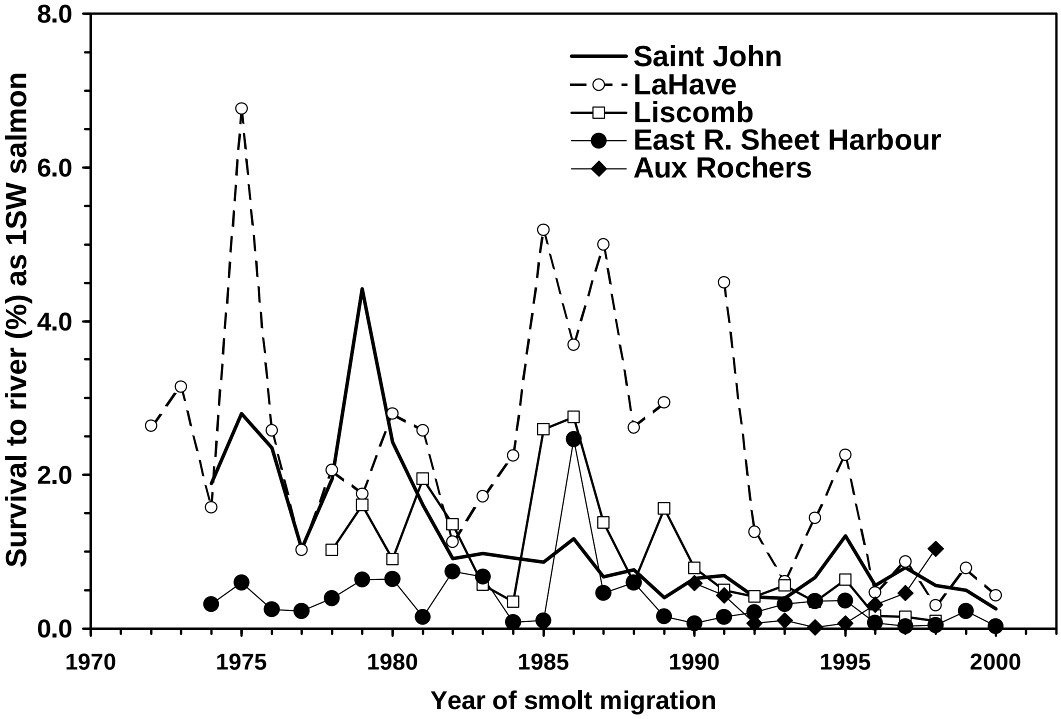


Figure 4.2.5.3. Survival rates (%) of hatchery released smolts from the Saint John River (SFA 23), LaHave River (SFA 21), Liscomb and East rivers (SFA 20), and Aux Rochers River (Q7) as 1SW (upper panel) and 2SW (lower panel) returns to the river.



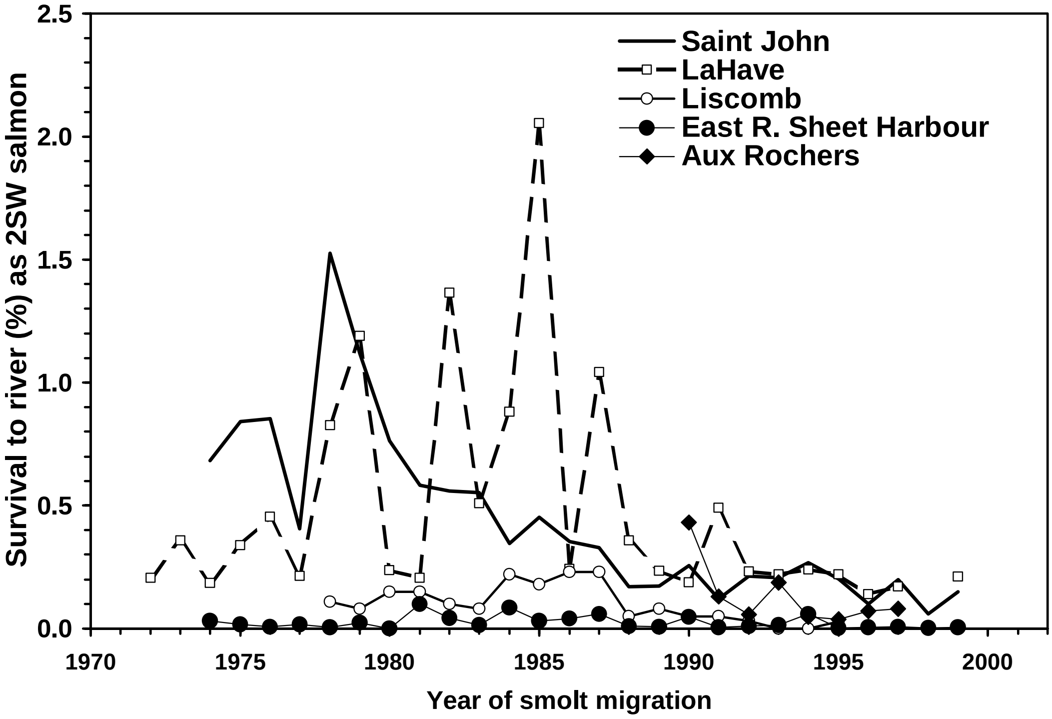


Figure 4.2.5.4. Survival rates (%) of hatchery released smolts from the Penobscot River (Maine, USA) as 1SW and 2SW returns to the river.

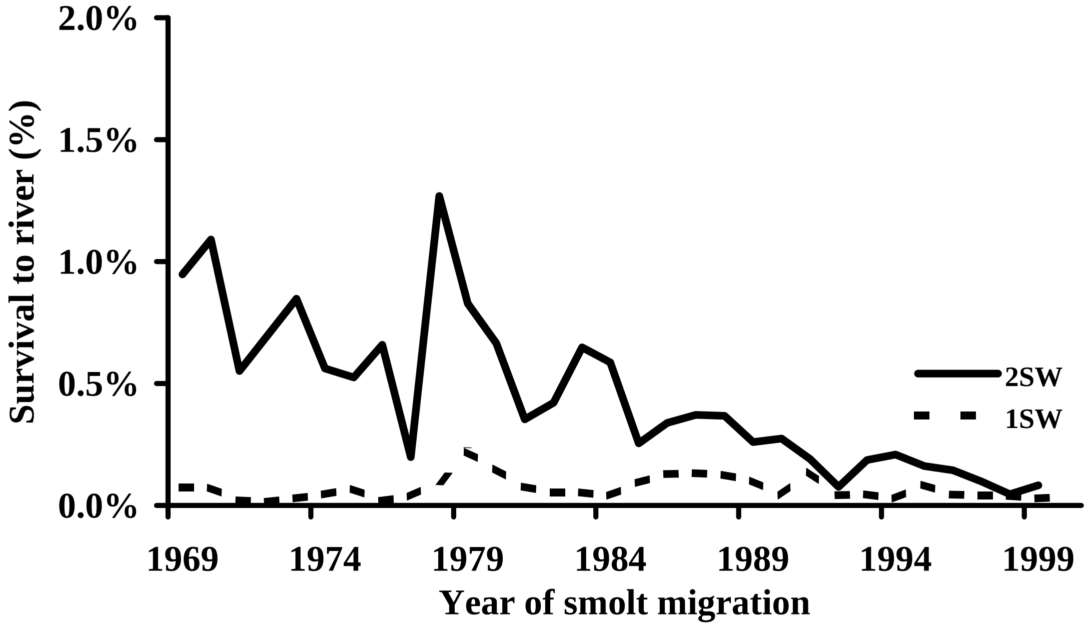


Figure 4.5.1 Proportional contribution of four salmon production regions to the lagged numbers of spawning salmon contributing to the estimate of the pre-fishery abundance of maturing two-sea-winter Atlantic salmon in the North Atlantic 1978 to 2002.

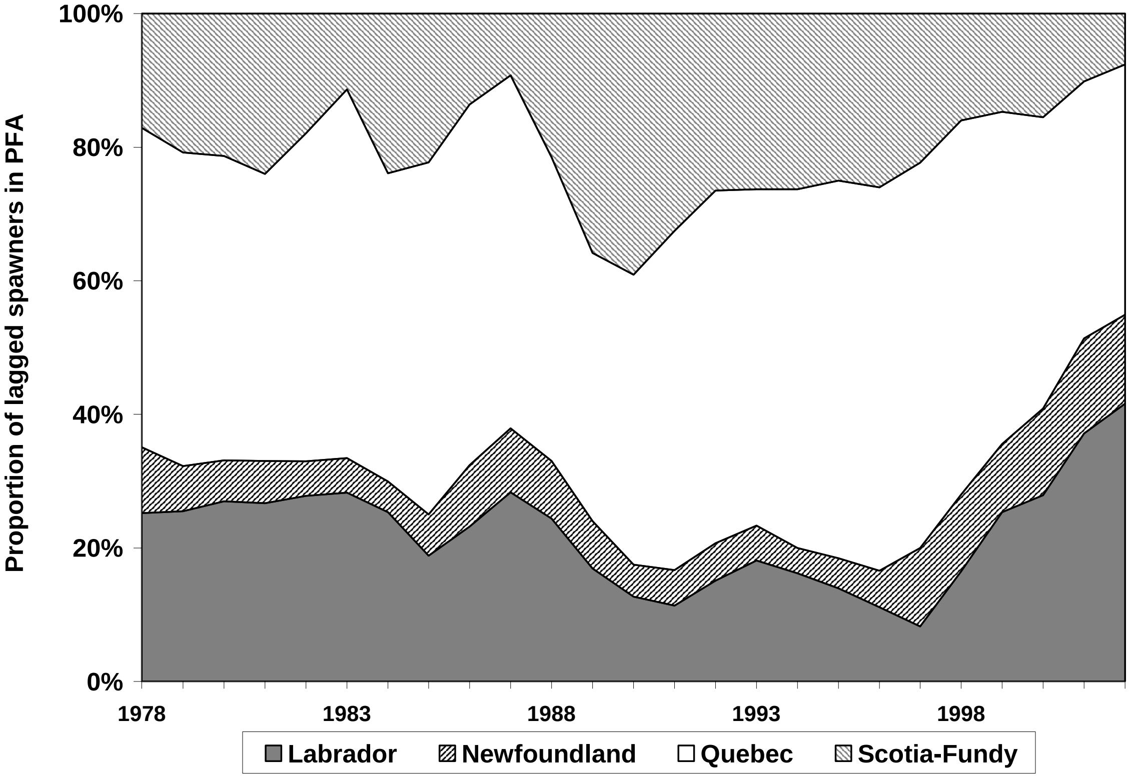


Figure 4.5.2. The lagged spawner variable used to forecast pre-fishery abundance and its relationship to the total number of lagged spawners in North America and and the Labrador component.

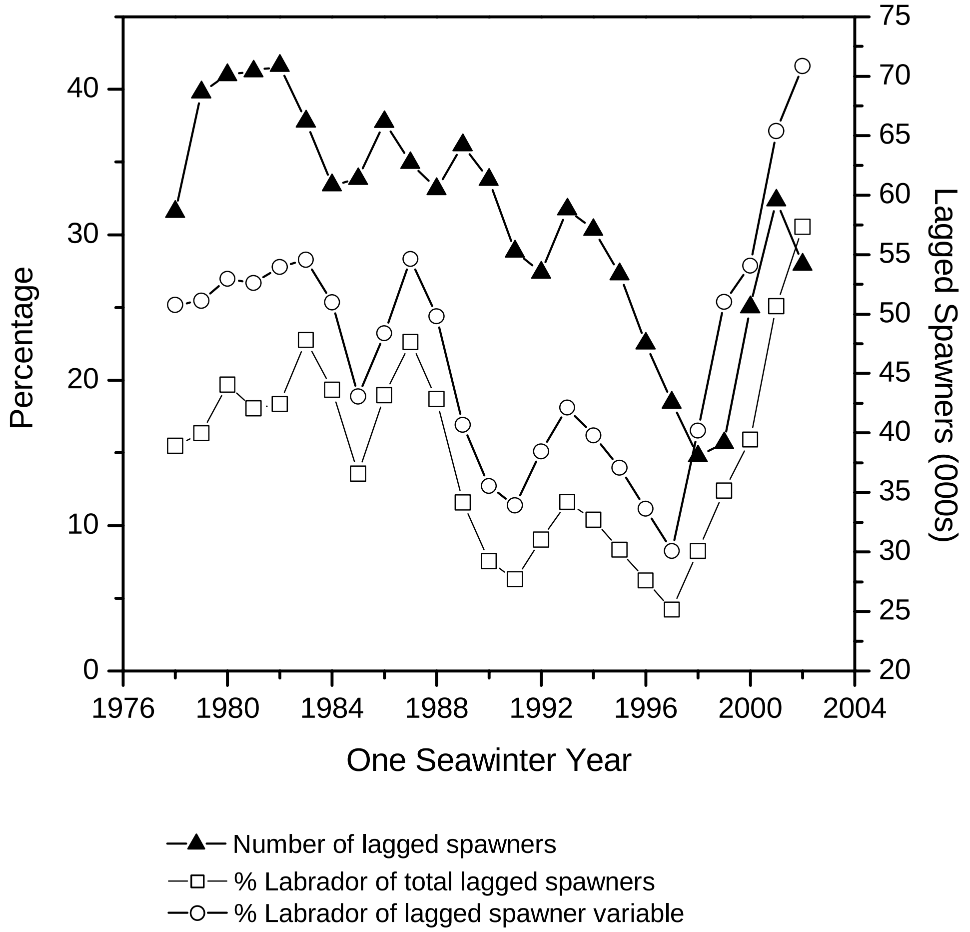
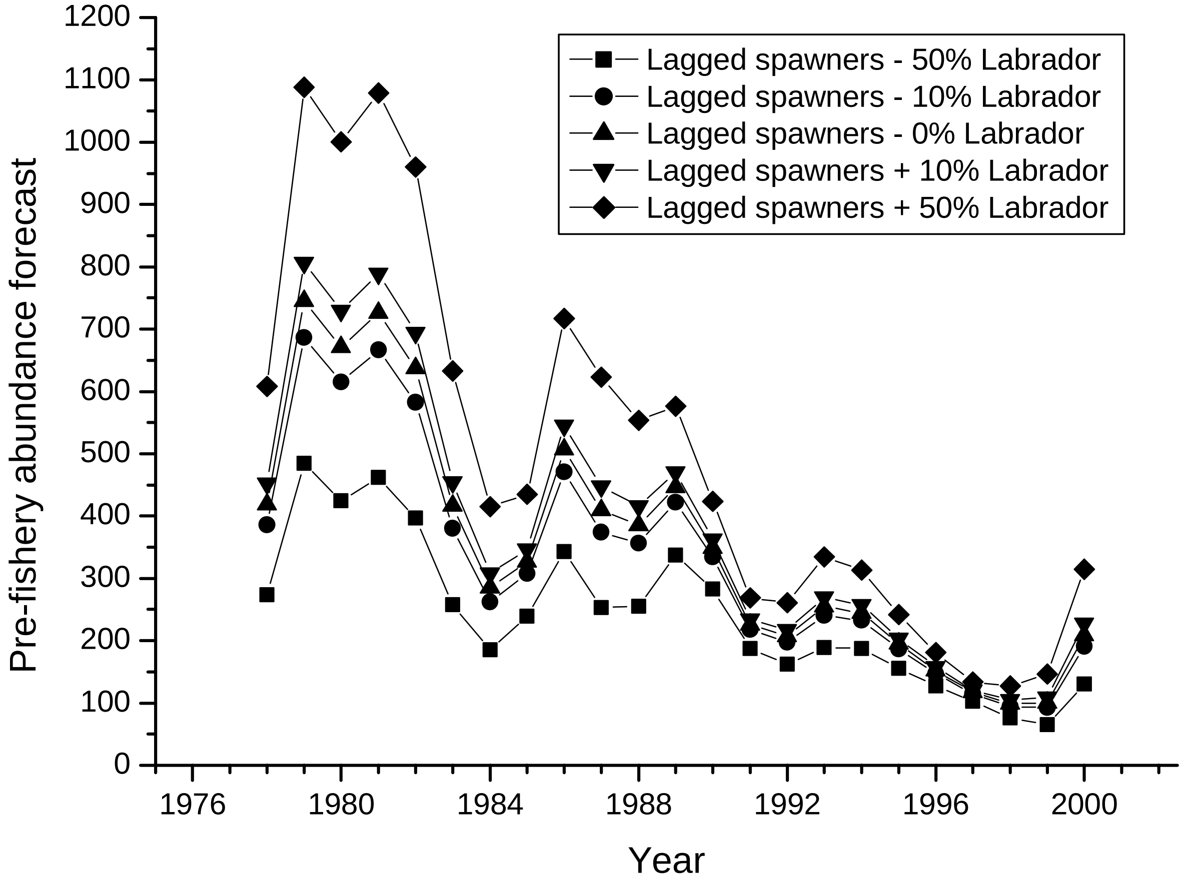


Figure 4.5.3. An examination of the sensitivity of the lagged spawner variable to changes in its Labrador component evaluated at variations of 0%, ±10% and ±50%.



5 ATLANTIC SALMON IN THE WEST GREENLAND COMMISSION AREA

5.1 Description of fishery at West Greenland

5.1.1 Catch and effort in 2001

At its annual meeting in June 2001 NASCO introduced and agreed to a new *ad hoc* management programme for the 2001 fishery at West Greenland that incorporated the use of real-time data to allocate quota for the commercial fishery. The commercial fishery is defined as landings sold to processing plants and excludes reported private landings (not sold to plants) and unreported catch. Three harvest periods were implemented with quotas dependent on the observed average CPUE during the fishery. A total quota of 114 t was allocated for the 2001 fishery.

By regulation, all catches including landings to local markets, privately purchased salmon, and salmon caught by food fishermen, were reported on a daily basis to the Fishery License Office. The fishery was opened on August 13, and after closing of the agreed season of seven weeks the reported commercial landings totalled to 34.5 t (Table 5.1.1.1). A total of 8.0 t of private landings were reported during the 2001 season, which extended later than the closure of the commercial fishery. The geographical distribution of catches by Greenland vessels is given in Table 5.1.1.2 for the years 1977-2001. Compared to earlier years, a higher proportion of catch occurred in southern Greenland with 65% and 66 % taken in NAFO Division 1F in 2000 and 2001, respectively.

Licenses for the salmon fishery are issued to fishermen fishing for the factories, local markets, hotels, hospitals etc., while fishing for personal use was permitted without license for residents of Greenland. The number of active fishermen in the salmon fishery has decreased sharply since 1987, when a catch of more than 900 t was allowed and more than 500 licenses were active in the fishery. During the abbreviated five-day season in 2000, the number of active fishermen was only 46; a significant reduction from the 102 West Greenland fishermen reporting catches in 1999 and also the lowest recorded number. In 2001, the number of licenses reporting landings increased to 76, probably due to the expected higher quota. Of these reporting licenses, 50 licenses reported commercial landings, 23 reported private landings, and 3 licenses reported both commercial and private landings.

The average weekly CPUE varied between 90 and 161 kg per landing through the season with an overall mean of 124 kg. This was higher than any other year since 1991 apart from the record high CPUE in 2000 (343 kg).

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

5.1.2 Evaluation of the ad Hoc Management System Implemented in 2001

At its 2001 meeting, NASCO implemented an ad Hoc management program that provided for in-season adjustments to allocated quota based on real-time observation of catch per unit effort (CPUE) in the fishery at West Greenland (NASCO 2001). The program was based on an apparent relationship between annual catch per unit effort estimates for the West Greenland fishery and pre-fishery abundance (PFA) estimates for the North American stock complex (Figure 5.1.2.1, top panel). The Working Group noted that there is also an apparent relationship for the Southern European stock complex (Figure 5.1.2.1, middle panel). The management system allocated an initial quota corresponding to a 25% probability level from the quota options table (28 t) during an initial harvest period of 7 days. At the end of the first harvest period (7 days), CPUE during the harvest period was assessed to determine if the fishery would remain open and the levels of additional quota to be allocated. At the end of the 2nd harvest period, aggregate CPUE over the first two harvest periods was assessed leading to a second and final decision regarding fishery closure and quota allocation.

CPUE thresholds for management decision points in the program were established based on CPUE levels associated with specific probability forecasts of 2001 PFA. There is an implicit assumption that CPUE during the harvest period considered accurately reflects the overall PFA level. The threshold level between the low and medium CPUE levels were established based on the CPUE associated with the 25% probability estimate of PFA (187,700 salmon in 2001). The CPUE level associated with this PFA forecast was estimated by regressing CPUE against PFA (1987 to 1992 and 1995 to 1999), using the resulting equation with an input of 187,700 salmon in 2001 to estimate a CPUE level of approximately 100 kg/day (Figure 5.1.2.2, top panel). The threshold level between the medium and high CPUE levels were established based on the CPUE associated with the 50% probability estimate of PFA (295,678 salmon in 2001).

Similarly, the regression equation was used to estimate the CPUE associated with this PFA as approximately 135 kg/day (Figure 5.1.2.2, top panel).

The rationale associated with using the 25% and 50% PFA levels was that the fishery would be closed if CPUE data indicated that the actual PFA was below 187,700 (CPUE < 100 kg/day), and conversely, the quota associated with the 50% probability level of the PFA forecast should not be fully allocated unless CPUE provided confirmatory information that the PFA exceeded 295,678 salmon (CPUE > 135 kg/day).

During the 2001 commercial fishery, the aggregate CPUE remained at a medium level (between 100 and 135 kg/landing) at both decision points (Figure 5.1.2.3) and a total quota of 114 t (the average of the quotas indicated by the 25% and 50% risk levels) was allocated. Decisions regarding the length of harvest periods and decision points were not critical during implementation of the management system during 2001 given the NASCO established CPUE thresholds of 100 and 135 kg/landing, because CPUE levels remained intermediate to these two thresholds following the 2nd day of the season (Figure 5.1.2.3). Of the allocated quota, only 34.5 t (30.3% of the allocated quota) was actually landed by the commercial fishery (see Section 5.1.1).

The Working Group examined the robustness of CPUE data used at decision points to make quota allocation decisions during the fishery. Although CPUE aggregated on an annual basis is available from 1987 to 1992 and 1995 to 2001, CPUE data on a daily trip basis were only available from 1997 to 2001. These data included date, port landed, NAFO Division, fisher name and/or license and landed and live weight of salmon caught. Trip information was only available for commercial trips that landed and reported salmon. Information on commercial trips that targeted, but did not land or report landing salmon are not available. Other information that could be used to characterize fishing effort including vessel size, gear type, amount of gear deployed, soak time, and other trip information are unavailable for historical data.

Examination of Spatial and Temporal Variability in Fishing Effort

The number of trips reporting commercial landings of Atlantic salmon was used to estimate commercial fishing effort. However, trips that did not land salmon could not be quantified. The number of trips reporting commercial landings of Atlantic salmon ranged from 712 trips (1997) to 58 trips on an annual basis (2000; Table 5.1.2.1). Distribution of trips across NAFO Divisions and weeks has been variable through time, and number of trips landing within given weeks is often very low, as observed during the 1998 and 1999 fisheries. The proportion of effort within Greenland was not constant among NAFO Divisions over the period 1997 to 2001 (Figure 5.1.2.4). The relative instability of fishing effort across area and time may introduce biases in CPUE estimates. In other fisheries, effort standardization procedures (e.g., General Linear Modelling approaches) have been applied to standardize effort relative to week, area, vessel size, etc., but the low number of trips within cells and lack of information about trips, vessels, and gear precludes the application of many standardization approaches to existing data.

Patterns in CPUE

The CPUE data available to the Working Group was slightly different from data available at the 2001 NASCO meeting, and was updated to include currently available estimates of PFA and CPUE data. Commercial CPUE over the course of the entire season seems to correspond to general trends in the North American PFA estimate for the period 1986 to 2001 (Figures 5.1.2.1 top panel, and 5.1.2.5), with the exception of a large outlier in the 2000 when CPUE was much higher than the apparent pre-fishery abundance of the resource. In addition, there appears to be a significant relationship between annual commercial CPUE and trends in the Southern European PFA estimate for the period 1986 to 2001 (Figure 5.1.2.1 top panel), with the same outlying point in 2000. However, residual patterns for both relationships are non-random, with blocks of positive residuals preceding the 1993 and 1994 fishery buyout, and a block of negative residuals after this period. This residual pattern may indicate changes in the relative efficiency of the fishery following the buyout, resulting in higher CPUE levels during the post-1994 period when overall effort levels were lower. The residual pattern is of particular concern because the apparent relationship between CPUE and PFA may not be valid, particularly for associating current and future CPUE with higher levels of abundance that were generally observed before 1993.

Catch levels in the fishery from 1997 to 2001 were skewed toward lower catches, with trips landing less than 100 kg representing 60% to 80% of all trips landed (Figure 5.1.2.6). Since fishers do not report information on trips taken, no effort data are available for trips that targeted but did not land salmon (zero catches). The absence of zero catch trips in the time-series may represent a bias leading to an overestimation of actual CPUE, particularly during periods of low abundance. If the proportion of zero catch trips increased during periods of lower abundance, this would tend to change the shape of the relationship between CPUE and PFA in this region, possibly producing non-linearity. Higher proportion of trips reporting landings in excess of 100 kg in 2000 and 2001 may reflect higher levels of availability or abundance since 1999 (Figure 5.1.2.6).

The ad Hoc Management Program assumes a relationship between PFA and CPUE over a period as short as 5 to 7 days prompting a need to examine CPUE on a finer temporal scale than an annual basis. On a weekly basis, CPUE was relatively stable and at low levels in 1997 and 1998, but was more variable among weeks from 1999 and 2001 (Table 5.1.2.2). Exceptionally high CPUE levels (343 kg/landing) were observed during the first week of the 2000 fishery, more than 2.5-fold higher than levels observed during the corresponding week in 1997, 1998, 1999, and 2001. In addition, when aggregating CPUE over the harvest periods utilized is compared to pre-fishery abundance estimates, there is considerably less correspondence with PFA trends observed over the past five years (Figure 5.1.2.7), although there is little contrast in the levels of both PFA and CPUE between 1997 and 1999.

Given issues of variability of effort and CPUE levels among weeks and NAFO Divisions, unstandardized catch per unit effort data should only be used with extreme caution relative to in-season quota allocation decisions. If this framework is used to manage the West Greenland fishery in the future, decision thresholds (CPUE levels delineating low, medium, and high abundance zones) and quota allocation levels will need to be updated annually to reflect changes in PFA forecasts and levels of precaution utilized to identify ranges in quota levels allocated at in-season decision points (see Figure 5.1.2.2, bottom panel).

Concerns about CPUE thresholds

The relation between CPUE and PFA is relatively flat (Figure 5.1.2.1), meaning that relatively small changes in CPUE levels are associated with large changes in PFA. This indicates that both the CPUE thresholds and in-season measures of CPUE must be accurately estimated to provide useful information relative to abundance. The Working Group notes that CPUE thresholds were established based on 25% and 50% probability levels associated with PFA forecasts, and recommends that if future adaptive management frameworks are developed, decision thresholds should be established based on more precautionary probability levels, consistent with limit reference points (S_{lim}).

Conclusions

Despite concerns about the use of CPUE data as a source of confirmatory information for abundance estimates, the Working Group endorses the general principal of using informative in-season measures of abundance to adaptively manage fisheries. Development of more refined data characterizing fishing effort (e.g., vessel size, gear type, amount of gear deployed, soak time, documentation of zero landings trips and private sales trips) would allow for detailed analyses of CPUE data to characterize availability of Atlantic salmon in West Greenland. Development of alternative in-season measures of abundance such as relationships between 1SW returns to rivers from the same cohort should be investigated as a future method to confirm abundance.

5.1.3 Origin of catches at West Greenland

An international sampling program was instituted in 2001 to sample landings at West Greenland. The sampling program included sampling teams from Greenland, United Kingdom, Ireland, United States, and Canada. Teams were in place at the start of the fishery and continued late in the autumn. In total, about 3,000 specimens, representing 20% of the landings, were sampled for presence of tags, fork length, weight, scales, tissue samples for DNA analysis, and a few for the presence of disease pathogens. The sampling program was successful in adequately sampling the Greenland catch temporally and spatially. Due to the large volume of data it is not completely analysed yet and more details will follow in next years report.

Tissue and biological samples were collected from the mixed stock fisheries at West Greenland caught in 2001. Samples were obtained from four landing sites, Qaqortoq (NAFO Division 1F), Qeqertarsuatsiaat (1D), Nuuk (1D), and Kangaamiut (1C). The sampled salmon were measured, scales were removed for aging, and gutted weight recorded.

A total of 1329 tissue samples were removed and preserved for DNA analysis. Funding was available to analyse 580 tissue samples, so collected samples were subsampled to be representative of standard weeks and statistical areas where landings were prevalent. A total of 575 samples from the following areas, 40 from NAFO Division 1C, 158 from NAFO Division 1D, and 377 from NAFO Division 1F were genotyped at 4 microsatellite DNA loci for assignment to continent-of-origin. For Atlantic salmon, these loci have been shown to provide 100% correct assignment to their continent-of-origin, and 83% correct classification to country or province of origin (King et al. 2001). A database of 4347 Atlantic salmon genotypes of known origin was used to assign the 575 salmon to continent-of-origin using the maximum likelihood algorithm. In total, 67.5% (388) of the salmon sampled from the 2001 fishery were of North American (NA) origin and 32.5% (187) fish were determined to be of European origin (Table 5.1.3.1).

From the samples taken at Kangaamiut in NAFO Division 1C, 39 (97.5%) salmon were determined to be of North American origin and 1 (2.5%) was of European origin. From the samples taken at Nuuk and Qeqertarsuatsiaat in 1D, 144 (90.6%) salmon were determined to be of North American origin and 15 (9.4%) were of European origin. The Qaqortoq in 1F collection on the other hand yielded an equivalent distribution of salmon of North American (205 or 54.5%) and European (171 or 45.5%) origins. The Working Group noted that the lack of correspondence in the portion of continental representation between these two collections underscores the need to sample multiple NAFO Divisions to achieve the most accurate estimate of the contribution of fish from each continent to the mixed fishery.

Applying the results of the above analysis to the reported catch indicated that 27.2 t (9,849 salmon) of North American origin and 15.4 t (5,389 salmon) of European origin were landed in West Greenland in 2001. Quota reductions have resulted in an overall reduction in the numbers of both North American and European salmon landed at West Greenland until 1999. The number of North American salmon remained about the same in 1999 and 2000 (5,000-6,000 salmon), but doubled in 2001. The number of landed salmon of European origin increased in 2000 due to a higher proportion of European salmon in the Division 1F. A high proportion of European salmon in Div. 1F was again observed in 2001 (45.5 %). The data for 1982 to 2001 (no data for 1993-94) are summarised in Table 5.1.3.2, Figure 5.1.3.1.

5.1.4 Biological characteristics of the catches

Biological characteristics (length, weight, and age) were recorded for 575 fish in catches from NAFO Divisions 1C, 1D, and 1F in 2001 and presented in Tables 5.1.4.1 to 5.1.4.3, together with corresponding data from sampling in Greenland since 1968.

The general downward trend in mean length and weight (unadjusted for sampling date) of both European and North American 1SW salmon observed from 1969 to 1995 reversed in 1996 when mean lengths and weights increased (Table 5.1.4.1). From 1996 to 1998 the mean lengths and weights were relatively stable but increased significantly in 1999. In 2000, a decrease was observed, mainly in the North American component where the mean lengths and weights were among the lowest observed in the time-series. In 2001, mean lengths and mean weights increased again to a level close to the overall average for the recent decade.

Distribution of the catch by river age in 1968 to 2001 as determined from scale samples is shown in Table 5.1.4.2. The proportion of the European origin salmon that were river age 1 fish has been quite variable through the later years with relatively high values in 1998-2000, the 2000 value being the highest on record. In 2001 this proportion was close to the overall mean value. A high proportion of this group suggests a high contribution from Southern European stocks. In 1998 and 1999 low percentages of 7.6% and 7.2%, respectively, of river age 3 were observed, the lowest on record. An increase from 1999 to 2001 (to 26.1%) was observed, higher than the overall mean of 16.8% and among the highest in the data series. The percentage of river age 2 salmon of North American origin declined somewhat from 1998, which was close to the overall mean value of 34.0%, to 22.6 in 2001.

The sea-age composition of the samples collected from the West Greenland fishery showed no significant changes in the proportions in the North American component of fish from 1998 to 2001 (Table 5.1.4.3). The proportion of 1SW salmon in the European component has been very high since 1997 (99.3 %), and was in 1999 and 2000 estimated at 100 %. A low proportion of 2SW fish and previous spawners (both components were 1.1 %) were observed in 2001.

In August 2001, 19 Atlantic salmon sampled from the commercial fishery at Nuuk, Greenland were tested for *Renibacterium salmoninarum* (BKD) and infectious salmon anaemia virus (ISAv), and genetically typed to determine continent-of-origin. Genetic typing indicated 16 of the 19 fish tested originated from North America. DFAT and ISAv specific immuno-fluoresence antibody test (IFAT) assays were negative for all specimens. A reverse transcriptase polymerase chain reaction (rtPCR) test gave a weak positive band for ISAv, and sequencing of the PCR product confirmed ISAv and showed closest similarity to the North American strain of the virus. A cell culture test on this specimen was negative for ISAv. The specimen was determined to be of North American origin. These results indicate that additional disease testing of Atlantic salmon in West Greenland may be warranted.

5.2 Status of the stocks in the West Greenland area

The salmon caught in the West Greenland fishery are mostly (>90%) non-maturing 1SW salmon, many of which would return to homewaters in Europe or North America as MSW fish if they survived the fishery. 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. Most MSW stocks, with the exception of Newfoundland, are thought to contribute to the fishery at West Greenland. Status of relevant stocks in the NEAC and NAC areas are summarized below, and detailed information can be found in Sections 3.4 and 4.2, respectively.

Southern European Stocks:

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. A Run-Reconstruction Model was used to update the estimates of pre-fishery abundance of non-maturing 1SW salmon. MSW salmon stocks in the Southern NEAC area show a consistent decline over the past 10-15 years, and recent spawning escapement has been below conservation limits (S_{lim}). In summary:

- the proportion of European fish in catches at West Greenland decreased steadily during the 1990s, reaching levels of 10% to 15% in recent years.
- marine survivals of wild and hatchery-reared smolts in Southern NEAC area show a constant decline over the past 10-20 years.
- MSW returns and spawning stocks in the Southern NEAC area derived from the NEAC PFA model show a consistent decline over the past 20 to 30 years (Figure 3.5.2.3).
- consistent trends in marine survival of smolts and the estimated returns and spawners as derived from the PFA model suggest that returns are strongly influenced by factors in the marine environment.
- overall spawning escapement has fallen below the conservation limit in four of the past five years.

North American Stocks:

The North American Run-Reconstruction Model was used to update the estimates of pre-fishery abundance of non-maturing and maturing 1SW salmon from 1971-2000. The 1998 estimate of pre-fishery abundance of non-maturing 1SW salmon was the lowest on record and continues a decline that began in 1979. A slight increase is indicated for the period 1998-2000 (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. 2SW returns have declined from a peak of 121,000 in 1980 to 58,000 in 2001. The percentage of North American salmon in the West Greenland catch increased steadily from 50% to 60% in the early 1990s to approximately 90% by 1997, and declined to approximately 66% in 2000 and 2001 (Table 5.1.3.1).

Newfoundland:
- 2SW and MSW salmon are a relatively small component of this stock complex
- 2SW returns 6th highest in a 31-year time-series
- 2SW spawners in 2001 at approximately twice 2SW stock conservation limits

Labrador:
- 2SW returns peaked in 1995, and decreased again in 1996 and 1997
- no estimate is given since 1997 from this area, there being no commercial fishery, which was the basis for the return and spawner model for Labrador

Quebec:
- 2SW salmon an important part of this stock complex
- 2SW returns 3rd lowest in a 31-year time-series
- 2SW spawners in 2001 at 71% of 2SW conservation limit (S_{lim})

Gulf of St. Lawrence:
- 2SW salmon an important part of this stock complex
- 2SW returns 5th lowest in a 31-year time-series
- 2SW spawners in 2001 at 77% of 2SW conservation limit (S_{lim})

Scotia-Fundy:
- 2SW returns 3rd lowest in a 31-year time-series
- 2SW spawners in 2001 at 19% of 2SW conservation limit (S_{lim})
- inner Bay of Fundy stocks listed as Endangered, some of which may have contributed to the fishery at West Greenland

United States:
- 2SW returns 2nd lowest in a 31-year time-series
- 2SW returns in 2001 at 3% of 2SW conservation limit (S_{lim})
- stocks in two of three regions extirpated, 8 remaining rivers listed as Endangered

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 historical levels.

5.3 Changes in the continent-of-origin of salmon captured at West Greenland, including changes in migration patterns

The Working Group noted the considerable increase in proportion of North American origin salmon in the fishery at West Greenland in recent years. The proportion has changed dramatically over the period of observation, 1969-2001, from below 40 % to 90 %, with the highest proportion of North American salmon observed in 1999; the proportion declined in 2001. In order to more completely describe the historical and current temporal and spatial distribution of North American and European salmon at Greenland, the Working Group decided first to examine the catch distributions, because variations in location of landings both spatially and temporally could have an important influence on the apparent distribution of North American and European salmon as measured in samples from the catches. As examples, five years viz. 1987, 1990, 1992, 1997, and 2001 were arbitrarily chosen and the catch patterns are displayed in Figure 5.3.1 to show the variability in landings by week and NAFO Division. In several years, the highest landings occurred in weeks 33 to 38 and were distributed along the coast from NAFO Division 1A to 1F. However, in both 1992 and 2001 higher proportions of the overall landings occurred in NAFO Division 1F compared with all other divisions. Also in 1990 and 1992, higher proportions of the landings were distributed over more weeks than in the other years. Since landings varied both spatially and temporally, it was thought that further analyses should take into consideration the catch to more completely describe temporal and spatial distribution of North American and European salmon. This was done through general linear models using catch to weight the results.

Application of General Linear Models to Catch Data

The biological explanation(s) for the changes in North American and European salmon will continue to elude us due to incomplete knowledge of migration of the various components contributing to the West Greenland fishery and, more importantly, the relative contributions of various stock groupings. Previous tagging studies, including tagging at west Greenland, had shown that the southern European stock group contributed more heavily to Greenland than did the northern group. Within North America, it has been shown that stocks in the Gulf of St. Lawrence contributed more heavily than others to Greenland. The DNA analysis of salmon captured at West Greenland that started in 2000 has shown that annual variations in proportional contributions do occur (ICES 1998/ACFM:15), and should lead to a greater understanding of the mixed stock fishery.

The Working Group analysed the North American proportions from 1987 to 1999. The year 2000 samples were not included because of the short time scale and geographical distribution of the catch, and the results from the 2001 samples are not yet fully available.

Analysis of Variance for North American proportion at West Greenland:

Dependent Variable: Proportions of North American salmon

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	32	0.099992	0.003125	15.93	<.0001
Error	47	0.009217	0.000196		
Corrected Total	79	0.109209			

R-Square	Coeff Var	Root MSE	NA Mean
0.915604	2.1781	0.014004	0.6429

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Year	10	0.013720	0.001372	7.00	<.0001
NAFO	5	0.002799	0.002799	2.85	<.0001
Year*NAFO	17	0.009516	0.000560	2.85	0.0023

The North American proportion varies over year, between NAFO Divisions, and there is a significant interaction effect between year and the various NAFO Divisions. For NAFO Divisions, the North American proportion increased from NAFO Division 1A to 1C, then declined from 1D to 1E and 1F (Figure 5.3.2). The North American proportion has increased significantly from 1987 to 1999 (Figure 5.3.3). The reasons for the varying North American proportions among NAFO Divisions and years are not known. However, this possibly reflects different migration patterns and time of arrival at Greenland of the various stock components as well as a highly variable fishery.

Analysis of Microtag Recoveries

The recovery of tagged salmon within the West Greenland fishery provided an additional option for investigating fish distribution patterns. In 1982, the Working Group recommended coded wire microtagging programs in salmon producing countries (Anon., 1982) to investigate marine survival and exploitation, and to evaluate stocking. Details of all the batches of tagged fish have been collated and reported annually to ICES as part of the Working Group report.

From 1985, the biological sampling program at West Greenland included the identification of adipose fin-clipped salmon and the recovery of microtags. The Working Group also recommended sampling more uniformly across the landings at West Greenland so that data might be used to identify temporal and spatial differences among stocks (Anon., 1986). However, the nature of the West Greenland fishery has generally constrained sampling in both space and time, with sampling being targeted at times and sites where peak catches occurred.

Microtags were recovered at West Greenland from 1985 to 1992. The fishery was closed in 1993 and 1994, and very few tags have been recovered since 1995. Overall, 631 microtags were recovered at West Greenland in the period 1985 to 1992 (Table 5.3.1). Numbers of tag recoveries are not sufficient to allow comparison of individual stocks or national stock groupings (tags from 7 countries and over 60 stocks), but do enable comparison between continent-of-origin (North America 407 tags and Europe 224 tags). Aggregated over all years the proportions of tags from North American countries and Europe recovered in each of the NAFO Divisions at West Greenland seem broadly similar (Table 5.3.1). However, this does not account for differences in the relative size of the tagged groups at large (Table 5.3.1).

Over the period, 1985 to 1991, European countries released around 4.7 million microtagged fish between 1985 and 1991, of which 4% were wild. North American countries released 4.4 million microtagged fish over the same period, with 1% wild. Thus, 51% of the tagged fish at large during the time period were European. However, only 35.5% of the recoveries were of European origin. Thus North American tagged salmon were captured in higher proportion than their proportion in the tagged population at large (Chi Square $p < 0.0001$). Recoveries were scaled by dividing counts by 100,000 tags released in the previous year. In addition, recoveries were corrected for the scanning effort using a raising factor based on the scanned proportion of the catch for each NAFO Division and sampling week. This had the effect of making tag recoveries proportional to the landings.

The analysis of the proportions of North American tagged stocks in the catch was strongly influenced by year. This was, in part at least, thought to reflect scanning programs, because scanning did not occur in all divisions (i.e. catches in 1A were not sampled at all, sampling in 1C only occurred in 1990 to 1992, and 1F was not sampled from 1989 to 1991). For the seven years and five divisions where a comparative analysis was possible, 13 combinations had no sampling (Figure 5.3.4). The fishery also shifted over time within seasons. By constraining analysis to standard weeks 33 to 35, there were only six of 21 weeks without tag recoveries from 1986 to 2001. This annual variation in sampling for tags precluded modelling the data over the entire time and space array, and makes any analysis excluding year exploratory at best.

However, to attempt to describe the distribution of fish from each of the continents (North America and Europe), the total tag returns for each were plotted over the selected NAFO Divisions and standard weeks (Figure 5.3.4). These plots describe the pattern in the fishery within the period, but do not highlight any major differences in distribution between the continents of origin; only relatively small differences were noted. Of North American tagged fish captured, approximately 30% were captured in standard week 33, whereas for European fish, captures at this time represent approximately 20% of the total. For catches in 1D for standard week 34 the European catch was 17% of the continental total and the North American catch was 10% of that total.

The key points of the above assessments indicate that:

- The proportion of North American fish recovered at West Greenland has significantly increased from 1987 to 1999.
- North American tagged fish have been more vulnerable to capture in the fishery than European fish; based primarily on hatchery fish.
- The fact that the fishery has not been stable annually in either time (standard week) or space (NAFO Division) precludes evaluating general migratory patterns, let alone patterns for different stocks.

5.4 Evaluation of the effects on European and North American stocks of the West Greenland management measures since 1993

There have been the following significant changes in the management regime at West Greenland since 1993:

1) NASCO adopted a new management model (Anon., 1993) based upon ICES' assessment of the PFA of non-maturing 1SW North American salmon and the spawner escapement requirements for these stocks. This resulted in a substantial reduction in the TAC agreed to by NASCO from 840 t in 1991 to 258 t in 1992, and further reductions in subsequent years.
2) The next change in management was the suspension of fishing in 1993 and 1994 following the agreement of compensation payments by the North Atlantic Salmon Fund. Due to the closure of the fishery in the two years no sampling could be carried out in Greenland, and no biological data were collected.
3) In 1995 and 1997, established quotas were substantially lower than quotas established before 1993. In 1996, NASCO failed to reach an agreement and Greenland unilaterally established a quota of 174 t.
4) In 1998, NASCO agreed on a subsistence fishery of 20 t, which in the past has been estimated for internal consumption at Greenland. In 1999, a multi-year management plan was agreed restricting the annual catch to that amount used for internal consumption.
5) An *ad hoc* management arrangement for 2001 was agreed by NASCO, implementing an adaptive quota calculation, based upon three harvest periods. The resulting total quota for all harvest periods was 114 t.

To evaluate the effects of management since 1993, a possible TAC was calculated according to the agreed quota allocation model (Anon., 1993) using biological parameters from sampling in 1992 (Table 5.4.1). The variables given in the table (proportion of origin, mean weights, and proportion of 1SW fish) are those used in the analyses of Sections 5.1 and 5.6. The estimate of natural mortality has been changed from 0.01 per month to 0.03 per month for all years according to recent analyses (Section 2.3).

The numbers of fish spared by the 1993 to 1994 closure are shown in Table 5.4.1. The potential catches in the years 1993 and 1994 of 89 and 137 t, respectively, correspond to the TACs calculated in accordance with the quota allocation computation model that was agreed by NASCO at its annual meeting in 1993. For the successive years nominal catch figures are used. The table shows the number of salmon returning to homewaters provided no fishing of the given magnitude took place in Greenland. The biological parameters given in the table represent the annual sampling data. From 1993 to 2001, the mean number of potentially returning fish per ton caught at Greenland is calculated to 171 and 87 salmon for North America and Europe, respectively.

From 1972 to 1992 exploitation rates in Greenland of the North American component of the salmon stock fluctuated between 10% and 45 % around an average of 34 % (Figure 5.4.1). The management measures in force since 1993 resulted in an average exploitation rate of this component of 13 %, for the period 1995 to 1997, about one third of its previous level after reopening of the fishery in 1995. After the 1998 agreement the exploitation rates decreased to about 5 %.

In the current analysis the effects of the management measures taken at West Greenland have been examined in terms of numbers of fish only. Thus it has been difficult to show direct benefits to homewater stocks from these measures. The Working Group recommends that future analyses focus on partitioning total mortality into fishing and natural mortality to assess changes in fishing mortality related to management. Further, efforts should focus on evaluating sensitivity to detect changes attributed to management actions in homewaters.

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

Sampling of the fishery at West Greenland (Table 5.1.4.3) since 1985 has shown that both European and North American stocks harvested are primarily (greater than 90%) 1SW non-maturing salmon that would mature as either 2 or 3SW salmon, if surviving to spawn. Usually less than 3% of the harvest is composed of salmon that have previously spawned and a few percent are 2SW salmon that would mature as 3SW or older salmon. For this reason, conservation limits defined previously for North American stocks have been limited to this cohort (2SW salmon on their return to homewaters) that may have been at Greenland as 1SW non-maturing fish. These numbers have been documented previously by the Working Group and are shown in Section 4.4. The 2SW spawner limits of salmon stocks from North America total 152,548 fish, with 123,349 and 29,199 required in Canadian and USA rivers, respectively.

Conservation limits for the NEAC area have been split into 1SW and MSW components on the basis of the average age composition of catches in the past ten years. The stocks have also been partitioned into northern and southern stock complexes, and tagging information and biological sampling indicates that the majority of the European salmon caught at West Greenland originate from the southern stock complex. The current conservation limit estimate for southern European MSW stocks is approximately 260,000 fish (Table 3.4.3.1). There is still considerable uncertainty in the conservation limits for European stocks. The Working Group has previously noted that outputs from the national PFA model are only designed to provide a guide to the status of stocks in the NEAC area. It has been noted that the conservation limit estimates may change from year to year as the input of new data affects the 'quasi-stock-recruitment relationship'. Previously, the conservation limits for MSW salmon in the NEAC area have not been incorporated into the modelling of catch options for West Greenland.

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 that would maintain spawning escapements sufficient to achieve conservation limits. Although advances have been made in our understanding of the population dynamics of Atlantic salmon and the exploitation occurring in the fisheries, the concerns about the implications of applying TACs to mixed-stock fisheries are of concern. In principle, adjustments to catches in mixed-stock fisheries provided by means of an annually adjusted TAC would reduce mortality on the contributing populations. However, benefits losses to particular stocks would be difficult to demonstrate, in the same way that damages to individual stocks are difficult to identify.

In 1993, the Working Group considered how the predictive measures of abundance could be used to give annual catch advice (ICES 1993/Assess:10; Sections 5.3 and 5.4). The aim of management is to regulate catches while achieving overall spawning escapement reflecting the spawner limits in individual North American and European rivers (when the latter have been defined). In order to achieve the desired level of exploitation for a given level of predicted abundance, a TAC could be fixed or some form of effort adjustment introduced. Such an assessment would also depend on a forecast of pre-fishery abundance for both North American and European salmon stocks.

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

The Working Group has advocated models based on thermal habitat in the northwest Atlantic and spawning stock indices to forecast pre-fishery abundance and provide catch advice for the West Greenland fishery. While the approach has been consistent since 1993, the models themselves have varied slightly over the years. Changes have been made to these models in attempts to improve their predictive capabilities and add more biological reality. In particular, the models since 1996 have used a spawning stock surrogate variable (lagged spawners) in an attempt to describe the variations in parental stock size of the non-maturing 1SW component (PFA). The models of previous years included the following predictor variables: 1993 - thermal habitat in March; 1994 - thermal habitat in March; 1995 -thermal habitat in January, February, and March; and 1996-2001 - thermal habitat in February and lagged spawners from the Labrador, Newfoundland, Québec, and Scotia-Fundy regions of Canada. In 2000-2001, the model was based on the natural log of PFA relative to the natural log of spawners and habitat variables. In this way, the survival rate of salmon (PFA / Spawners) has a mean survival level that is modified by the habitat environmental variable.

The Working Group noted that because the method of estimating spawning escapement for Labrador was based on commercial catches and exploitation rates which ended in 1997, lagged spawner values will have missing components in year 2003. Thus, an alternative index of salmon abundance will be required in the future. Preliminary investigations into the development of a juvenile abundance index as an alternative index of salmon abundance were reported in 2001, and continued in the current report (Section 5.8).

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 to 2000 returns were estimated as a proportion of the total for other areas based on historical data (Section 4.2.3).

Update of thermal habitat

The Working Group has been using the relationship between marine habitat, 2SW lagged spawners and estimated pre-fishery abundance to forecast pre-fishery abundance in the year of interest (ICES 1993/Assess:10; 1994/Assess:16; 1995/Assess:14; 1996/Assess:11, 1997/Assess:10; 1998/ACFM:15, 1999/ACFM:14; 2000/ACFM:13, and 2001/ACFM:15). Marine habitat is measured as a relative index of the area suitable for salmon at sea, termed thermal habitat, and was derived from sea surface temperature (SST) data obtained from the National Meteorological Center of the National Ocean & Atmospheric Administration and previously published catch rates for salmon from research vessels fishing in the northwest Atlantic (Reddin *et al*. 1993 and ICES 1995/Assess:14). The SST data were determined by optimally interpolating SSTs from ships of opportunity, earth observation satellites (AVHRR), and sea ice cover data. The area used to determine available salmon habitat encompassed the northwest Atlantic north of 41°N latitude and west of 29°W longitude and includes the Davis Strait, Labrador Sea, Irminger Sea, and the Grand Bank of Newfoundland.

Thermal habitat has been updated to include 2001 and January and February 2002 year data. Two periods of decline in the available habitat are identified (1980 to 1984 and 1988 to 1995) in the February index (Table 5.6.1.1 and Figure 5.6.1.1). Available habitat for February increased (10%) in 2002 from 1,685 to 1,865. The 2002 February value is more than 10% higher than the long-term mean of 1,661.

Update of Lagged Spawners

The lagged spawner variable used in the model is an estimate of the 2SW parental stock of the PFA. The calculation procedure is described in Section 4.2.4. Previous analyses indicated that the sum of lagged spawner components from Labrador, Newfoundland, Québec, and Scotia-Fundy, and excluding Gulf and U.S., was the strongest explanatory variable for the model. Inclusion of the Gulf spawning component reduced the explanatory power of the variable.

The Working Group recognized the problems inherent in this variable. The exclusion of a major component of the spawning stock contributing to the PFA was less than satisfactory. As well, spawning escapement estimates for Labrador are not available for the years 1998-2001. The previously formulated lagged spawner variable will therefore not be available beyond 2002. Alternatives to the lagged spawner variable are explored in Section 5.8.

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

North American Forecast Model

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

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

This model relates directly to a survival relationship of the form: $N_t = N_0 \, e^{-Z}$.

In the case of the PFA model, the survival rate of salmon (PFA / Spawners) has a mean survival level that is modified by the habitat variable. A linear form of the model fits the natural log of PFA relative to the natural log of spawners and habitat variables:

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

The basis for the model is the same two predictor variables as were used from 1999 to 2001: thermal habitat for February (term H2) and lagged spawners (sum of lagged spawners from Labrador, Newfoundland, Scotia-Fundy, and Quebec, term SLNQ) (ICES 1996/Assess:11). This was justified on the basis of studies showing that salmon stocks over wide geographic areas tend to have synchronous survival rates and that the winter period may be the critical stage for post-smolt survival and maturation (Scarnecchia 1989; Reddin and Shearer 1987; Friedland *et al.* 1993; Friedland *et al.* 1998). Consequently, the model used in 2001 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.

There was a significant linear relationship between estimated and predicted values of pre-fishery abundance versus February thermal habitat and lagged spawners (SLNQ) (log transformed model: $F_{2,18} = 66.41$; $r^2 = 0.87$). All model parameters were significant at less than the 5% level (Table 5.6.2.1). Individually, the two predictor variables are also significantly related to pre-fishery abundance. Similar to last year, February habitat accounted for 12% of the total sum of squares and SLNQ spawners was 75% (Table 5.6.2.1). The jackknife and simulated predicted values for pre-fishery abundance for 1978 to 2002 are shown in Table 5.6.1.1 and Figure 5.6.2.1. The predicted values fit the observed data quite well, except in the late 1980s and 90s when abundance was low and there are small positive residuals at the end of the time-series (Figure 5.6.1.1). Also the residual in 2000 is one of the highest in the time-series, which is of concern. This may indicate a developing trend to negative residuals, meaning that pre-fishery abundance will be over-forecasted. The predicted pre-fishery abundance for 2002 using the February thermal habitat and lagged spawner model is about 329,600 at the 50% probability level (Table 5.6.1.1).

Predictions continue to be influenced primarily by the spawning stock variable (Table 5.6.2.1). Thus, low levels of spawning stocks would modify the predictions of pre-fishery abundance during periods of high levels of habitat. During 1998 and 1999 thermal habitat has increased considerably, but the predicted pre-fishery abundance has remained low due to the large decline in spawners (Figure 5.6.1.1). However, the estimated two-sea-winter spawners have improved in the year 2002, resulting in an increase of forecasted pre-fishery abundance.

Using the current model to estimate the 2001 pre-fishery abundance yields a value of 332,455. Note that the previously reported values of pre-fishery abundance based on natural mortality rates of M=0.01 which were revised to M=0.03, and thus previously reported values of pre-fishery abundance cannot be compared to those reported here in this report. The inclusion of errors in the lagged spawners has been shown to increase the median value and to widen the distribution of the forecast (ICES CM 2000/ACFM:13). Also due to the time lag between forecasted and estimated pre-fishery abundance there is a delay of two years before comparison of estimated and forecasted values can be made. Consequently, any developing trend in high positive or negative residuals indicating a poor fit to recent data will be hard to detect until after the fishery.

Southern European Forecast Model

The development of a preliminary model to forecast the pre-fishery abundance of non-maturing (potential MSW) salmon from the Southern European stock group is discussed in Section 3.5.2. Stocks in this group are the main European contributors to the West Greenland fishery (Section 3.3.6). The following model form was proposed:

$$PFA = Spawners^{\lambda} \times e^{\beta_0 + \beta_1 Habitat + \beta_2 Year + noise}$$

This is similar to the North American model. The parameter, λ, allows for a non-proportional relationship between PFA and Spawners for a fixed Habitat; furthermore, a non-zero value of β_2 implies that there is a trend in the efficiency of conversion of Spawners into PFA.

The data used in the model (Table 3.5.2.1) consisted of:

- PFA: the pre-fishery abundance of MSW salmon from Southern Europe for the period 1977 to 2000 taken from the output of NEAC PFA model as reported in Section 3.5.1.1;
- Stock: the index used in the model is the 'lagged egg' numbers for the period 1977-2002 derived from the national PFA and CL analysis (Section 3.5.1.2);
- Habitat: the same habitat index was used as in the North American PFA prediction model. (Table 5.6.1.1).

The chosen final model was:

$$\log(PFA / Spawners) = -1.165 \log(Spawners) + 20.49 - 0.0475(Year - 1900)$$

with residual standard deviation of about 20% on a PFA scale. The fitted model is equivalent to:

$$PFA = Spawners^{-0.165} \times e^{20.49 - 0.0475(Year - 1900)}.$$

The pre-fishery abundance forecast in 2002 for Southern European MSW stock will decline to approximately 552,000 (Table 3.5.2.3). This is about one-third of the estimated PFA in the mid-1970s, and lower PFA levels have only been estimated for three years (1996 to 1998). The probability distribution of the 2002 forecast is shown in Table 3.5.2.4. Although the model is not strongly driven by Year this decline is consistent with the continuing decline in estimated lagged egg deposition (egg numbers) in Southern European stocks.

Stochastic Analyses for North American PFA

Although the exact error bounds for the estimates of pre-fishery abundance (NN1(i)) are unknown, minimum and maximum values of component catch and return estimates have been estimated. Simulation methods, in the software package SAS (SAS Institute, 1996), were used to generate the probability density function of NN1(i). This was done as a seven-step procedure as follows:

Step 1: Annual values (1978–2000) of pre-fishery abundance (NN1) were generated assuming a uniform distribution of the minimum to maximum values of input parameters NC1, NC2, and NR2.

Step 2: Annual values (1978-2000) of lagged spawners (SLNQ) were generated assuming a uniform distribution of the minimum to maximum values of SLNQ.

Step 3: 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 steps 1 and 2.

Step 4: A single pre-fishery forecast value for 2002 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 (after log transformation) is assumed to be normal.

Step 5: Step 4 was repeated 1,000 times to generate a vector of forecast values from an individual regression fit.

Step 6: Steps 1 to 5 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 2) and the unexplained variance in pre-fishery abundance from the regression (step 5).

Step 7: The probability profile of these stochastic realizations (in 5% intervals) of the pre-fishery abundance forecast was generated from the vector of pre-fishery abundance forecast values obtained in step 6 (Table 5.6.2.2).

These estimates will be used to develop risk analysis and catch advice presented in Section 5.6.3 and 5.6.4. Managers may use this information to determine the relative risks borne by the stock (i.e., not meeting spawning limits S_{lim}) versus the fishery (e.g., reduced short-term catches).

5.6.3 Development of catch options for 2002

Development of catch advice

Atlantic salmon are managed with the objective of achieving spawning conservation limits. A composite spawning limit (S_{lim}) for the North American 2SW stock complex was developed by summing the spawning limits of Salmon Fishing Areas in Canada and river basins within the USA. Details on the methodology to estimate and update the spawner limits are provided in (ICES 1996/Assess:11) and in Section 4.4 of this report. With these data, it is possible to compute a total available catch. This procedure is unchanged from the previous assessment.

Catch advice for 2002

The fishery allocation for West Greenland is for fisheries on 1SW salmon in 2002, whereas the allocation for North America can be harvested in fisheries on 1SW salmon in 2002 and/or in fisheries on 2SW salmon in 2003. To achieve spawner limits, a pool of fish must be set aside prior to fishery allocation in order to meet spawner limits and allow for natural mortality in the intervening months between the fishery and return to river. In 2000, the spawner limit for North America was 152,548 2SW fish. Thus, 212,189 pre-fishery abundance fish must be reserved ($152{,}548/\exp^{(-.03*11)}$) to equate to inriver S_{lim} because of natural mortality between Greenland and Canada. The difference between the value reported in last year's report of 170,286 is entirely due to the change in a natural mortality rate of 0.03 per month from 0.01 per month previously used.

Quota computation for the 2002 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]. Exponentially smoothed values of biological characteristics were based on the previous years (1996-1999) samples and samples collected in 2001 (Table 5.6.3.1).

The quota values based on this forecast between interquartile limits of the probability density function from Table 5.6.2.2 are in Table 5.6.3.1. At the sharing fraction (Fna) of 0.4, quota options range from 0 to 167 t.

5.6.4 Risk assessment of catch options

The provision of catch advice in a risk framework involves incorporating the uncertainty in all the factors used to develop the catch options. The ranges in the uncertainties of all the factors will result in assessments of differing levels of precision.

The analysis of risk involves four steps: 1) identifying the sources of uncertainty; 2) describing the precision or imprecision of the assessment; 3) defining a management strategy; and 4) evaluating the probability of an event (either desirable or undesirable) resulting from the fishery action. 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 limit reference point. The undesirable event to be assessed is that the spawning escapement after fisheries will be below the conservation limit.

The risk analysis of catch options for Atlantic salmon from North America incorporates the following input parameter uncertainties:

1) the uncertainty in the conservation requirement,
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 2002 fishery in West Greenland.

The spawning requirement risk profile for North America was described previously in ICES 1997/Assess:10. Briefly, North America is divided into six stock areas that correspond to the areas used to estimate returns and spawning escapements (Table 4.4.1). Under the assumption of equal production from all stock areas (i.e., recruitment in direct proportion to the spawner requirement) just over 172,000 fish should escape to North America as spawners to achieve the spawner requirement in all six stock areas at a 50% probability level. This value is higher than the point estimate for the North American stock complex (152,548 2SW salmon, Table 4.4.1) because it includes the annual variation in proportion female and the objective to have sufficient escapement in six stock areas simultaneously.

Last year, the Working Group expressed concerns that the spawning requirement presently used for North America is for the continent as a whole and does not reflect the expected returns to the six regions, i.e. even if 172,000 2SW salmon reach the coast of North America, there will be severe under-escapement in some regions. Specifically, the 2SW returns to Labrador, Scotia-Fundy, and USA have been below their corresponding conservation limits since 1985 (Fig. 4.2.2.2). Between 1992 and 1997, the most recent years when estimates are available for all regions of North America, the Quebec and Gulf regions have accounted for a disproportionate number of salmon relative to their 2SW requirements, (Figure 5.6.4.1).

Based on past performance, there is no reason to expect the abundance of salmon in the North Atlantic to be proportional to the regional 2SW spawner requirements. Assuming that the abundance of Atlantic salmon in 2002 will be proportional to the lagged spawners that would have contributed to the pre-fishery abundance, we can calculate the number of salmon required to return to North America to achieve region-specific conservation requirements. To achieve the Newfoundland 2SW requirement, just over 41,000 2SW in theory would be required to return to North America. In the regions with lower stock performance, returns to North America of about 441,000 fish would be required for the Scotia-Fundy region, and returns to North America of more than 1.5 million fish would be required for achieving the USA conservation requirements (Table 5.6.4.1).

There is a zero chance that the returns to USA rivers will be anywhere near 29,000 2SW salmon in 2003 (Section 4.2.7). There is little chance of returns in 2003 being sufficient to meet the Scotia-Fundy requirement even in the absence of high seas fisheries. The other four regions could meet conservation requirements based on the realized returns in recent years and the anticipated PFA of salmon in 2002 (Table 5.6.4.1).

To guide the management, an alternative risk analysis was conducted. The Working Group recommends that fisheries managers attempt to meet the conservation limits simultaneously in the four northern regions of North America: Labrador, Newfoundland, Quebec, and Gulf. For the two southern regions, Scotia-Fundy and USA, an alternate objective to that of achieving the conservation requirement would be to rebuild the stocks, i.e. assess fisheries relative to the objective of achieving minimally a pre-agreed increase in returns relative to the realized returns of a previous time. Rates of increase could be as low as a 10% annual increase relative to the stock levels observed in the previous five years for those stocks that are approaching a stock status objective. More aggressive rebuilding rates such as 25% per year could be used for stocks that are very far from their desired state. Both levels of rebuilding were quantified in the following risk analysis.

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).

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 and biological characteristics in the fishery (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). In the risk analysis, the biological characteristics for 2002 were assumed to potentially vary between the minimum and maximum values of the previous five years fisheries, 1997 to 2002 (Tables 5.1.3.2; 5.1.4.1).

The final step in the risk analysis of the catch options involves combining the conservation requirement with the probability distribution of the returns to North America for different catch options. The returns to North America are partitioned into regional returns based on the proportions of lagged spawners for 2002. Estimated returns to each region are compared to the conservation objectives of Labrador, Newfoundland, Quebec, and Gulf. Estimated returns for Scotia-Fundy and US are compared to the objective of achieving at least a 10% increase or a 25% increase relative to average returns of the previous five years. The input parameters for the risk analysis are in Table 5.6.4.2.

The pre-fishery abundance of salmon in 2002 is expected to be moderate relative to recent years (Figure 5.6.4.2). In the absence of any marine-induced fishing mortality, there is a high probability (85% probability) that the returns of 2SW salmon to North America in 2002 will be sufficient to meet the conservation requirements of the four northern regions (Labrador, Newfoundland, Quebec, and Gulf) (Table 5.6.4.1; Figure 5.6.4.3). There is also a high probability that the returns in the southern regions (Scotia-Fundy and USA) will increase by at least 10% relative to the returns of the previous five years if the predicted PFA abundance is realized (Table 5.6.4.1; Figure 5.6.4.3).

At a quota of 70 t in West Greenland and a subsequent allocation of 81 t to North America (based on the historical sharing agreement of 40:60), there is at best a 75% chance of meeting the conservation objectives in the four northern regions (Table 5.6.4.1; Figure 5.6.4.3). **There are no fishery allocations that will ensure (probability of 0.99) the objective of achieving the conservation requirements for 2SW salmon in the four northern regions or an alternative objective of seeing an increased number of 2SW salmon returning to the under-escaped southern regions of North America.**

The Working Group concludes that the North American stock complex of non-maturing salmon remains in tenuous condition. Increased spawning escapements to rivers of some areas of eastern North America resulted in improved abundance of the juvenile life stages, and perhaps now at adult life stages. Despite the closure of Canadian commercial fisheries in 1992 and subsequently in Labrador in 1998 and Quebec in 1999, sea survival of adults returning to rivers has not improved and in some areas has declined further. The abundance of maturing 1SW salmon has also declined in many areas of eastern North America. Associations between 1SW returns in year i and 2SW returns in year i+1 observed in several rivers in eastern Canada suggest that abundance of 2SW salmon in 2002 in eastern Canada will be similar to or less than recent years (Sections 4.2.6 and 4.5.1). Smolt production in 2000 and 2001 in monitored rivers of eastern Canada were similar to or below the average of the last five years and unless sea survival improves, the abundance of non-maturing 1SW salmon in the Northwest Atlantic is not expected to improve above the levels of the last five years.

There is little information available to confirm the possibility of an improvement in pre-fishery abundance in 2001 and 2002 as predicted by the model. One sea winter adult returns in 2002 will provide initial indications regarding the overall abundance of adult salmon in 2003. Although the model has successfully tracked two sharp increases in pre-fishery abundance previously, caution is urged regarding the harvest decisions for 2002. The increasing advantage associated with each additional spawner in under-seeded river systems makes a strong case for a conservative management strategy.

The Working Group also noted that the PFA of non-maturing 1SW salmon from Southern Europe has been declining steadily since the 1970s (Fig. 3.5.1.5), and the preliminary quantitative prediction of PFA for this stock complex indicates that PFA will remain close to present low levels for each of the next two years (575,000 and 552,000 fish) (Fig. 3.5.2.3). There is evidence from the prediction that PFA will decrease in the near future and the spawning escapement has not been significantly above the conservation limit for the last six years (Fig. 3.5.1.6). The stock group is therefore thought to remain very close to safe biological limits, and the Working Group therefore considers that precautionary reductions in exploitation rates are required for as many stocks as possible, in order to ensure that conservation requirements are met for each river stock with high probability. The Working Group also notes that mixed stock fisheries present particular threats to conservation.

5.7 Changes to and Critical Assessment of the 'Model' Used to Provide Catch Advice and Impacts of Changes on the Calculated Quota

There were no changes to the model structure used to forecast pre-fishery abundance (PFA) of non-maturing 1SW salmon or methods used to provide catch advice for the West Greenland fishery. However, a revised estimate of natural mortality occurring at sea was produced and adopted by the Working Group. Previous to this assessment, ICES used an instantaneous rate of natural mortality of 0.01 per month in the NEAC and NAC models to estimate PFA of salmon. Based on analytical work completed and reviewed over the past two years, a revised estimate of 0.03 per month was adopted for use in estimating PFA (see Section 2.3).

The Working Group reviewed effects of this revision on estimates of PFA and conservation limits and implications for management advice (see Section 2.3.2). Natural mortality enters into the PFA model used to estimate the non-maturing 1SW component at the stage when the numbers of salmon alive at the beginning of the second sea winter are back-calculated from the estimated numbers of fish returning to homewaters. Increasing natural mortality from 0.01 to 0.03 per month increases both the estimated PFA and conservation limit of non-maturing salmon by approximately 20%. In addition, the harvestable surplus of salmon (if a surplus exists) will also increase by the same amount. However, salmon not taken in the fishery (assuming that the full quota is harvested) will also be subject to the higher level of natural mortality, and as a result there is no change in the estimated numbers of fish returning to homewaters. It should also be noted that for 2003, the lagged spawner variable will need to be revised to account for missing data from Labrador and this will necessarily result in a change in the current model or development of alternative models.

In the future the Working Group anticipates incorporating output from the NEAC PFA forecast model into the catch options advice for West Greenland. The Working Group has made a recommendation that a study group should be set up to enable a focused effort to investigate alternative models and management systems for providing scientific catch advice for mixed stock and homewater fisheries.

5.8 Continuing Model Development

5.8.1 Development of Juvenile Abundance Indices

As an alternative to the lagged spawner variable, juvenile abundance indices were considered as surrogates of potential smolt production from eastern Canada as described in Section 4.2.1. The individual river abundance indices were standardized to a common currency (juvenile per egg) using the river-specific conservation limit (in units of eggs).

The information from the surveyed rivers was combined into an index of freshwater production for North America by weighting the annual river indices by the relative contribution to the 2SW spawner requirements of the six main areas within North America. This allowed indices of smolt production from all areas of North America to be used but attributed weights to the area indices according to the expected contribution to 2SW abundance. The relative index indicated a doubling of the freshwater production from the 1970s into the 1990s, with freshwater production being highest and relatively constant since 1992 (Figure 4.2.1.7).

Model formulations identical to those described in Section 5.6 were analysed after substituting the juvenile index (Juv_{ind}) for the lagged spawner variable (SLNQ). The juvenile index was advanced one year to correspond to the year of PFA (i.e. the PFA of year i corresponded to the juvenile index of year i-1, which was a combination of smolt indices of year i-1 and the parr indices of year i-2). For exploratory purposes, the 1978 to 2000 PFA years as tabled in last year's Working Group report and corresponding juvenile and habitat indices were used in the model (Table 5.8.1; Figure 5.8.1).

The models examined were:

(1) $PFA = Juv_{ind}^{\gamma} \exp^{(\alpha + \beta Habitat + \varepsilon)}$ (model formulation of Section 5.6)
(2) $PFA = Juv_{ind} \exp^{(\alpha + \beta Habitat + \varepsilon)}$
(3) $PFA = Juv_{ind} \exp^{(\alpha + \beta Habitat + \gamma JuvIndex + \varepsilon)}$

These models can be solved by general linear fitting for the association between PFA or recruits per spawner and explanatory variables after conversion to linear forms:

$$Ln(PFA) = \gamma Ln(Juv_{ind}) + \alpha + \beta Habitat + \varepsilon$$

$$Ln(PFA/Juv_{ind}) = \alpha + \beta Habitat + \varepsilon$$

$$Ln(PFA/Juv_{ind}) = \alpha + \beta Habitat + \gamma Juv_{ind} + \varepsilon$$

The habitat variable was a weak explanatory variable in the models and explained at best 16% of the variance in log PFA/Juv_{ind}. It was not a significant variable when the juvenile index is included as an explanatory variable of density dependence.

Model formulation (1) considers PFA to be a compensatory function of juvenile index modified by a proportionate survival rate associated with the habitat variable. The habitat variable was not significant ($P > 0.50$) and the log of juvenile index variable explained 58% of the log of PFA variance. The habitat variable explained less than 16% of the variance in log(pfa/juvenile) (Model 2). The addition of the juvenile index in model formulation (3) resulted in the habitat variable becoming non-significant. The juvenile index variable explained 77% of the variance in log(pfa/juvenile). The overall association indicates that the recruits per juvenile decreases with increasing juvenile index.

All the models had a temporal trend in the residuals, with model formulation (3) having the strongest trend; the model tended to over-predict abundance in recent years because of decreases in juvenile abundance (Figure 5.8.2).

The modeled relationship between juvenile index and PFA is negative indicating that as the juvenile index increases, PFA decreases (Figure 5.8.1). Both variables in the model have been unidirectional such that a generally increasing trend in juveniles corresponds to the generally decreasing trend in PFA over the time-series examined.

Concerns regarding the juvenile index

A juvenile index model is conceptually more attractive as juveniles represent a stage closer to the PFA than the lagged spawner variable used previously. Consequently, some of the noise corresponding to the stochasticity in the recruitment process should be reduced, favoring a more direct link between the predictors and the PFA. The Working Group noted that many of the concerns raised regarding the appropriateness of the juvenile index for predictive PFA also apply to the assumptions about the lagged spawner variable.

The juvenile index would be an attractive alternative to the lagged spawner variable if it could be demonstrated that there was an association between spawners and the juvenile index. Specifically, the lagged spawner index for each region should relate to the regional juvenile index, lagged to the appropriate PFA year. The strongest association between the juvenile index and the lagged spawners was observed in the Quebec region of North America with 31% of the variation in the index explained by the lagged spawner variable (Figure 5.8.3). The association for the Gulf Region was weaker (15% explained variance) with the juvenile index of recent years remaining high, while the lagged spawner estimate declined. However, there was generally a higher probability of obtaining a high juvenile index when lagged spawners were high (Figure 5.8.3). The juvenile indices for Scotia-Fundy (parr derived index) and for Newfoundland (smolt-derived index) were not associated with measures of lagged spawners (Figure 5.8.3).

The juvenile index has become more representative of freshwater production since the mid-1980s as smolt enumeration programs commenced in Quebec and Newfoundland and juvenile surveys were expanded to more rivers of the Maritime provinces. However, the number of sampling stations by river remains limited and the individual river indices may reflect the habitat characteristics of the site sampled rather than differences in abundance among rivers. The standardization of the juvenile indices used in the present analyses can correct for variations in relative abundance (much as CPUE data can be corrected for variations in catchability among gear), but the combined index is sensitive to the presence or absence of individual river indices through the time-series. Juvenile abundance has been shown to be affected by small-scale spatial variations and the measurement errors made at each station tend to be ignored. As a first step, a sensitivity analysis of the PFA forecast to measurement errors in juvenile indices would be informative before applying the index in a predictive framework for PFA abundance.

Additionally, the rivers monitored for juveniles are assumed to represent the relative production levels within a broader geographic area. This assumption should be examined.

Furthermore, the juvenile index also assumes that parr to smolt translations are proportional and equivalent in all areas. This assumption also needs to be examined where parr and smolt data sets from the same river are available. Such data are presently being obtained from three rivers of the Maritime provinces (Nashwaak, LaHave, and Northwest Miramichi rivers), the region with the longest and most comprehensive series of juvenile indices. This will provide information to address the concerns that increased juvenile densities may not translate directly into smolts, especially where overwinter survival of large parr has been shown in some rivers to be limiting smolt production.

As with the other indices of spawning stock, there is an assumption of stationarity over time in parr to smolt dynamics. Again, where data sets exist, this should be examined.

5.8.2 Constraints to stock and recruitment modelling

All the models examined to date assume that the habitat, spawning stock indicators and PFA estimates are temporally independent. In reality, all these data sets are time-series with autocorrelation (as evidenced in residual patterns), therefore, models to treat time-series data should be examined.

There is also the potential problem of non-stationarity in the data sets being examined. Examples from both sides of the Atlantic provide evidence of shifts in marine survival over the few decades of observations available. Models such as dynamic linear modeling would permit the integration of this information sequentially through time. It would be useful for the Working Group to review these approaches in the near future to address the various problems identified with the modeling approaches to date.

5.9 Data Deficiencies and Research Needs in the WGC area

1) Continued efforts should be made to improve the estimates of the annual catches of salmon taken for private sales and local consumption in Greenland.
2) The mean weights, sea and freshwater ages, and continent-of-origin are essential parameters to provide catch advice for the West Greenland fishery. The Working Group recommends that the sampling program be continued and closely coordinated with fishery harvest plans to be executed annually in West Greenland.
3) Scale analysis of salmon captured at West Greenland indicated an infrequent appearance of escaped-farm salmon. To investigation this observation, farmed salmon need to be genetically characterized and included as baseline populations in continent-of-origin analyses of samples collected at West Greenland.
4) Continue testing for ISAv and other diseases in Atlantic salmon caught in West Greenland.
5) Development of more refined data characterizing fishing effort (e.g., vessel size, gear type, amount of gear deployed, soak time) would allow for detailed analyses of CPUE data to characterize availability of Atlantic salmon in West Greenland.
6) Development of alternative in-season measures of abundance such as relationships between 1SW returns to rivers from the same cohort should be investigated as a future source of confirmatory information of abundance.
7) The catch options for the West Greenland fishery are based almost entirely upon data taken 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 emphasized the need for information from these stocks to be incorporated into the modelling and abundance forecasts as soon as possible.
8) Further basic research is needed on the spatial/temporal distribution and migration patterns of salmon and their predators at sea to assist in explaining variability in survival rates.
9) Other indices of change, i.e. changes in age composition, size at age, and sea survival, should also be included in this evaluation.
10) An ICES Study Group is needed to allow for a focused effort to investigate alternative models and management systems for providing scientific catch advice for mixed stock and homewater fisheries.

Table 5.1.1.1. Nominal catches of salmon, West Greenland 1960-2001 (tonnes 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]
1999	-	-	-	-	19	19	20[10]
2000	-	-	-	-	21	21	20[10]
2001	-	-	-	-	43	43	114[11]

[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.
[11] Calculated final quota in *ad hoc* management system.

Table 5.1.1.2. Distribution of nominal catches (t), Greenland vessels (1977-2001).

Year	NAFO Division 1A	1B	1C	1D	1E	1F	NK	Total Westgrl.	East Greenland	Total 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
1999	+	2	3	9	2	2	-	19	+	19
2000	+	+	1	7	+	13	-	21	-	21
2001	+	1	4	5	3	28	-	43	-	43

[1]) The fishery was suspended
+) Small catches <0.5 t
-) No commercial landings

Table 5.1.2.1. Distribution of commercial fishing effort (excluding private landings) by calendar week (Monday – Sunday beginning on the Monday nearest August 15th) and NAFO statistical area from 1987 to 2001.

Year	Week	1A	1B	1C	1D	1E	1F	XIV	Total
1997	1	0	24	78	10	68	81	0	**261**
	2	2	20	56	8	48	42	1	**177**
	3	2	5	19	0	11	17	3	**57**
	4	0	4	20	0	7	20	9	**60**
	5	1	9	50	6	10	15	15	**106**
	6	0	0	30	4	10	4	3	**51**
	Total	**5**	**62**	**253**	**28**	**153**	**179**	**31**	**712**
1998	1	6	1	3	1	0	8	0	**19**
	2	2	0	4	1	0	4	0	**11**
	3	3	0	2	0	0	3	0	**8**
	4	2	0	0	0	1	1	0	**4**
	5	1	0	2	0	0	3	0	**6**
	6	0	1	1	0	0	1	0	**3**
	7 & Later	1	2	5	2	0	5	0	**15**
	Total	**15**	**4**	**17**	**4**	**1**	**25**	**0**	**66**
1999	1	0	0	1	1	0	6	0	**8**
	2	0	1	13	5	0	0	0	**19**
	3	0	1	8	0	0	1	2	**12**
	4	0	0	9	2	1	7	0	**19**
	5	1	0	4	2	2	0	0	**9**
	6	0	0	10	2	0	1	0	**13**
	7 & Later	2	18	35	29	1	3	0	**88**
	Total	**3**	**20**	**80**	**41**	**4**	**18**	**2**	**168**
2000	**1**	**1**	**1**	**6**	**16**	**2**	**32**	**0**	**58**
2001	1	0	0	0	22	0	64	0	**86**
	2	0	0	5	14	0	37	0	**56**
	3	0	1	15	11	0	25	0	**52**
	4	0	6	7	1	0	24	0	**38**
	5	0	1	10	0	0	15	0	**26**
	6	0	0	7	0	0	5	0	**12**
	7 & Later	0	0	6	1	0	2	0	**9**
	Total	**0**	**8**	**50**	**49**	**0**	**172**	**0**	**280**

Table 5.1.2.2. Commercial (excluding private landings) catch per unit effort [live weight (kg) / landing] by calendar week (Monday Sunday beginning on the Monday nearest August 15th) from 1997 to 2001.

Year	Week	Effort Units	CPUE (kg/landing-day) by Week	CPUE (kg/landing-day) by Harvest Period	Aggregate CPUE by Harvest Period
1997	1	**261**	89	89	89
	2	**177**	75	72	81
	3	**57**	63		
	4	**60**	59	68	--
	5	**106**	74		
	6	**51**	67		
	Total	**712**	**77**	**77**	--
1998	1	**19**	57	57	57
	2	**11**	44	46	51
	3	**8**	48		
	4	**4**	54	131	--
	5	**6**	59		
	6	**3**	87		
	7 & Later	**15**	190		
	Total	**66**	**85**	**85**	--
1999	1	**8**	82	82	82
	2	**19**	184	136	125
	3	**12**	61		
	4	**19**	171	83	--
	5	**9**	140		
	6	**13**	57		
	7 & Later	**88**	62		
	Total	**168**	**93**		--
2000	**1**	**58**	**343**	**343**	343
2001	1	**86**	115	115	115
	2	**56**	118	107	111
	3	**52**	96		
	4	**38**	161	153	--
	5	**26**	192		
	6	**12**	90		
	7 & Later	**9**	91		
	Total	**280**	**123**	**123**	--

Table 5.1.3.1. Size of biological samples and percentage (by number) of North American and European salmon in research vessel catches at West Greenland (1969-82), from commercial samples (1978-92, 1995-97 and 2001), and from local consumption samples (1998-2000).

		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	68	(72,65)	32	(35,28)
	1996	3341	1297	73	(76,71)	27	(29,24)
	1997	794	282	80	(84,75)	20	(25,16)
Local cons.	1998	540	406	79	(84,73)	21	(27,16)
	1999	532	532	90	(97,84)	10	(16,3)
	2000	491	491	70		30	
Commercial	2001	388	187	67		33	

[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 5.1.3.2. The weighted proportions and numbers of North American and European Atlantic salmon caught at West Greenland 1982-1992 and 1995-2001. Numbers are rounded to the nearest hundred fish.

	Proportion weighted by catch in number		Numbers of Salmon caught	
Year	NA	E	NA	E
1982	57	43	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	67	33	21400	10700
1996	73	27	22400	9700
1997	85	15	18000	3300
1998	79	21	3100	900
1999	91	9	5700	600
2000	65	35	5100	2700
2001	67	33	9849	5389

Table 5.1.4.1. Annual mean fork lengths and whole weights of Atlantic salmon caught at West Greenland, 1969-1992 and 1995-2001. Fork length (cm); whole weight (kg). NA = North America; E = Europe.

	Whole weight (kg)									Fork length (cm)					
	Sea age & origin									Sea age & origin					
	1SW		2SW		PS		All sea ages		TOTAL	1SW		2SW		PS	
Year	NA	E	NA	E	NA	E	NA	E		NA	E	NA	E	NA	E
1969	3.12	3.76	5.48	5.80	-	5.13	3.25	3.86	3.58	65.0	68.7	77.0	80.3	-	75.3
1970	2.85	3.46	5.65	5.50	4.85	3.80	3.06	3.53	3.28	64.7	68.6	81.5	82.0	78.0	75.0
1971	2.65	3.38	4.30	-	-	-	2.68	3.38	3.14	62.8	67.7	72.0	-	-	-
1972	2.96	3.46	5.85	6.13	2.65	4.00	3.25	3.55	3.44	64.2	67.9	80.7	82.4	61.5	69.0
1973	3.28	4.54	9.47	10.00	-	-	3.83	4.66	4.18	64.5	70.4	88.0	96.0	61.5	-
1974	3.12	3.81	7.06	8.06	3.42	-	3.22	3.86	3.58	64.1	68.1	82.8	87.4	66.0	-
1975	2.58	3.42	6.12	6.23	2.60	4.80	2.65	3.48	3.12	61.7	67.5	80.6	82.2	66.0	75.0
1976	2.55	3.21	6.16	7.20	3.55	3.57	2.75	3.24	3.04	61.3	65.9	80.7	87.5	72.0	70.7
1977	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1978	2.96	3.50	7.00	7.90	2.45	6.60	3.04	3.53	3.35	63.7	67.3	83.6	-	60.8	85.0
1979	2.98	3.50	7.06	7.60	3.92	6.33	3.12	3.56	3.34	63.4	66.7	81.6	85.3	61.9	82.0
1980	2.98	3.33	6.82	6.73	3.55	3.90	3.07	3.38	3.22	64.0	66.3	82.9	83.0	67.0	70.9
1981	2.77	3.48	6.93	7.42	4.12	3.65	2.89	3.58	3.17	62.3	66.7	82.8	84.5	72.5	-
1982	2.79	3.21	5.59	5.59	3.96	5.66	2.92	3.43	3.11	62.7	66.2	78.4	77.8	71.4	80.9
1983	2.54	3.01	5.79	5.86	3.37	3.55	3.02	3.14	3.10	61.5	65.4	81.1	81.5	68.2	70.5
1984	2.64	2.84	5.84	5.77	3.62	5.78	3.20	3.03	3.11	62.3	63.9	80.7	80.0	69.8	79.5
1985	2.50	2.89	5.42	5.45	5.20	4.97	2.72	3.01	2.87	61.2	64.3	78.9	78.6	79.1	77.0
1986	2.75	3.13	6.44	6.08	3.32	4.37	2.89	3.19	3.03	62.8	65.1	80.7	79.8	66.5	73.4
1987	3.00	3.20	6.36	5.96	4.69	4.70	3.10	3.26	3.16	64.2	65.6	81.2	79.6	74.8	74.8
1988	2.83	3.36	6.77	6.78	4.75	4.64	2.93	3.41	3.18	63.0	66.6	82.1	82.4	74.7	73.8
1989	2.56	2.86	5.87	5.77	4.23	5.83	2.77	2.99	2.87	62.3	64.5	80.8	81.0	73.8	82.2
1990	2.53	2.61	6.47	5.78	3.90	5.09	2.67	2.72	2.69	62.3	62.7	83.4	81.1	72.6	78.6
1991	2.42	2.54	5.82	6.23	5.15	5.09	2.57	2.79	2.65	61.6	62.7	80.6	82.2	81.7	80.0
1992	2.54	2.66	6.49	6.01	4.09	5.28	2.86	2.74	2.81	62.3	63.2	83.4	81.1	77.4	82.7
1995	2.37	2.67	6.09	5.88	3.71	4.98	2.45	2.75	2.56	61.0	63.2	81.3	81.0	70.9	81.3
1996	2.63	2.86	6.50	6.30	4.98	5.44	2.83	2.90	2.88	62.8	64.0	81.4	81.1	77.1	79.4
1997	2.57	2.82	7.95	6.11	4.82	6.90	2.63	2.84	2.71	62.3	63.6	85.7	84.0	79.4	87.0
1998	2.72	2.83	6.44	-	3.28	4.77	2.76	2.84	2.78	62.0	62.7	84.0	-	66.3	76.0
1999	3.02	3.03	7.59	-	4.20	-	3.09	3.03	3.08	63.8	63.5	86.6	-	70.9	-
2000	2.47	2.81	-	-	2.58	-	2.47	2.81	2.57	60.7	63.2	-	-	64.7	-
2001	2.62	2.83	6.67	4.03	4.40	4.36	2.76	2.86	2.79	63.1	64.2	83.9	71.0	78.1	77.1

Table 5.1.4.2. River age distribution (%) for all North American and European origin salmon caught at West Greenland, 1968-1992 and 1995-2001.

	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	2.4	19.0	45.4	22.6	8.8	1.8	0.1	0.0
1996	1.7	18.7	46.0	23.8	8.8	0.8	0.1	0.0
1997	1.3	16.4	48.4	17.6	15.1	1.3	0.0	0.0
1998	4.0	35.1	37.0	16.5	6.1	1.1	0.1	0.0
1999	2.7	23.5	50.6	20.3	2.9	0.0	0.0	0.0
2000	3.2	26.6	38.6	23.4	7.6	0.6	0.0	0.0
2001	4.0	22.6	39.4	26.0	7.7	0.3	0.0	0.0
Mean	3.1	34.0	38.0	17.0	6.6	1.3	0.1	0.0

Table 5.1.4.2. (cont.)

	River age							
Year	1	2	3	4	5	6	7	8
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	14.8	67.3	17.2	0.6	0.0	0.0	0.0	0.0
1996	15.8	71.1	12.2	0.9	0.0	0.0	0.0	0.0
1997	4.1	58.1	37.8	0.0	0.0	0.0	0.0	0.0
1998	28.6	60.0	7.6	2.9	0.0	1.0	0.0	0.0
1999	27.7	65.1	7.2	0.0	0.0	0.0	0.0	0.0
2000	36.5	46.7	13.1	2.9	0.7	0.0	0.0	0.0
2001	19.3	48.9	26.1	4.5	1.1	0.0	0.0	0.0
Mean	19.2	61.5	16.8	2.2	0.3	0.0	0.0	0.0

Table 5.1.4.3. Sea-age composition (%) of samples from commercial catches at West Greenland, 1985-2001.

Year	North American			European		
	1SW	2SW	Previous Spawners	1SW	2SW	Previous spawners
1985	92.5	7.2	0.3	95.0	4.7	0.4
1986	95.1	3.9	1.0	97.5	1.9	0.6
1987	96.3	2.3	1.4	98.0	1.7	0.3
1988	96.7	2.0	1.2	98.1	1.3	0.5
1989	92.3	5.2	2.4	95.5	3.8	0.6
1990	95.7	3.4	0.9	96.3	3.0	0.7
1991	95.6	4.1	0.4	93.4	6.5	0.2
1992	91.9	8.0	0.1	97.5	2.1	0.4
1993	-	-	-	-	-	-
1994	-	-	-	-	-	-
1995	96.8	1.5	1.7	97.3	2.2	0.5
1996	94.1	3.8	2.1	96.1	2.7	1.2
1997	98.2	0.6	1.2	99.3	0.4	0.4
1998[1]	96.8	0.5	2.7	99.4	0.0	0.6
1999[1]	96.8	1.2	2.0	100.0	0.0	0.0
2000[1]	97.4	0.0	2.6	100.0	0.0	0.0
2001	95.0	2.6	2.4	97.8	1.1	1.1

[1] Catches for local consumption only.

Table. 5.3.1. Distribution of coded wire microtag recoveries by NAFO Division and the numbers of tagged fish released for North American and European stocks, 1985 to 1992. Numbers at large represent fish released in the previous year.

Continent	Year	Number of Recoveries by NAFO Division							Number
		1A	1B	1C	1D	1E	1F	Total	at large
N. America	1985	0	0	0	0	0	0	0	
	1986	0	10	0	11	4	1	26	178,888
	1987	0	33	0	43	11	16	103	517,435
	1988	2	25	0	40	12	2	81	702,900
	1989	0	31	0	34	7	0	72	736,722
	1990	0	0	16	29	1	0	46	720,110
	1991	0	0	14	9	5	0	28	962,019
	1992	0	0	31	0	6	14	51	602,675
	All years	2	99	61	166	46	33	407	4,420,749
	%	0.5	24.3	15.0	40.8	11.3	8.1		
Europe	1985	0	14	2	15	3	0	34	
	1986	0	15	0	20	5	4	44	381,766
	1987	0	13	0	18	7	5	43	361,340
	1988	1	10	0	11	6	1	29	490,620
	1989	0	10	0	10	7	0	27	645,742
	1990	0	0	1	3	4	0	8	851,487
	1991	0	0	4	3	2	0	9	848,675
	1992	0	0	7	0	13	10	30	1,097,663
	All years	1	62	14	80	47	20	224	4,677,293
	%	0.4	27.7	6.3	35.7	21.0	8.9		

Table 5.4.1. Numbers of salmon returning to homewaters provided no fishing took place at Greenland. The average number of potentially returning salmon per ton caught in Greenland is also given.

Year	1993	1994	1995	1996	1997	1998	1999	2000	2001
Nominal catch at Greenland (tons) [1]:	89	137	83	92	58	11	19	21	43
Proportion of NA fish in catch (PropNA):	0.540	0.540	0.680	0.732	0.796	0.785	0.910	0.650	0.670
Proportion of EU fish in catch (PropEU):	0.460	0.460	0.320	0.268	0.204	0.215	0.090	0.350	0.330
Mean weight, NA fish, all sea ages (kg):	2.655	2.655	2.450	2.830	2.630	2.760	3.090	2.470	2.760
Mean weight, EU fish, all sea ages (kg):	2.745	2.745	2.750	2.900	2.840	2.840	3.030	2.810	2.860
Mean weight of all sea ages (NA+EU fish):	2.696	2.696	2.546	2.849	2.673	2.777	3.085	2.589	2.793
Proportion of 1SW NA-fish in catch:	0.919	0.919	0.968	0.941	0.982	0.968	0.968	0.974	0.950
Catch of 1SW NA fish:	16635	25607	22300	22392	17238	3029	5416	5383	9916
Catch of 1SW EU fish:	13706	21098	9349	8000	4091	806	546	2548	4713
Natural mortality during migration:	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Additional fish if no fishery at Greenland:									
2SW fish returning to NA (numbers):	**12324**	**18970**	**16520**	**16589**	**12771**	**2244**	**4013**	**3988**	**7346**
2SW fish returning to EU (numbers):	**10154**	**15630**	**6926**	**5927**	**3031**	**597**	**405**	**1887**	**3492**

Average number of salmon potentially returning to home waters per ton caught in Greenland:	
2SW fish returning to NA (numbers per ton, average of 1993-2001):	**171**
2SW fish returning to EU (numbers per ton, average of 1993-2001):	**87**

[1]) Figures for 1993 and 1994 correspond to calculated quotas.

Table 5.6.1.1. Pre-fishery abundance estimates, thermal habitat index for February based on sea surface temperature (H2), lagged spawner index for North America excluding Gulf and US spawners (SLNQ), results of a jacknife cross-validation of the multiplicative forecast model, and simulated forecasts.

	Pre-fishery abundance			Thermal Habitat	Lagged spawners (SLNQ)			Jacknife Cross-validation	
Year	Low	High	Mid-point	February (H2)	Low	High	Mid-point	Prediction	Residuals
1971	642,329	819,161	730,745	2,011	.	.	.	.	.
1972	636,223	847,929	742,076	1,990	.	.	.	.	.
1973	767,427	1,001,959	884,693	1,708	.	.	.	.	.
1974	711,852	923,630	817,741	1,862	.	.	.	.	.
1975	801,808	1,032,778	917,293	1,827	.	.	.	.	.
1976	710,616	970,441	840,529	1,676	.	.	.	.	.
1977	574,996	766,338	670,667	1,915	.	.	.	.	.
1978	325,344	423,326	374,335	1,951	35,453	81,767	58,610	425,024	-50,688
1979	725,593	969,695	847,644	2,058	42,626	94,677	68,652	718,629	129,015
1980	626,755	845,327	736,041	1,823	43,173	97,017	70,095	663,245	72,796
1981	589,988	775,253	682,620	1,912	43,268	97,575	70,421	733,879	-51,259
1982	491,695	642,923	567,309	1,703	43,381	98,372	70,876	644,223	-76,914
1983	279,924	399,893	339,909	1,416	40,413	91,967	66,190	425,449	-85,540
1984	290,960	413,606	352,283	1,257	37,647	84,066	60,856	275,323	76,960
1985	455,731	624,417	540,074	1,410	39,344	83,435	61,389	295,522	244,551
1986	490,832	658,410	574,621	1,688	40,567	91,757	66,162	502,977	71,644
1987	444,070	596,354	520,212	1,627	36,636	88,818	62,727	404,174	116,038
1988	359,883	485,729	422,806	1,698	37,131	83,891	60,511	383,809	38,997
1989	279,510	404,579	342,045	1,642	41,955	86,459	64,207	454,430	-112,385
1990	250,138	343,986	297,062	1,503	40,948	81,667	61,307	350,810	-53,748
1991	282,412	405,168	343,790	1,357	37,582	72,966	55,274	210,786	133,004
1992	167,578	256,321	211,949	1,381	35,596	71,384	53,490	206,923	5,027
1993	118,852	224,147	171,500	1,252	38,387	79,232	58,810	277,951	-106,451
1994	137,048	270,162	203,605	1,329	38,395	75,762	57,079	249,397	-45,792
1995	144,618	247,008	195,813	1,311	36,740	69,943	53,342	195,165	648
1996	122,042	192,428	157,235	1,470	33,492	61,600	47,546	151,964	5,271
1997	80,686	146,928	113,807	1,594	29,876	55,241	42,558	118,042	-4,236
1998	68,977	146,973	107,975	1,849	25,629	50,461	38,045	95,636	12,339
1999	67,666	149,236	108,451	1,741	25,658	52,637	39,147	98,008	10,443
2000	81,470	169,954	125,712	1,634	32,960	68,185	50,572	229,349	-103,637
2001	.	.	.	1,685	37,414	81,709	59,561	*332,455* [1]	
2002	.	.	.	1,865	33,942	74,377	54,159	*329,552* [1]	

[1] Simulated forecast values.

Table 5.6.2.1 Results of analysis of pre-fishery abundance (NN1) on February thermal habitat (H2) and North American spawners (SLNQ) from the multiplicative model, 1978-2000.

General Linear Models Procedure

Dependent Variable: LNN1

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	8.03061735	4.01530868	66.41	<.0001
Error	20	1.20917182	0.06045859		
Corrected Total	22	9.23978917			

	R-Square	C.V.	Root MSE	NN1 Mean
	0.869134	1.949360	0.245883	12.61354

Source	DF	Type I SS	Mean Square	F Value	Pr > F
H2	1	1.06588889	1.06588892	17.63	0.0001
LN(SLNQ)	1	6.96472843	6.96472843	115.20	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
H2	1	0.62237837	0.80611073	14.52	0.0012
LN(SLNQ)	1	6.96472843	6.96472843	115.20	<.0001

Regression statistics

Parameter	Estimate	Standard Error	t Value	Pr > |t|
INTERCEPT	-23.15497945	3.21276009	-7.21	<.0001
H2	0.00072590	0.00022625	3.21	0.0044
LN(SLNQ)	3.15910423	0.29433430	10.73	<.0001

Table 5.6.2.2 Multiplicative model estimate of pre-fishery abundance for North American salmon in 2002 with probability levels between 5 and 95%.

Cumulative Density Function %	Forecast
5	101880
10	132305
15	157875
20	181472
25	204485
30	227572
35	251166
40	275683
45	301666
50	329552
55	359752
60	392915
65	430495
70	474268
75	526212
80	590251
85	674419
90	797109
95	1021989

Table 5.6.3.1 Quota options (mt) for 2001 at West Greenland based on H2-SLNQ multiplicative 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	5	11	16	22	27	33	38	44	49	55
35	0	14	28	42	55	69	83	97	111	125	139
40	0	23	45	68	90	113	136	158	181	203	226
45	0	32	64	95	127	159	191	223	255	286	318
50	0	42	84	125	167	209	251	292	334	376	418

Sp. res =	212,189
Prop NA =	0.803
WT1SWNA =	2.687
WT1SWE =	2.862
ACF =	1.050

Table 5.6.4.1. Total pre-fishery abundance (PFA) of Atlantic salmon required to meet regional 2SW conservation limits for the six regions of North America.

Region	2SW Conservation Limit		Lagged spawners for 2002		PFA required to meet regional 2SW conservation limits
	Number of fish	Proportion of North America	Number of fish	Proportion of North America	
Labrador	34,746	0.228	22,527	0.305	158,461
Newfoundland	4,022	0.026	7,215	0.098	57,086
Quebec	29,446	0.193	20,286	0.275	148,940
Gulf	30,430	0.199	18,205	0.247	171,365
Scotia-Fundy	24,705	0.162	4,133	0.056	613,640
USA	29,199	0.191	1,400	0.019	2,137,625
Total	152,548	1.000	73,764	1.000	

Table 5.6.4.2. Input parameters for a risk analysis to achieve conservation limits (S_{lim}) for Labrador, Newfoundland, Quebec, and Gulf, while achieving at least a 10% or 25% increase in returns to Scotia-Fundy and USA.

Region	**Management Objective**			Expected proportion of 2002 PFA
	Achieving conservation requirement	Rebuilding of 2SW salmon abundance		
	Number of 2SW fish	at ≥ 10% increase	at ≥25% increase	
Labrador	34,746			0.305
Newfoundland	4,022			0.098
Quebec	29,446			0.275
Gulf	30,430			0.247
Scotia-Fundy		5,061	5,751	0.056
USA		1,238	1,407	0.019

Table 5.6.4.3. Probability profiles for the management objectives of achieving the 2SW conservation limits simultaneously in the four northern areas of North America (Labrador, Newfoundland, Quebec, Gulf) and achieving the stock rebuilding objectives (examples: minimally 10% or minimally 25% increase in returns of 2SW salmon in 2003) in the two southern areas (Scotia-Fundy and USA) relative to quota options for West Greenland assuming a 40:60 allocation (Fna) of the salmon from North America.

Probability of meeting management objectives			
Allocation Agreement Greenland @).4 **Tons**	Simultaneous Conservation (Lab, NF, Queb, Gulf)	Simultaneous Rebuilding (SF, USA) >=10% in 2003	>=25% IN 2003
0	0.85	0.93	0.91
5	0.85	0.93	0.90
10	0.84	0.92	0.90
15	0.83	0.92	0.89
20	0.83	0.91	0.88
25	0.82	0.91	0.88
30	0.81	0.90	0.87
35	0.80	0.90	0.87
40	0.80	0.89	0.86
45	0.79	0.88	0.85
50	0.78	0.88	0.84
55	0.77	0.87	0.84
60	0.76	0.87	0.83
65	0.76	0.86	0.82
70	**0.75**	0.85	0.82
75	0.74	0.85	0.81
80	0.73	0.84	0.80
85	0.73	0.83	0.79
90	0.72	0.82	0.78
95	0.71	0.82	0.78
100	0.70	0.81	0.77
110	0.69	0.79	**0.75**
120	0.67	0.78	0.74
130	0.66	0.76	0.72
140	0.64	**0.75**	0.71
150	0.63	0.73	0.69
160	0.61	0.72	0.68
170	0.60	0.70	0.66
180	0.58	0.69	0.65
190	0.57	0.67	0.63
200	0.56	0.66	0.62
225	0.53	0.62	0.58
250	0.49	0.58	0.55

Table 5.8.1. Data used to explore alternative models and input variables to explain PFA abundance. For exploratory purposes, the PFA values from the previous year's Working Group report are used.

Smolt	Ln of juvenile index		Back-transformed	PFA	Prefishery Abundance Values			Habitat	Ln(R/S)
Year	Mean	Std. Error	Mean	Year	Mid-point	Minimum	Maximum	Index	(PFA/JuvIndex)
1971	.	.	.	1972	.	.	.	.	.
1972	-4.788	0.204	0.008	1973	.	.	.	.	.
1973	-4.799	0.183	0.008	1974	.	.	.	.	.
1974	-5.518	0.183	0.004	1975	.	.	.	.	.
1975	-4.288	0.183	0.014	1976	.	.	.	.	.
1976	-4.077	0.174	0.017	1977	.	.	.	.	.
1977	-4.175	0.174	0.015	1978	330,067	288,792	371,342	1,961	16.882
1978	-4.216	0.174	0.015	1979	730,751	630,091	831,411	2,068	17.718
1979	-4.157	0.174	0.016	1980	642,412	550,336	734,489	1,823	17.530
1980	-4.434	0.156	0.012	1981	605,835	527,318	684,352	1,912	17.748
1981	-4.563	0.162	0.010	1982	503,741	439,982	567,499	1,703	17.693
1982	-4.128	0.138	0.016	1983	286,882	236,377	337,388	1,416	16.695
1983	-4.133	0.141	0.016	1984	296,448	245,424	347,471	1,257	16.733
1984	-4.067	0.125	0.017	1985	469,065	399,028	539,102	1,410	17.115
1985	-4.407	0.125	0.012	1986	505,381	436,090	575,673	1,688	17.540
1986	-3.930	0.127	0.020	1987	462,966	398,168	527,764	1,627	16.975
1987	-3.798	0.126	0.022	1988	370,678	317,609	423,746	1,698	16.621
1988	-3.816	0.124	0.022	1989	293,487	241,044	345,930	1,642	16.406
1989	-3.868	0.122	0.021	1990	257,262	218,191	296,332	1,503	16.326
1990	-3.821	0.126	0.022	1991	301,232	250,831	351,634	1,357	16.437
1991	-3.864	0.120	0.021	1992	179,600	143,554	215,646	1,381	15.953
1992	-3.641	0.117	0.026	1993	138,525	95,987	181,062	1,252	15.480
1993	-3.402	0.115	0.033	1994	163,955	110,356	217,554	1,329	15.410
1994	-3.743	0.115	0.024	1995	161,799	120,564	203,304	1,311	15.737
1995	-3.581	0.109	0.028	1996	130,922	102,550	159,294	1,470	15.364
1996	-3.609	0.108	0.027	1997	95,039	68,315	121,764	1,594	15.071
1997	-3.884	0.114	0.021	1998	87,325	56,002	118,649	1,849	15.261
1998	-3.740	0.108	0.024	1999	88,169	55,414	120,924	1,741	15.127
1999	-3.604	0.114	0.027	2000	102,121	66,573	137,669	1,634	15.138
2000	-3.738	0.114	0.024	2001	.	.	.	1,685	
2001	-3.641	0.119	0.026	2002	.	.	.	.	

Figure 5.1.2.1 Relationship of CPUE and pre-fishery abundance estimates for the non-maturing 1SW component of the North American (top panel) and Southern European stock complex (middle panel). Input data have been updated with revised PFA values and CPUE data are slightly different than those available at the 2002 NASCO meeting. Regression relationships exclude the outlying point for 2000, and residuals from both regressions are shown in the bottom panel.

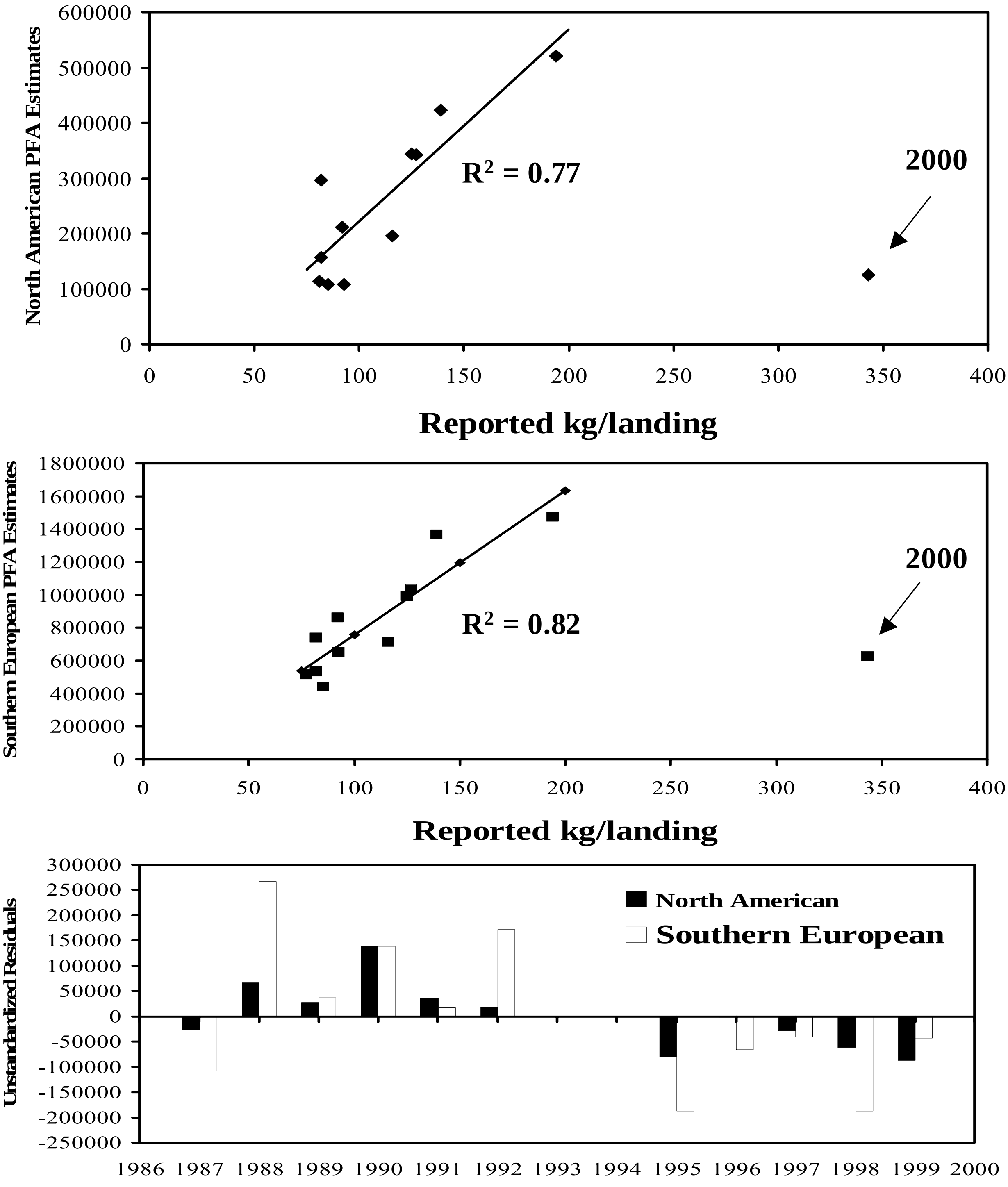
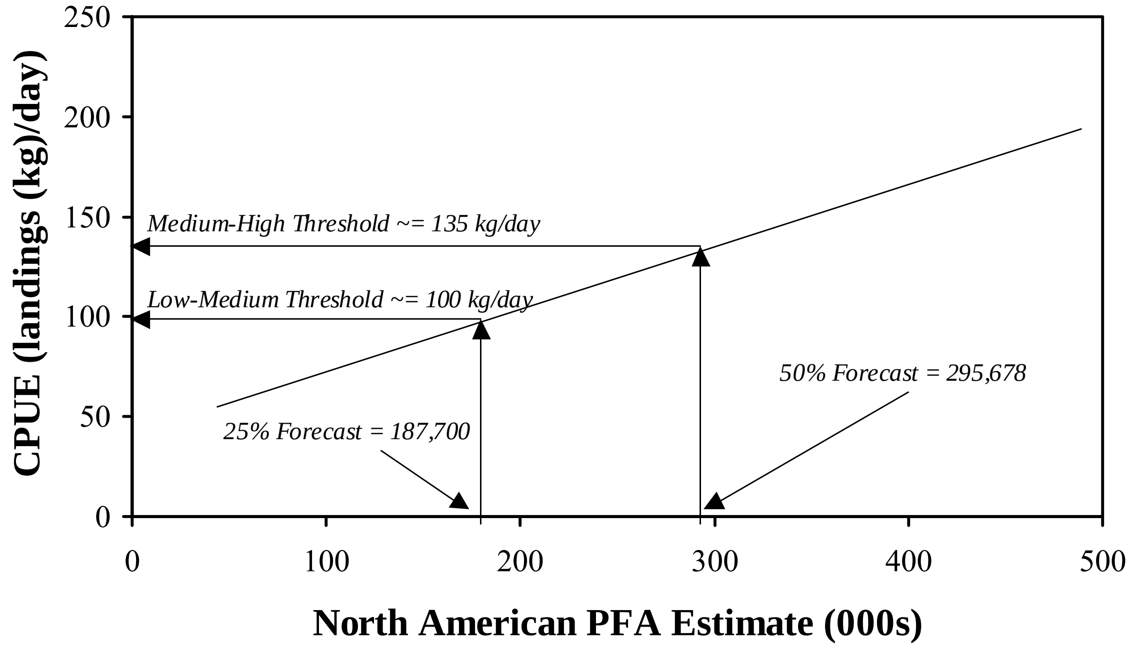


Figure 5.1.2.2. Illustration of method used to establish CPUE thresholds for the 2001 ad hoc management system, which included 1) regressing CPUE against the PFA estimates, 2) using the resulting relationship to estimate the CPUE associated with the 25% and 50% probability levels of the PFA forecasts to use as thresholds between the low, medium and high CPUE zones. Bottom panel provides an example of how threshold levels could change as a result of revised PFA estimates, and a different probability distribution of PFA estimates.



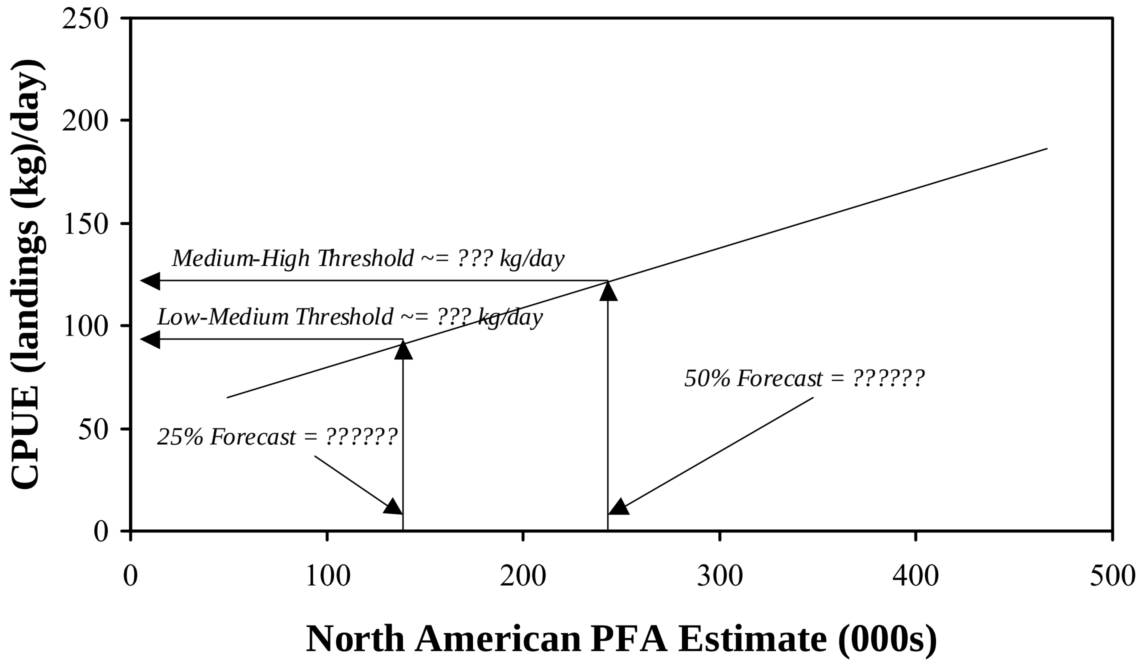


Figure 5.1.2.3. Daily landings and aggregated catch per unit effort (kg/landing) during the 2001 fishery relative to harvest periods and CPUE thresholds established for quota allocation decisions.

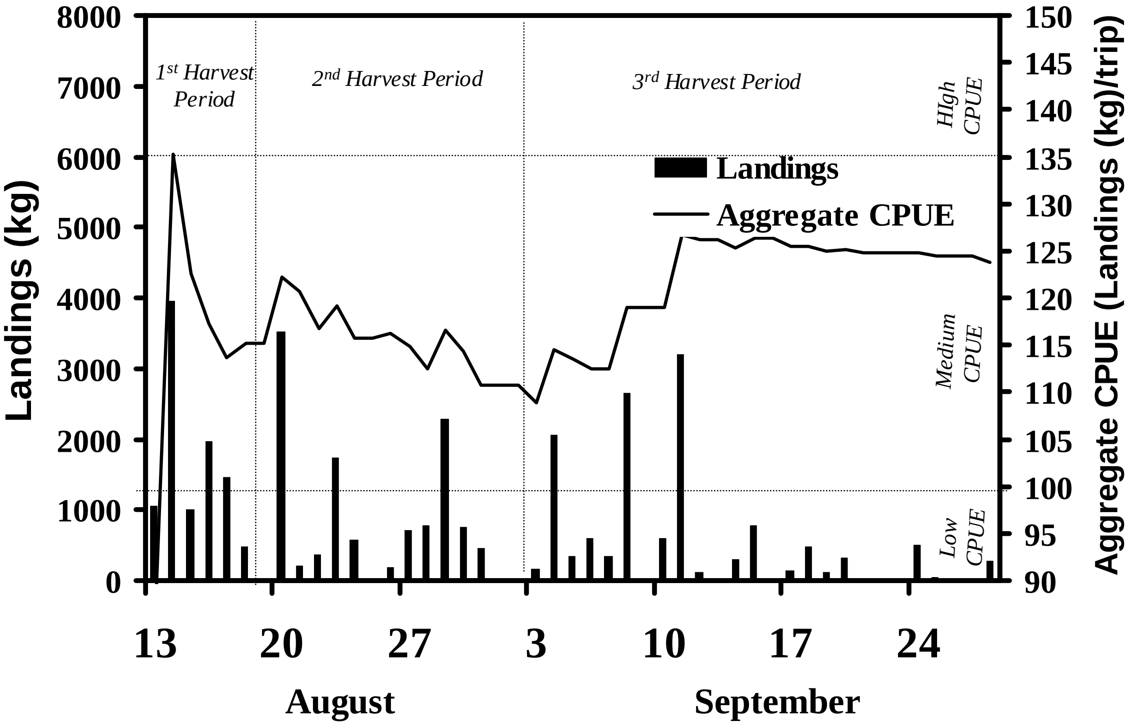


Figure 5.1.2.4. Distribution of commercial effort (number of trips reporting salmon landings) by NAFO area in the fisheries at West (regions 1A to 1F) and East Greenland fisheries from 1997 to 2001. The size of circles indicates the number of commercial trips reported in each year and area.

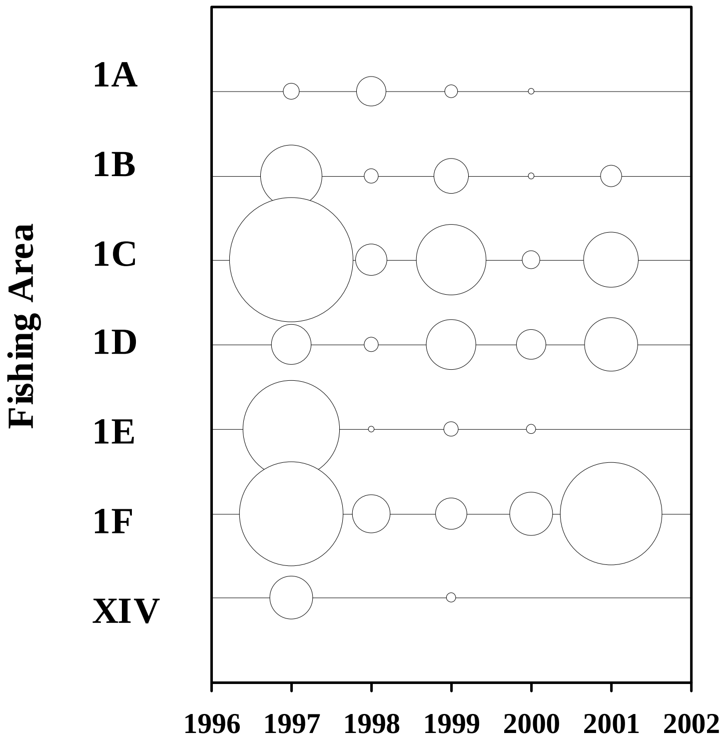


Figure 5.1.2.5. Relationship of CPUE and pre-fishery abundance estimates and forecasts for the non-maturing 1SW component of the North American Atlantic Salmon stock complex using PFA estimates updated in 2002.

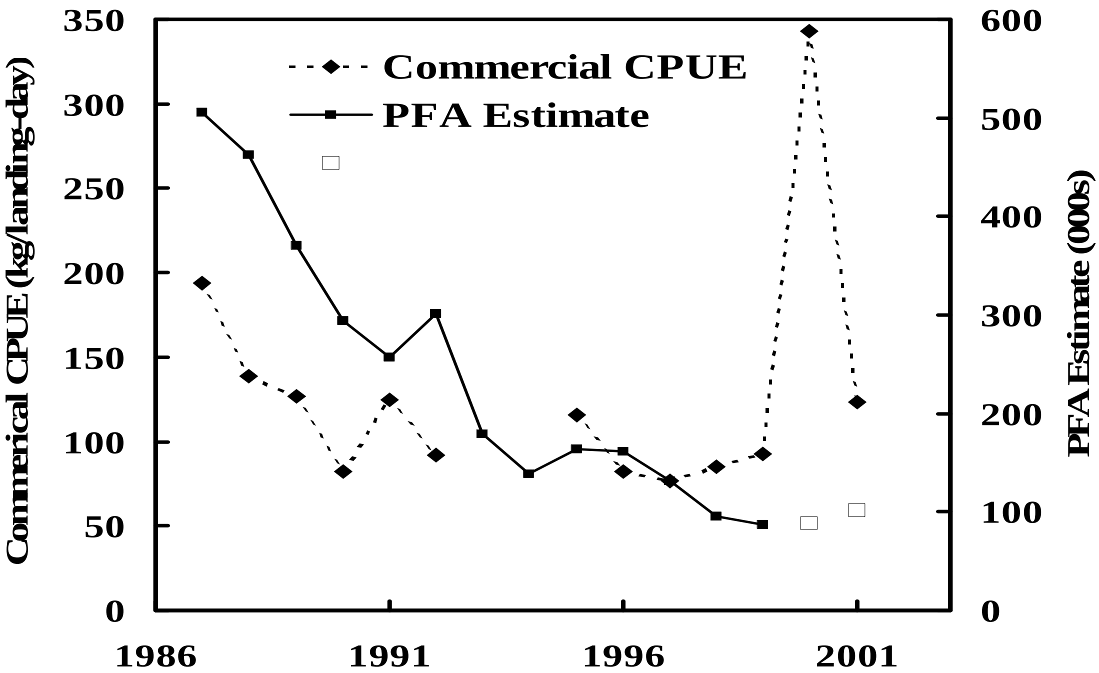


Figure 5.1.2.6. Distribution of landings (kg) of Atlantic salmon from individual commercial trips in the West Greenland fishery from 1997 to 2001.

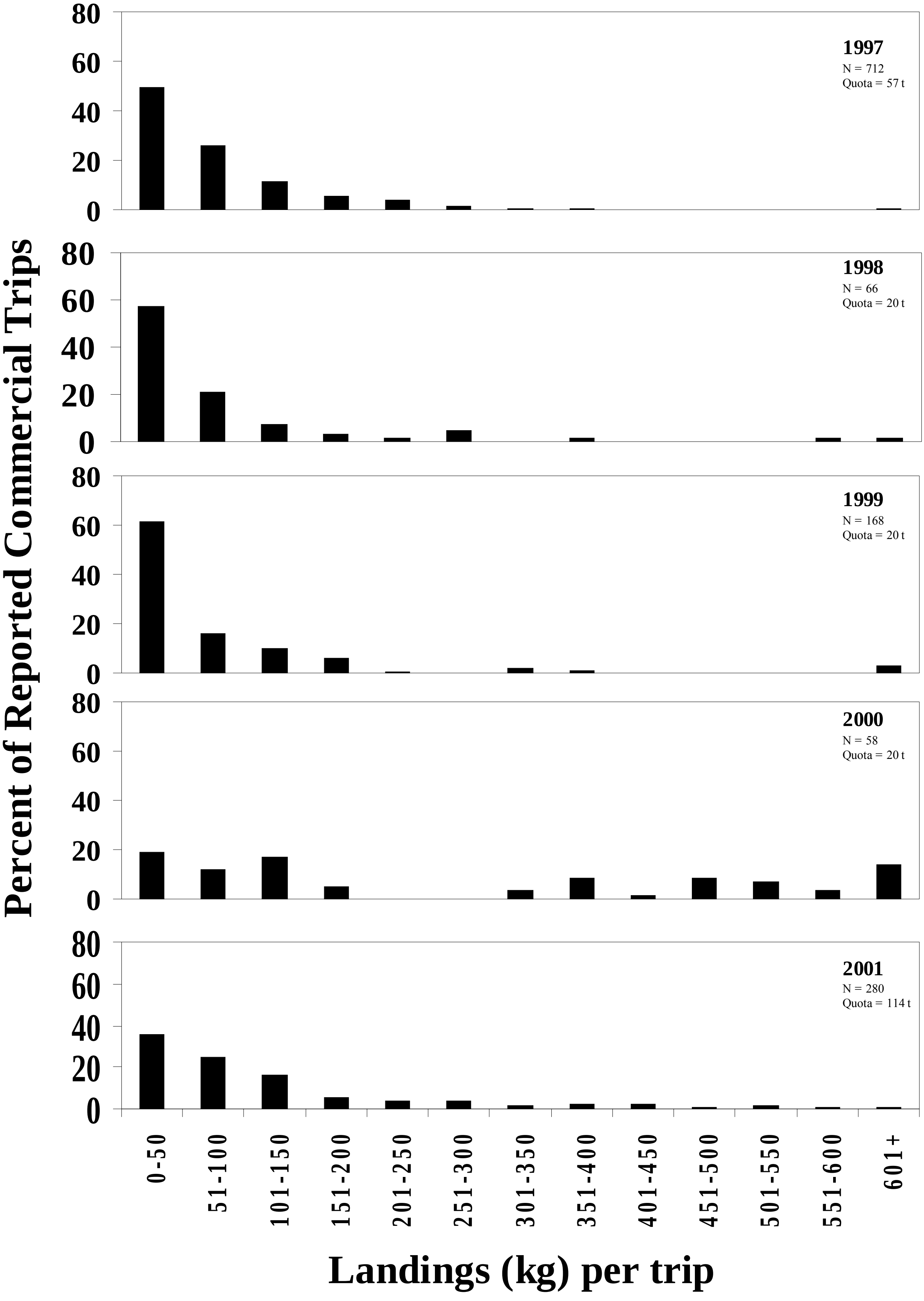
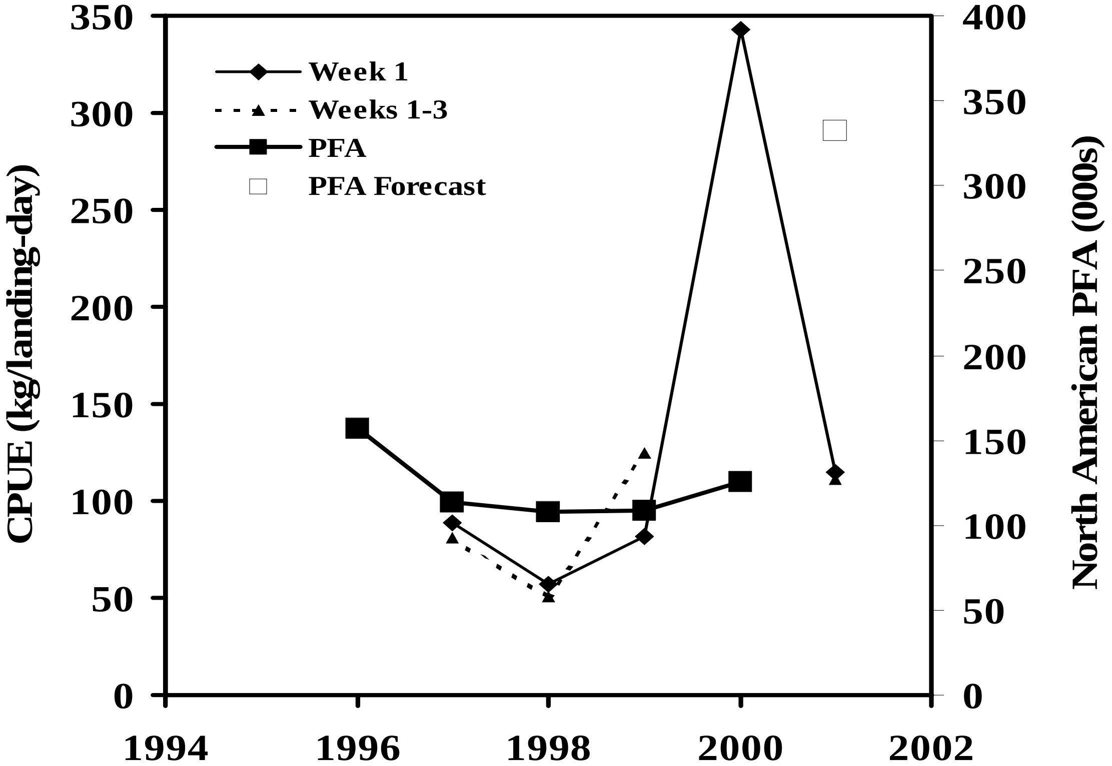


Figure 5.1.2.7. Relationship of CPUE indices used in decision points in the 2001 ad hoc management system and pre-fishery abundance estimates for the non-maturing 1SW component of the North American (top panel) and Southern European (bottom panel) salmon stock complexes.



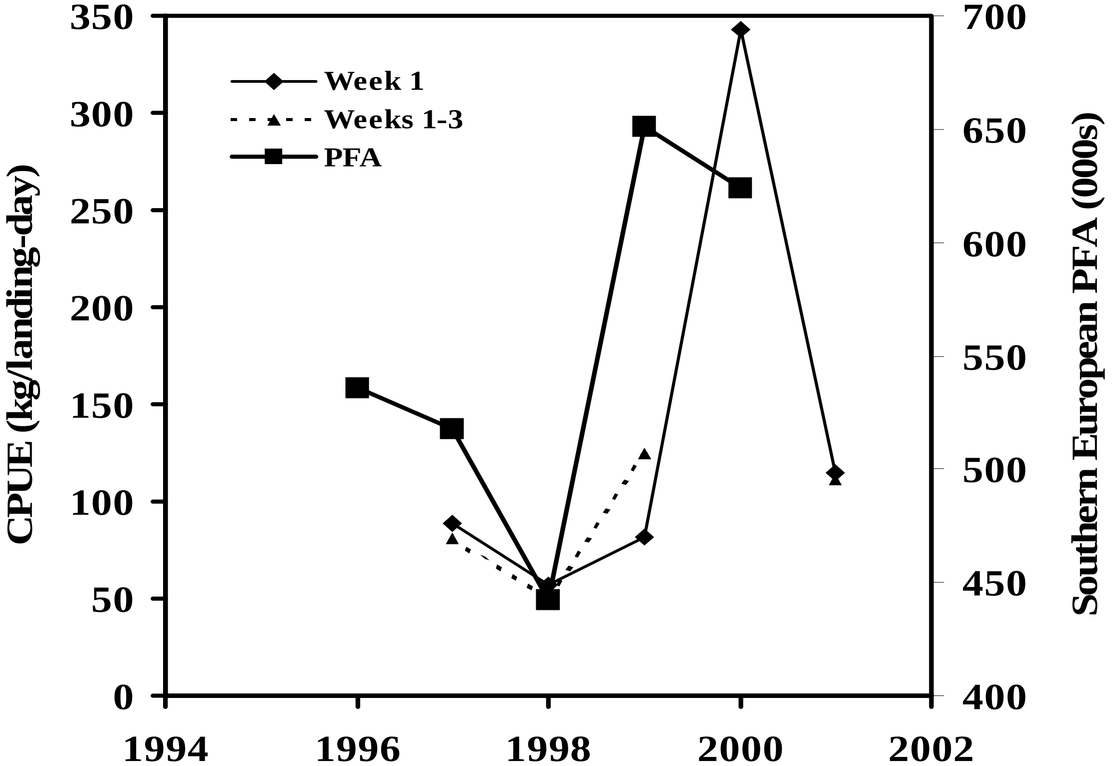
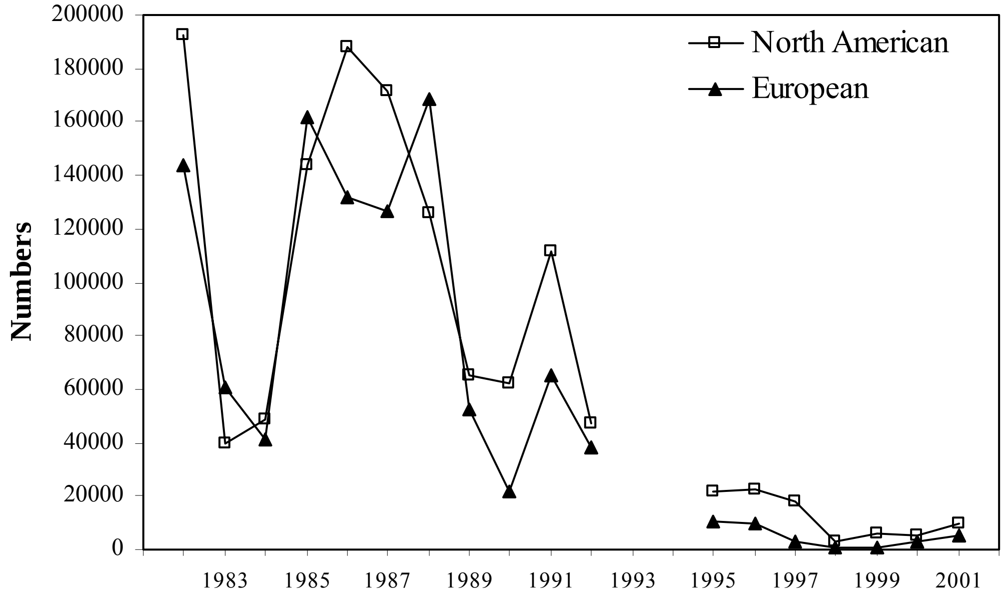


Figure 5.1.3.1. Numbers of North American and European Atlantic salmon caught at West Greenland 1982-1992 and 1995-2001.



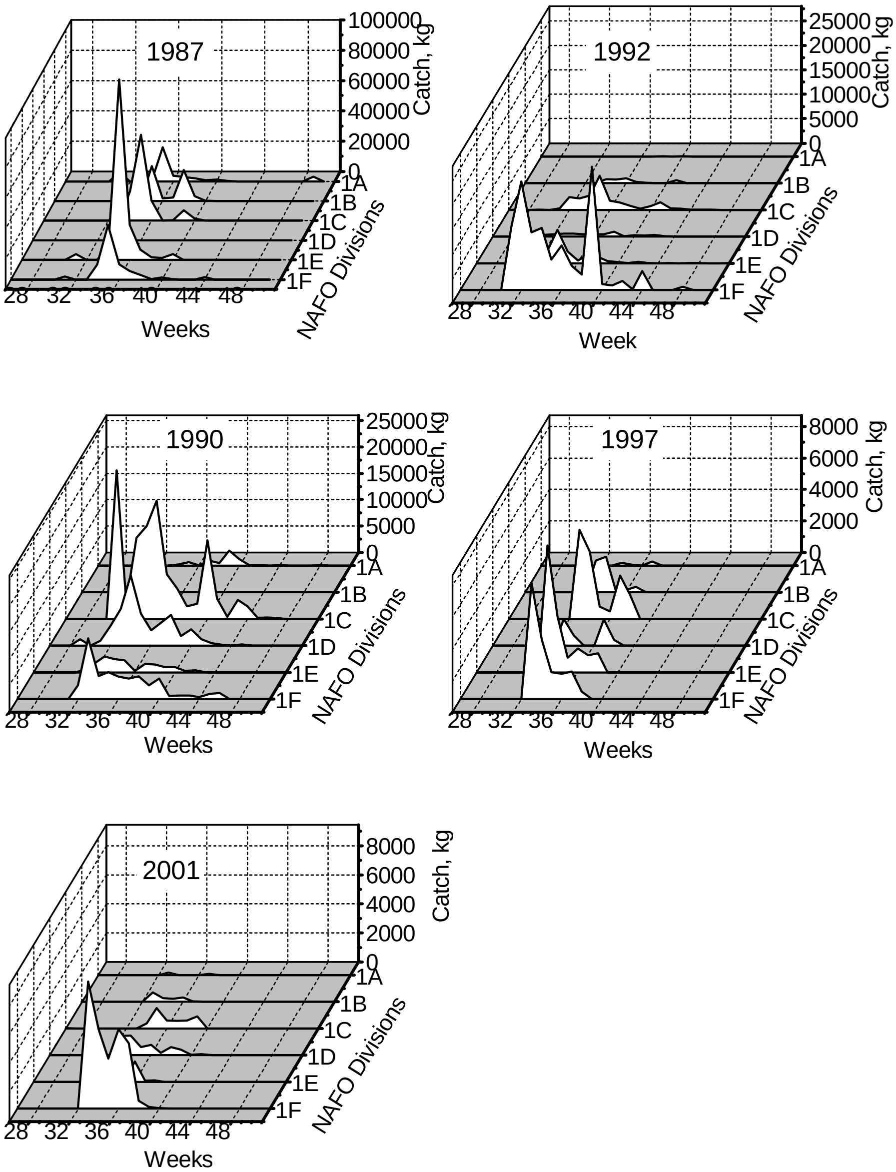


Fig. 5.3.1. The distribution of landings at Greenland for NAFO Divisions, weeks for the years 1987, 1990, 1992, 1997, and 2001.

Fig. 5.3.2. The proportion of North American salmon for NAFO Divisions.

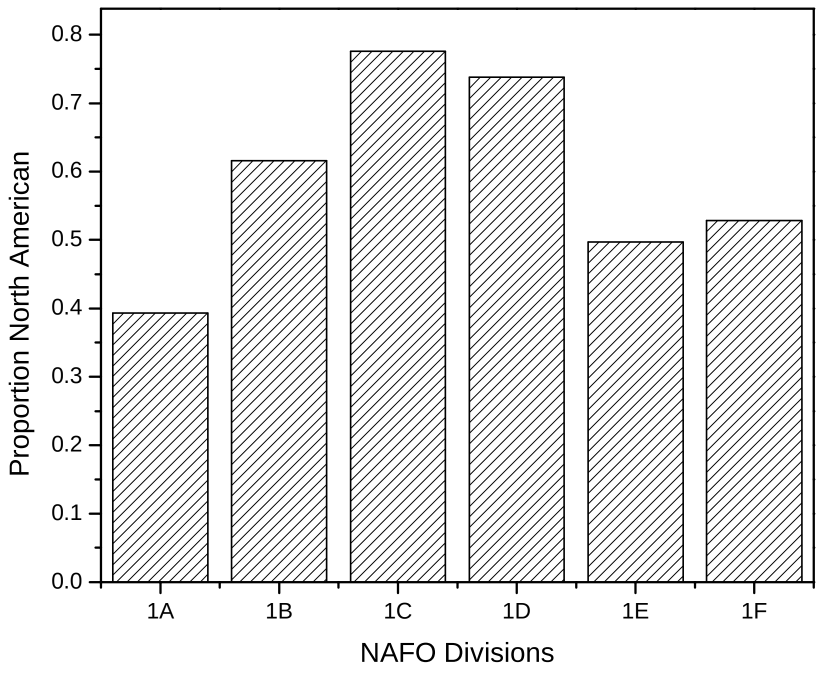


Fig. 5.3.3. The proportion of North American salmon for years, 1987-1999.

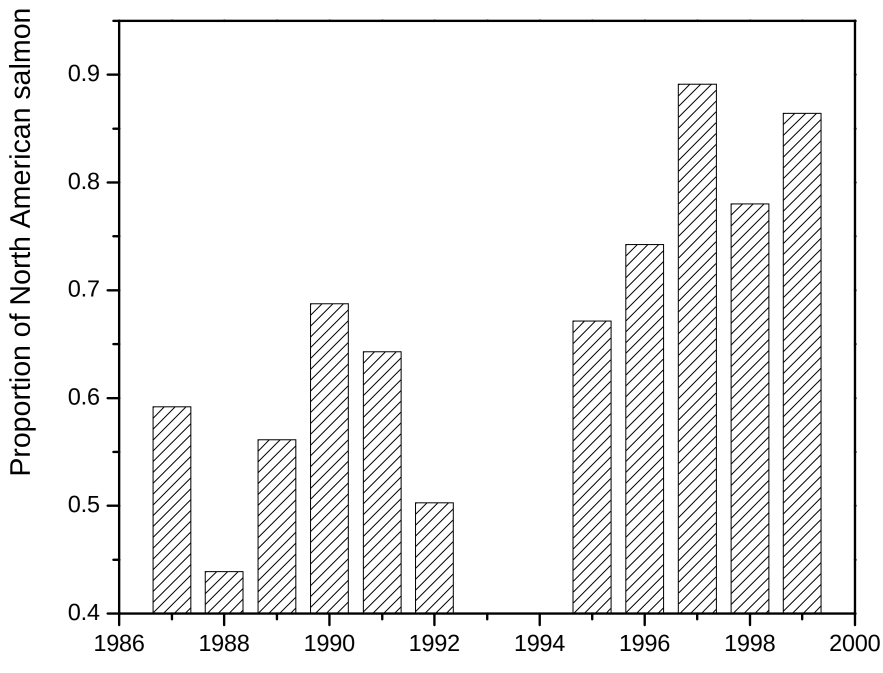
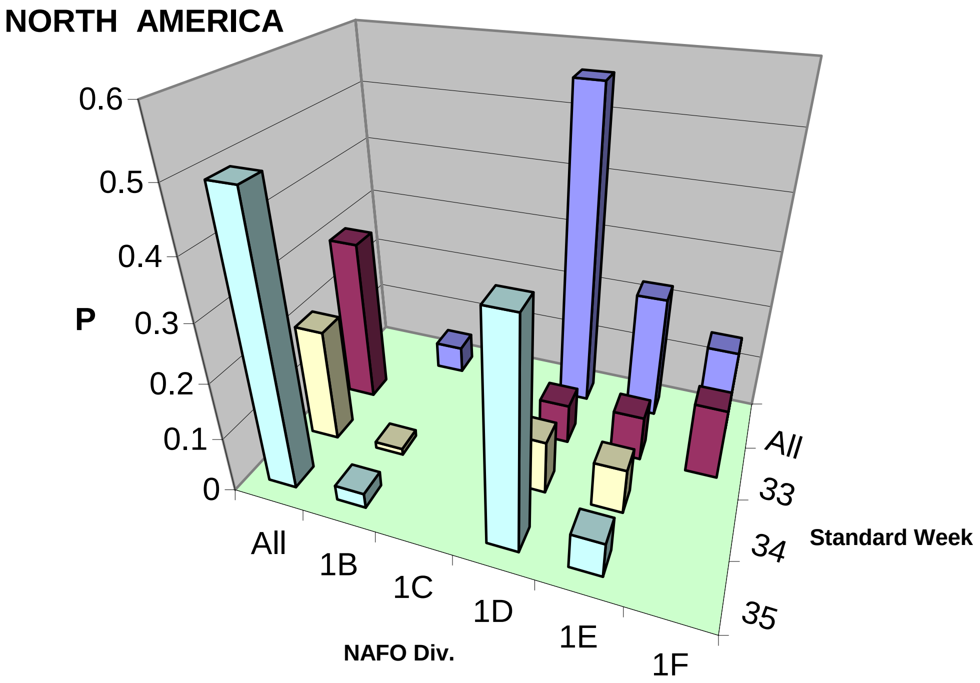


Figure 5.3.4 Probability of capture among standard weeks 33 through 35 and NAFO divisions 1B, 1C, 1D, 1E, 1F for fish originating from Europe and North America. Within each graph, the probabilities for rows closest to the walls (All) and within the 3 (week) x 5 (division) space each equal 1. No proportions are presented for under sampled cells. The two ALL rows collapse probabilities over standard week and NAFO division.



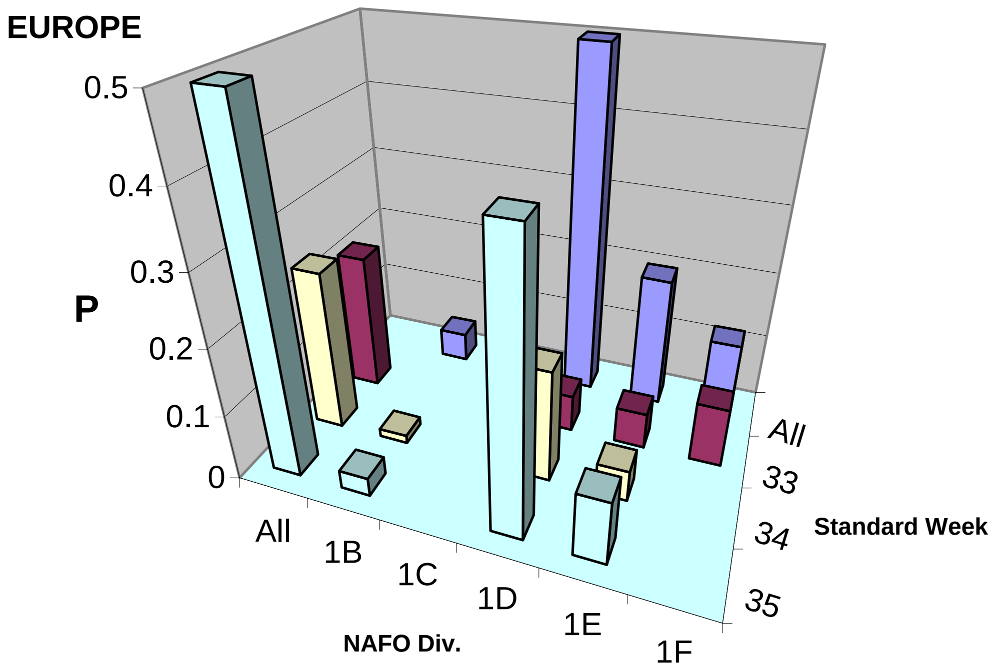


Figure 5.4.1. Extant exploitation of the non-maturing component of North American salmon as 1SW salmon in North America and Greenland from the run-reconstruction statistics.

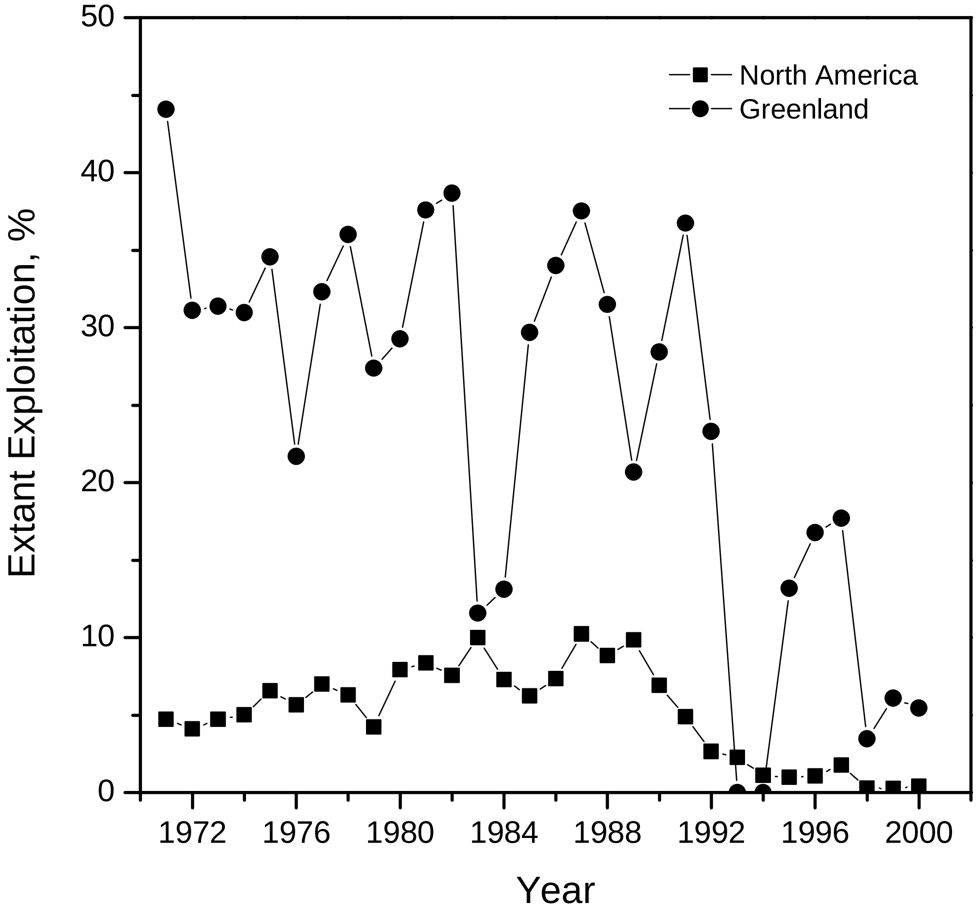


Fig. 5.6.1.1. Thermal habitat index for February (H2) and lagged spawners (SLNQ).

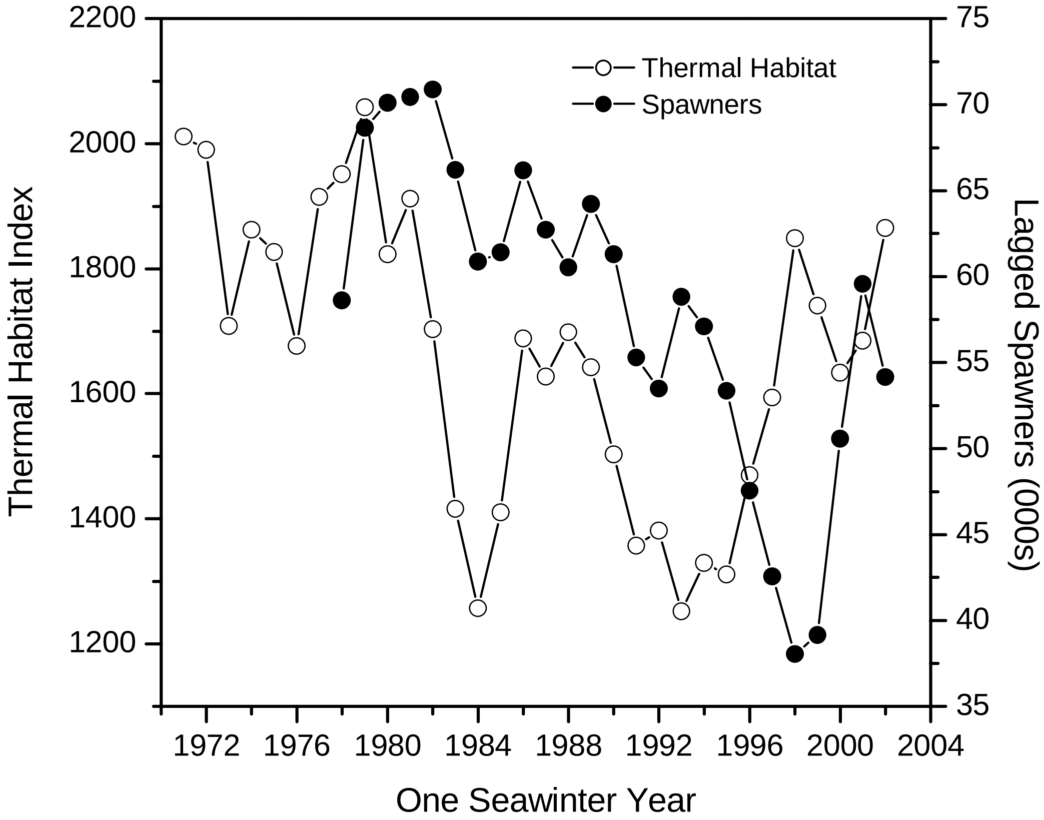


Figure 5.6.2.1. Observed estimates, jackknifed historical predictions, and deterministic forecasts (upper Panel A) of pre-fishery abundance from the multiplicative model. The residual pattern from the jackknifed predictions is shown in the lower panel (Panel B).

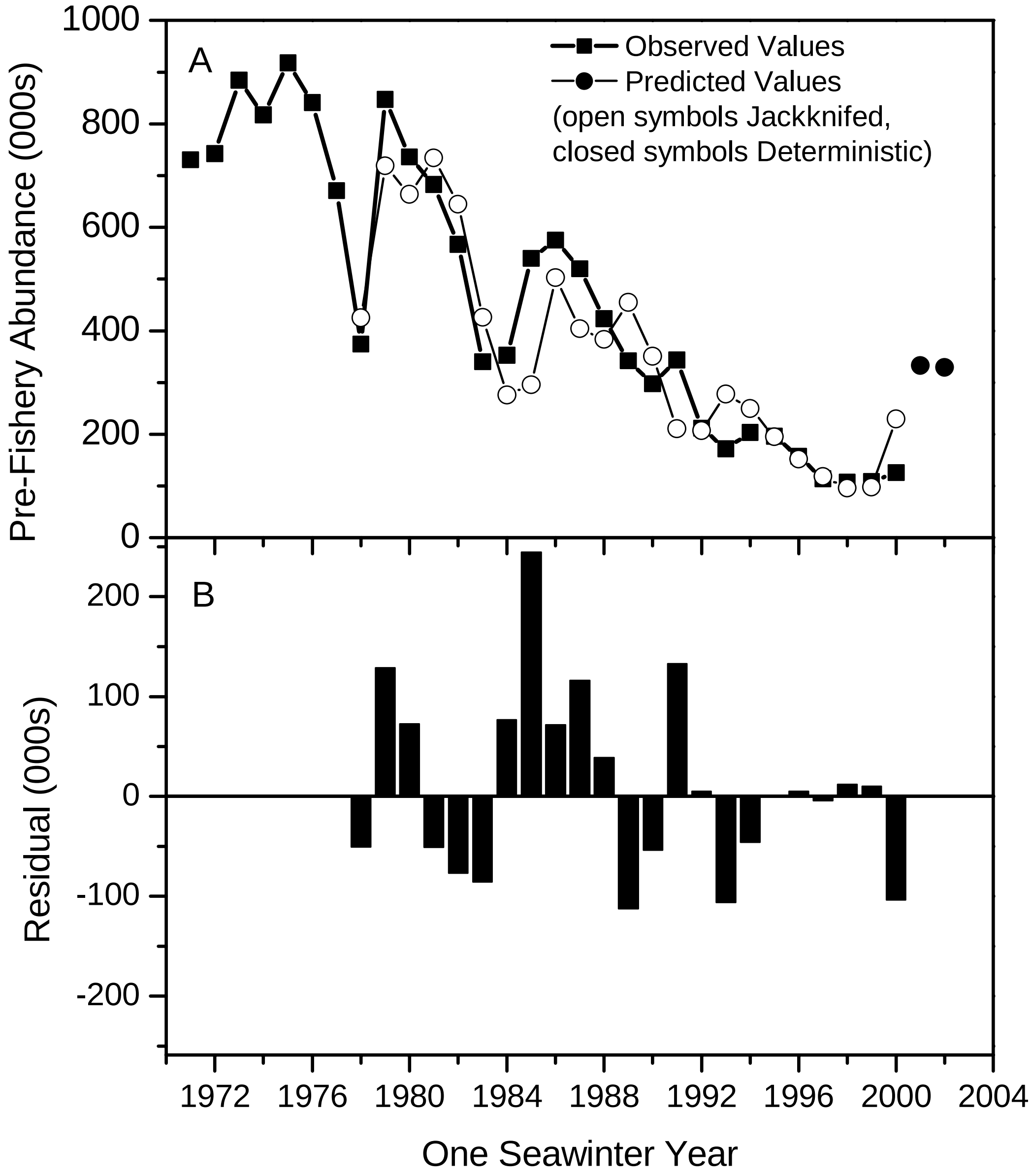


Figure 5.6.4.1. Average returns of 2SW salmon to six regions of North America, expressed as the proportion of total returns to North America, during 1992 to 1997 compared to the 2SW requirements of each region as a proportion of the conservation requirement for North America.

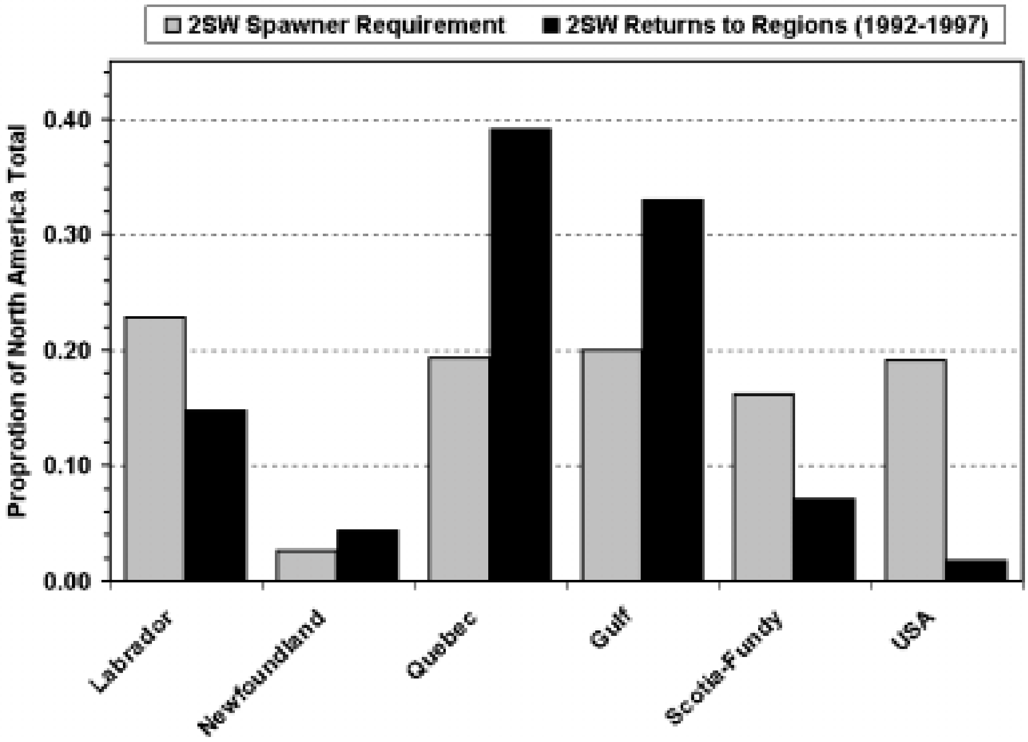


Figure 5.6.4.2. Exact posterior predicted probability distributions of the PFA in year 2002 based on the multiplicative model with errors in the PFA and SNLQ variables. The distributions were generated from 10,000 Monte Carlo simulations.

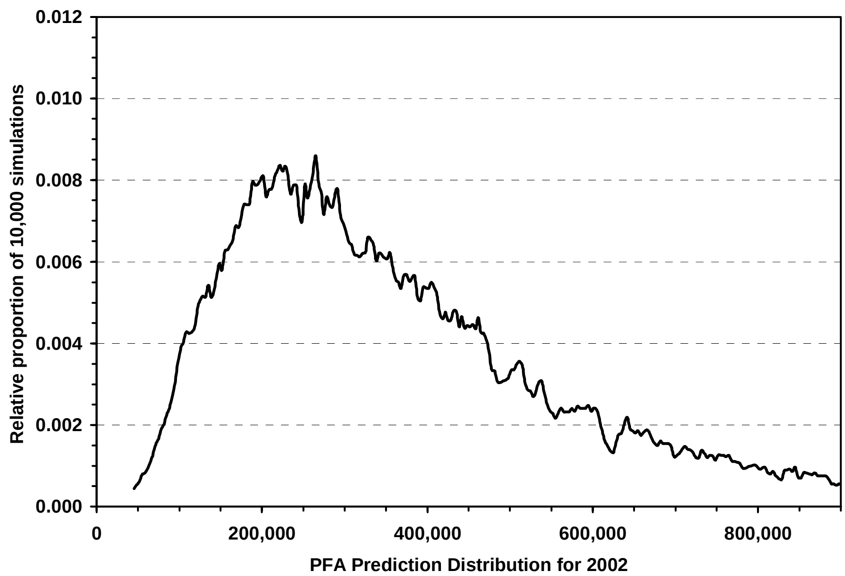


Figure 5.6.4.3. Probability profiles for the management objectives of achieving the 2SW conservation limits simultaneously in the four northern areas of North America (Labrador, Newfoundland, Quebec, Gulf – horizontal axis) and achieving the stock rebuilding objectives for the southern regions of Scotia-Fundy and USA (vertical axis) relative to quota options for West Greenland assuming a 40:60 allocation of the harvest. The symbols represent individual quota (t) options for the West Greenland fishery.

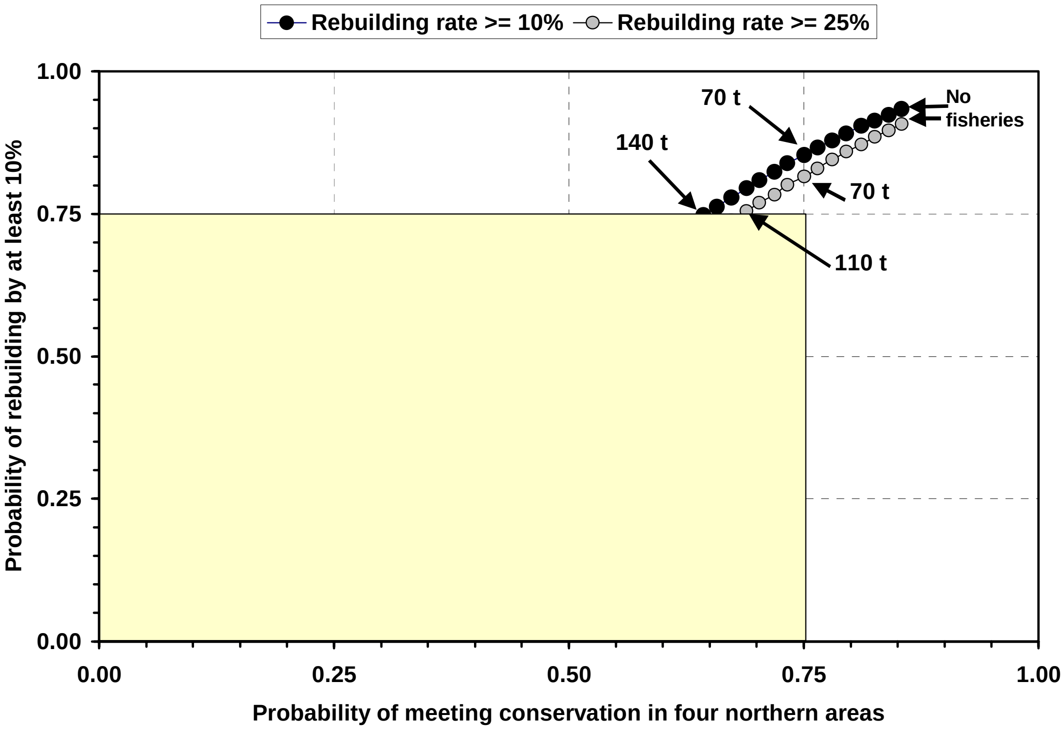


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Figure 5.8.1. Pre-fishery abundance estimates and juvenile abundance index from North America.

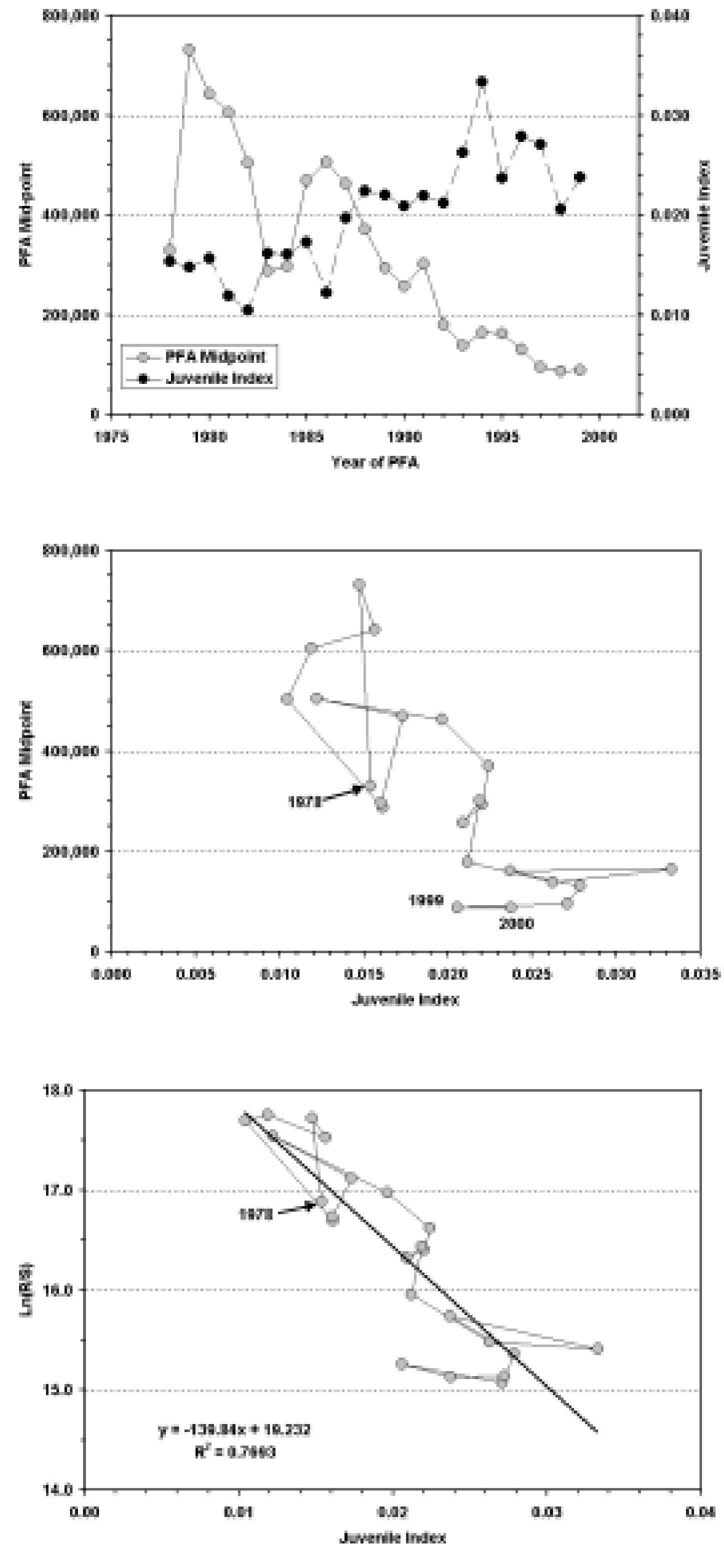
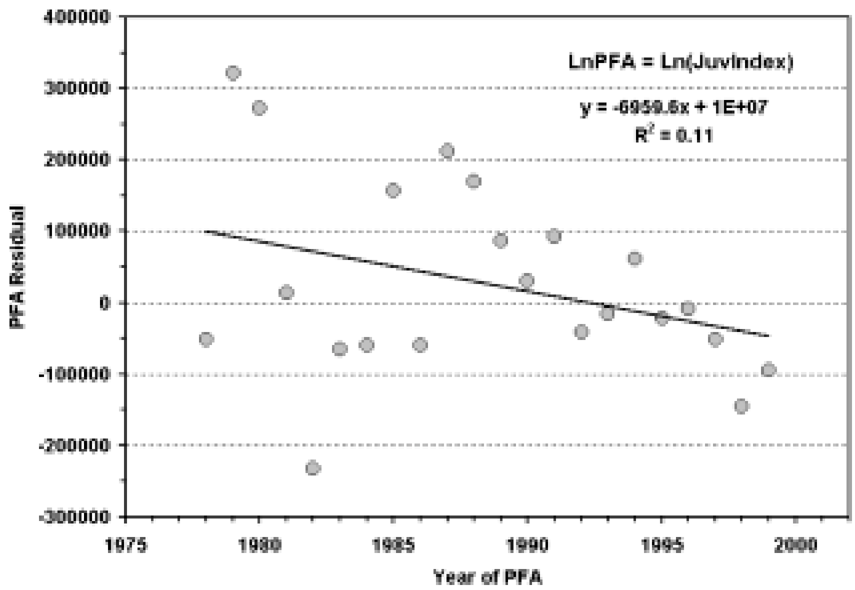


Figure 5.8.2. Temporal pattern in resdiuals of PFA predicted values based on juvenile index models.



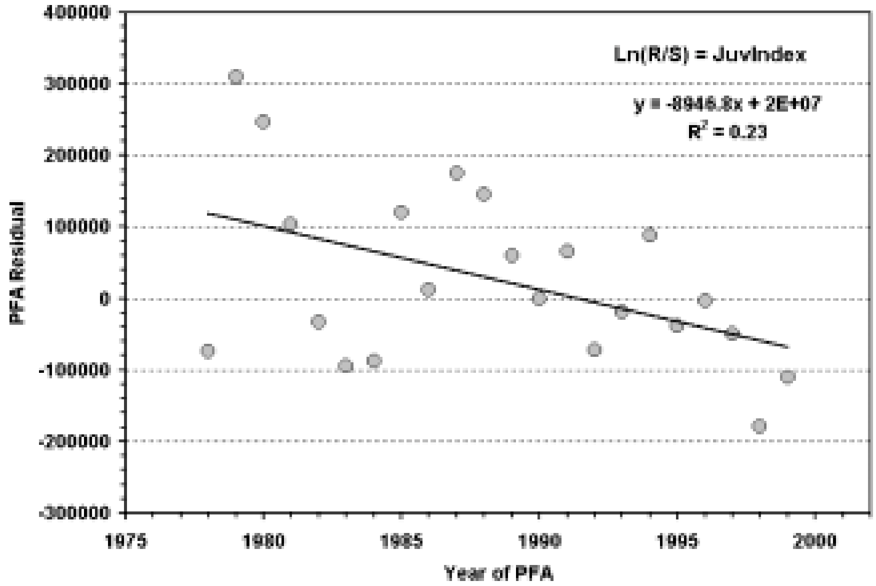
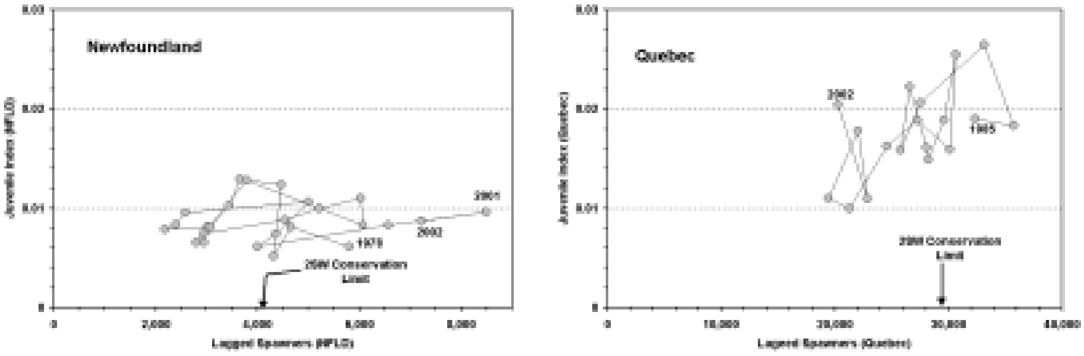
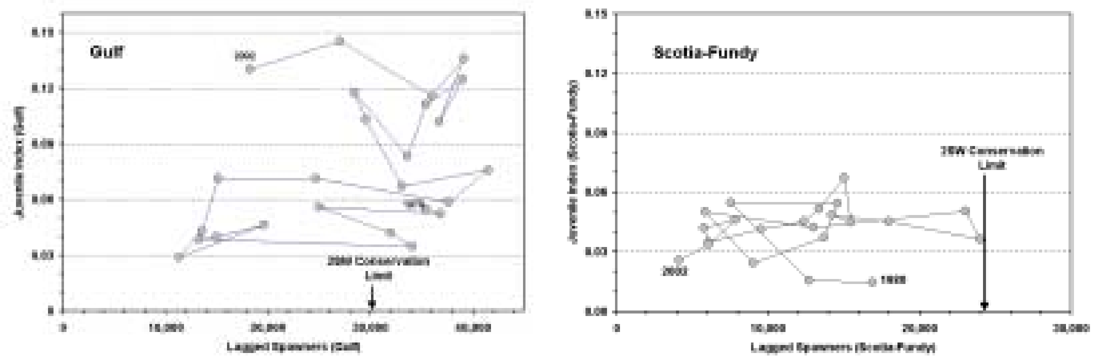


Figure 5.8.3. Association between lagged spawners and juvenile index lagged to the year of PFA abundance for four regions of North America. The year label in the figures refers to the year of PFA.

Smolt Derived Indices



Juvenile (Parr) Derived Indices



6 RECOMMENDATIONS

6.1 General recommendations

The Working Group recommends that it should meet in 2003 to address questions posed by ACFM, including those posed by NASCO. No invitation to host the meeting was proposed to the Working Group. Therefore, the Working Group should convene from 31 March to 10 April 2003, both days included, in Copenhagen, Denmark. It is strongly recommended by the Working Group that this period is adhered to in order to provide sufficient time to adequately review and complete the report.

6.2 Data deficiencies and research needs

Recommendations from Section 2- Atlantic salmon in the North Atlantic Area:

1. Given the importance of M in the provision of catch advice and in the understanding of the dynamics of Atlantic salmon in the ocean, further data sets (broadest range of stocks and for the greatest number of years possible) be subjected to the inverse-weight and maturity schedule methods. (Sections 2.3.1 & 2.3.2).

2. Study on size-selective mortality based on smolt size indices and survivors covering additional rivers and more years should be undertaken which may lead to additional insights into temporal variability of M and population dynamics (Sections 2.3.1, 2.3.2, & 2.4.3).

3. Further modeling and analyses are required to evaluate the consequences of allowing stocks to fall below S_{lim} or S_{pa} in order to improve the advice to managers (Section 2.5).

Recommendations from Section 3- Fisheries and Stocks from the North East Atlantic Commission Area:

1. To improve the input of environmental variables in the predictive models, research on temporal and spatial distribution on salmon post-smolt of different origin in the ocean should be continued and expanded. Two approaches are recommended: (a) A coordinated tagging program of salmon smolts throughout the distribution range followed by intensive sampling in local and distant waters, (b) tagging smolts with Data Storage Tags.

2. To improve the estimates of by-catch of post-smolts in the mackerel fishery, a continuing effort to develop and expand the surveys in the actual areas is required. Furthermore, the commercial catches of mackerel in the Norwegian Sea (ICES Divisions IIa and Vb), Northern North Sea (IVa), and west of Ireland and Scotland (VIa,b; VIIb,c,j,k) should be provided by ICES Divisions and per standard week during the period May-August (week 18-33) (Section 3.7).

3. Research on post-smolts in the early marine phase should be continued and expanded. This should include studies on interactions with parasites and assessments of the impact of sea lice on post-smolts.

4. Further progress should be made in establishing PFA methodologies (Section 3.5.3).

5. A study group should be formed to develop alternative models and management systems for providing management advice for homewater fisheries.

Recommendations from Section 4- Fisheries and Stocks from the North American Commission Area:

1. Estimates of total returns to Labrador no longer exist. There is a critical need to develop alternate methods to derive estimates of salmon returns and develop habitat-based spawner requirements in Labrador, and to monitor salmon returns in the Ungava regions of Québec (Sections 4.2.2; 4.2.4).

2. There is a need to investigate changes in the biological characteristics (mean weight, sex ratio, sea-age composition) of returns to rivers, spawning stocks of Canadian and US rivers, and the harvest in food fisheries in Labrador. These data and new information on measures of habitat and stock recruitment are necessary to re-evaluate existing estimates of spawner requirements in Canada and USA and for use in the run reconstruction model (Sections 4.2.2; 4.2.3; 4.4).

3. There is a requirement for additional smolt-to-adult survival rates for wild salmon. As well, sea survival rates of wild salmon from rivers stocked with hatchery smolts should be examined to determine if hatchery return rates can be used as an index of sea survival of wild salmon elsewhere (Section 4.2.5).

4. Further basic research is needed on the spatial and temporal distribution of salmon and their predators at sea to assist in explaining variability in survival rates (Sections 4.2.3; 4.2.5).

5. Return estimates for the few rivers (Annapolis, Cornwallis and Gaspareau) in SFA 22 that contribute to distant fisheries should be developed and when these are available, the SFA 22 spawning requirements for these rivers (476 fish) should be included in the total (Section 4.4).

6. A consistent approach to estimating returns is needed for instances in which offspring from broodstock are stocked back into the management area from which their parents originated (Section 4.1.3).

7. Scale analysis of salmon captured at West Greenland indicated an infrequent appearance of escaped-farmed salmon. To substantiate this conclusion, farmed salmon need to be genetically characterized and included as baseline populations in continent-of-origin analysis of samples collected from West Greenland.

8. The risk associated with being under or over S_{lim} needs to be determined.

9. The Working Group recommends that an ad Hoc modeling group be formed and that prior to the next WG meeting, the ad Hoc group develops a new model(s) for estimation of pre-fishery abundance.

<u>Recommendations from Section 5- Atlantic Salmon in the West Greenland Commission Area:</u>

1. Continued efforts should be made to improve the estimates of the annual catches of salmon taken for private sales and local consumption in Greenland.

2. The mean weights, sea and freshwater ages, and continent-of-origin are essential parameters to provide catch advice for the West Greenland fishery. The Working Group recommends that the sampling program be continued and closely coordinated with fishery harvest plan to be executed annually in West Greenland.

3. Scale analysis of salmon captured at West Greenland indicated an infrequent appearance of escaped-farm salmon. To investigation this observation, farmed salmon need to be genetically characterized and included as baseline populations in continent-of-origin analyses of samples collected at West Greenland.

4. Continue testing for ISAv and other diseases in Atlantic salmon caught in West Greenland.

5. Development of more refined data characterizing fishing effort (e.g., vessel size, gear type, amount of gear deployed, soak time) would allow for detailed analyses of CPUE data to characterize availability of Atlantic salmon in West Greenland.

6. Development of alternative in-season measures of abundance such as relationships between 1SW returns to rivers from the same cohort should be investigated as a future source of confirmatory information of abundance.

7. The catch options for the West Greenland fishery are based almost entirely upon data taken 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 emphasized the need for information from these stocks to be incorporated into the modelling and abundance forecasts as soon as possible.

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

9. Other indices of change, i.e. changes in age composition, size at age, and sea survival, should also be included in this evaluation.

10. An ICES Study Group is needed to allow for a focused effort to investigate alternative models and management systems for providing scientific catch advice for mixed stock and homewater fisheries.

APPENDIX 1

WORKING DOCUMENTS SUBMITTED TO THE WORKING GROUP
ON NORTH ATLANTIC SALMON, 2002

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APPENDIX 3

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APPENDIX 4

Example of 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 | Years78-01 ! R4C1:R28C14';
OPTIONS NOCENTER LINESIZE = 80;
*... DATA FOR CATCH ADVICE FOR 2002 FROM RISKVAR02.XLS ;
*<><><><><  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;
LN_NN1_M=LOG(NN1_M);
LN_GUS=LOG(GUS_M);
PROC PRINT;
PROC REG;
MODEL LN_NN1_M = H2 LN_GUS/P R;
•   <<<  In 2001, we changed to risk model with varying spawner and PFA inputs >>>;
•   * <<<  also switched to multiplicative model for logged PFA and spawners  >>>;
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 = LOG((((RAN_R2/0.970446) + RAN_C2)/0.740818) + 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 LN_GUS/ P R;
 output out=predic p=pran_pfa stdi=stdi_pfa;
*<><><><><  REMEMBER TO CHANGE THE YEAR BELOW  <><><><><><>;
data univ;
  set predic;
  if year=2002;
  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 5

Appendix 5(i). Estimated numbers of 1SW salmon recruits, returns and spawners for Labrador.

	Commercial catches of small salmon			Grilse Recruits		Grilse to rivers		Labrador grilse spawners Angling catch subtracted	
Year	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
*1969	10774	21627	6321	48912	122280	18587	65053	15476	61942
*1970	14666	29441	8605	66584	166459	25302	88556	21289	84543
*1971	19109	38359	11212	86754	216884	32966	115382	29032	111448
*1972	14303	28711	8392	64934	162335	24675	86362	21728	83415
*1973	3130	6282	1836	14208	35520	5399	18897	0	11405
1974	9848	37145	9328	71142	177856	27034	94619	24533	92118
1975	34937	57560	19294	141210	353024	53660	187809	49688	183837
1976	17589	47468	13152	98790	246976	37540	131391	31814	125665
1977	17796	40539	11267	87918	219796	33409	116931	28815	112337
1978	17095	12535	4026	42513	106282	16155	56542	13464	53851
1979	9712	28808	7194	57744	144360	21943	76800	17825	72682
1980	22501	72485	8493	130710	326776	49670	173845	45870	170045
1981	21596	86426	6658	144859	362147	55046	192662	49855	187471
1982	18478	53592	7379	100357	250892	38136	133474	34032	129370
1983	15964	30185	3292	62452	156129	23732	83061	19360	78689
1984	11474	11695	2421	32324	80811	12283	42991	9348	40056
1985	15400	24499	7460	59822	149555	22732	79563	19631	76462
1986	17779	45321	8296	90184	225461	34270	119945	30806	116481
1987	13714	64351	11389	112995	282486	42938	150283	37572	144917
1988	19641	56381	7087	104980	262449	39892	139623	34369	134100
1989	13233	34200	9053	71351	178377	27113	94896	22429	90212
1990	8736	20699	3592	41718	104296	15853	55485	12544	52176
1991	1410	20055	5303	33812	84531	12849	44970	10526	42647
1992	9588	13336	1325	29632	79554	17993	62094	15229	59331
1993	3893	12037	1144	33382	93231	25186	80938	22499	78251
1994	3303	4535	802	22306	63109	18159	56888	15228	53958
1995	3202	4561	217	28852	82199	25022	76453	22144	73575
1996	1676	5308	865	55634	159204	51867	153553	48362	150048
1997	1728	8025		72138	162610	66812	155963	64049	153200

Estimates are based on:

EST SMALL RETURNS - (COMM CATCH*PROP LAB ORIGIN)/EXP RATE, PROP SFAs1,2&14B=.6-.8, SFA 1:0.36-0.42&SFA 2:0.75-0.85(97)
EXP RATE-SFAs1,2&14B=.3-.5(69-91),.22-.39(92),.13-.25(93),
- .10-.19(94),.07-.13(95),.04-.07(96), SFA 1:0.07-0.14&SFA 2:0.04-0.07 (97)
EST GRILSE RETURNS CORRECTED FOR NON-MATURING 1SW - (SMALL RET*PROP GRILSE), PROP GRILSE SFAs1,2&14B=0.8-0.9
EST RET TO FRESHWATER - (EST GRILSE RET-GRILSE CATCHES)
EST GRILSE SPAWNERS = EST GRILSE RETURNS TO FRESHWATER - GRILSE ANGLING CATCHES
*Catches for 1969-73 are Labrador totals distributed into SFAs as the proportion of landings by SFA in 1974-78.
Furthermore small catches in 1973 were adjusted by ratio of large:small in 1972&74 (SFA 1-1.4591, SFA 2-2.2225, SFA 14B-1.5506).

Appendix 5(ii). Estimated numbers of 2SW salmon recruits, returns and spawners for Labrador salmon stocks including west Greenland.

Year	Commercial catches of large salmon SFA 1	SFA 2	SFA 14B	Labrador 2SW Recruits, SFAs 1,2 &14B Min	Max	NF & Greenland Labrador at Greenland	Labrador salmon Total+NF+WG Min	Max	Labrador 2SW to rivers SFAs 1,2 &14B Min	Max	Labrador 2SW spawners SFAs 1,2 &14B Angling catch subtracted Min	Max
*1969	18929	48822	10300	32483	69198	34280	80636	133032	3248	20760	2890	20287
*1970	17633	45479	9595	30258	68490	56379	99561	154121	3026	20547	2676	20085
*1971	25127	64806	13673	43117	97596	24299	85831	163577	4312	29279	4012	28882
*1972	21599	55708	11753	37064	83895	59203	112096	178927	3706	25168	3435	24812
*1973	30204	77902	16436	51830	117319	22348	96314	189771	5183	35196	4565	34376
1974	13866	93036	15863	50030	113827	38035	109433	200476	5003	34148	4490	33475
1975	28601	71168	14752	47715	107974	40919	109012	195006	4772	32392	4564	32119
1976	38555	77796	15189	55186	124671	67730	146485	245646	5519	37401	4984	36701
1977	28158	70158	18664	48669	110171	28482	97937	185706	4867	33051	4042	31969
1978	30824	48934	11715	38644	87155	32668	87816	157045	3864	26147	3361	25490
1979	21291	27073	3874	22315	50194	18636	50481	90267	2231	15058	1823	14528
1980	28750	87067	9138	51899	117530	21426	95490	189152	5190	35259	4633	34525
1981	36147	68581	7606	47343	106836	32768	100331	185233	4734	32051	4403	31615
1982	24192	53085	5966	34910	78873	43678	93497	156236	3491	23662	3081	23127
1983	19403	33320	7489	25378	57268	30804	67021	112531	2538	17181	2267	16824
1984	11726	25258	6218	18063	40839	4026	29802	62306	1806	12252	1478	11822
1985	13252	16789	3954	14481	32596	3977	24644	50494	1448	9779	1258	9530
1986	19152	34071	5342	24703	55734	17738	52991	97275	2470	16720	2177	16334
1987	18257	49799	11114	32885	74471	29695	76625	135970	3289	22341	2895	21821
1988	12621	32386	4591	20681	46789	27842	57355	94614	2068	14037	1625	13452
1989	16261	26836	4646	20181	45509	26728	55528	91673	2018	13653	1727	13270
1990	7313	17316	2858	11482	25967	9771	26158	46828	1148	7790	923	7493
1991	1369	7679	4417	5477	12467	7779	15596	25571	548	3740	491	3665
1992	9981	19608	2752	14756	37045	13713	28469	50758	2515	15548	2012	14889
1993	3825	9651	3620	10242	29482	6592	16834	36074	3858	18234	3624	17922
1994	3464	11056	857	11396	34514	0	11396	34514	5653	24396	5339	23981
1995	2150	8714	312	16520	51530	0	16520	51530	12368	44205	12006	43726
1996	1375	5479	418	11814	37523	4312	16126	41835	9113	32759	8838	32395
1997	1393	5550		13167	28647	3806	16973	32453	9384	23833	9221	23646

Estimates are based on:

EST LARGE RETURNS - (COMM CATCH*PROP LAB ORIGIN)/EXP RATE, PROP SFAs1,2&14B=.6-.8,SFA 1: 0.64-0.72 & SFA 2 0.88-0.95 (97);

EXP RATE-SFAs1,2&14B=.7-.9(69-91),.58-.83(92),.38-.62(93),.29-.50(94), .15-.26(95), .13-.23(96),

- SFA 1: 0.22-0.40, SFA 2: 0.16-0.28 (97)

EST 2SW RETURNS - (EST LARGE RETURNS*PROP 2SW), PROP 2SW SFA 1=.7-.9,SFAs 2&14B=.6-.8

WG - are North American 1SW salmon of river age 4 and older of which 70% are Labrador origin

EST RET TO FRESHWATER - (EST 2SW RET-2SW CATCHES)

EST 2SW SPAWNERS = EST 2SW RETURNS TO FRESHWATER - 2SW ANGLING CATCHES

*Catches for 1969-73 are Labrador totals distributed into SFAs as the proportion of landings by SFA in 1974-78.

Appendix 5(iii). Atlantic salmon returns to freshwater, total recruits prior to the commercial fishery and spawners summed for Salmon Fishing Area 3-14A, insular Newfoundland, 1969-2001.
Ret. = retained fish; Rel. = released fish.

	Small catch	Small returns to river		Small recruits		Small spawners		Large returns to river		Large recruits		Large catch	Large spawners		2SW returns to river		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	34,944	109,580	219,669	219,160	732,230	74,636	184,725	10,634	25,631	35,446	256,307	2,310	8,324	23,321	2,193	8,995	1,383	7,760	7,311	89,953
1970	30,437	140,194	281,466	280,388	938,221	109,757	251,030	12,731	29,313	42,435	293,127	2,138	10,593	27,175	3,135	11,517	2,359	10,340	10,450	115,168
1971	26,666	112,644	226,129	225,288	753,763	85,978	199,463	9,999	23,221	33,330	232,208	1,602	8,397	21,619	2,388	8,923	1,817	8,055	7,959	89,230
1972	24,402	109,282	219,412	218,564	731,374	84,880	195,010	10,368	23,434	34,560	234,343	1,380	8,988	22,054	2,511	9,003	2,008	8,240	8,371	90,031
1973	35,482	144,267	289,447	288,534	964,822	108,785	253,965	13,489	31,645	44,964	316,451	1,923	11,566	29,722	2,995	11,527	2,283	10,449	9,985	115,268
1974	26,485	85,216	170,748	170,431	569,159	58,731	144,263	10,541	21,113	35,137	211,133	1,213	9,328	19,900	1,940	6,596	1,510	5,942	6,465	65,964
1975	33,390	112,272	225,165	224,544	750,550	78,882	191,775	11,605	23,260	38,682	232,596	1,241	10,364	22,019	2,305	7,725	1,888	7,086	7,684	77,247
1976	34,463	115,034	230,595	230,068	768,650	80,571	196,132	10,863	21,768	36,211	217,677	1,051	9,812	20,717	2,334	7,698	2,011	7,198	7,781	76,982
1977	34,352	110,114	220,501	220,229	735,004	75,762	186,149	9,795	19,624	32,650	196,237	2,755	7,040	16,869	1,845	6,247	1,114	5,088	6,151	62,470
1978	28,619	97,375	195,048	194,751	650,159	68,756	166,429	7,892	15,841	26,307	158,411	1,563	6,329	14,278	1,991	6,396	1,557	5,712	6,637	63,959
1979	31,169	107,402	215,160	214,803	717,199	76,233	183,991	5,469	10,962	18,230	109,619	561	4,908	10,401	1,088	3,644	980	3,463	3,625	36,437
1980	35,849	121,038	242,499	242,076	808,330	85,189	206,650	9,400	18,866	31,335	188,656	1,922	7,478	16,944	2,432	7,778	1,888	6,925	8,108	77,784
1981	46,670	157,425	315,347	314,850	1,051,158	110,755	268,677	21,022	42,096	70,074	420,961	1,369	19,653	40,727	3,451	12,035	3,074	11,442	11,502	120,353
1982	41,871	141,247	283,002	282,494	943,342	99,376	241,131	9,060	18,174	30,198	181,736	1,248	7,812	16,926	2,914	9,012	2,579	8,481	9,714	90,117
1983	32,420	109,934	220,216	219,868	734,053	77,514	187,796	9,717	19,490	32,391	194,903	1,382	8,335	18,108	2,586	8,225	2,244	7,677	8,620	82,253
1984	39,331	130,836	262,061	261,673	873,537	91,505	222,730	8,115	16,268	27,052	162,684	511	7,604	15,757	2,233	7,060	2,063	6,800	7,445	70,602
1985	36,552	121,731	243,727	243,461	812,424	85,179	207,175	3,672	7,370	12,240	73,702	0	3,641	7,339	958	3,059	946	3,042	3,193	30,593
1986	37,496	125,329	251,033	250,657	836,778	87,833	213,537	7,052	14,140	23,505	141,400	0	6,972	14,060	1,606	5,245	1,575	5,198	5,353	52,445
1987	24,482	128,578	257,473	257,157	858,244	104,096	232,991	6,394	12,817	21,313	128,170	0	6,353	12,776	1,336	4,433	1,320	4,409	4,453	44,329
1988	39,841	133,237	266,895	266,474	889,652	93,396	227,054	6,572	13,183	21,908	131,832	0	6,512	13,123	1,563	5,068	1,540	5,033	5,211	50,681
1989	18,462	60,260	120,661	120,520	402,203	41,798	102,199	3,234	6,482	10,780	64,815	0	3,216	6,463	697	2,299	690	2,289	2,325	22,992
1990	29,967	99,543	199,416	199,086	664,721	69,576	169,449	5,939	11,909	19,798	119,093	0	5,889	11,859	1,347	4,401	1,327	4,372	4,489	44,011
1991	20,529	64,552	129,308	129,105	431,027	44,023	108,779	4,534	9,090	15,112	90,896	0	4,500	9,056	1,054	3,429	1,041	3,410	3,514	34,291
1992	23,118	118,778	237,811	118,778	237,811	95,096	214,129	16,705	33,463	16,705	33,463	0	16,564	33,322	3,111	10,554	3,057	10,474	3,111	10,554
1993	24,693	134,150	268,550	134,150	268,550	107,816	242,217	8,121	16,267	8,121	16,267	0	7,957	16,103	1,499	5,094	1,449	5,017	1,499	5,094
1994	28,959	95,981	192,138	95,981	192,138	66,185	162,342	8,089	16,216	8,089	16,216	0	7,884	16,010	1,902	6,174	1,840	6,077	1,902	6,174
1995	29,055	202,739	435,153	202,739	435,153	172,727	405,141	16,175	34,633	16,175	34,633	0	15,956	34,414	3,635	12,592	3,563	12,481	3,635	12,592
1996	36,715	257,215	559,079	257,215	559,079	218,639	520,504	21,957	46,706	21,957	46,706	0	21,693	46,442	4,457	14,159	4,372	14,028	4,457	14,159
1997	17,388	99,029	146,050	99,029	146,050	80,096	127,116	15,318	22,183	15,318	22,183	0	14,985	21,850	3,887	8,355	3,780	8,190	3,887	8,355
1998	19,672	146,371	247,035	146,371	247,035	124,551	225,216	23,032	36,266	23,032	36,266	0	22,672	35,906	5,322	12,453	5,222	12,295	5,322	12,453
1999	19,960	156,740	224,959	156,740	224,959	135,561	203,780	21,198	41,674	21,198	41,674	0	20,853	41,329	4,254	14,262	4,169	14,126	4,254	14,262
2000	20,486	151,313	260,251	151,313	260,251	127,209	235,410	16,735	55,085	16,735	55,085	0	16,202	54,552	3,176	16,144	2,873	15,704	3,176	16,144
2001	18,601	125,893	233,376	125,893	233,376	102,560	210,044	13,439	47,244	13,439	47,244	0	13,076	46,881	2,467	13,581	2,251	13,269	2,467	13,581

SRR (Small returns to river) are the sum of Bay St. George small returns (Reddin & Mullins 1996) plus Humber R small returns (Mullins & Reddin 1996) plus small returns in SFAs 3-12 & 14A.
SSR (Small recruits) = SRR/(1-Exploitation rate commercial (ERC)) where ERC=0.5-0.7, 1969-91 & ERC=0, 1992-98.
SS (Small spawners) = SSR-(SC+(SR*0.1))
SC = small salmon catch retained
SR = small salmon catch released with assumed mortalities at 10%
RL (RATIO large:small) are from counting facilities in SFAs 3-11, 13 & 14A, angling catches in SFA 12.
LRR (Large returns to river) = SRR * RL
LR (Large recruits) = LRR*(1-Exploitation rate large (ERL)), where ERL=0.7-0.9, 1969-91; & ERL=0, 1992-98.
LS (Large spawners) = LRR-large catch retained (LC)-(0.1*large catch released)
2SW-RR (2SW returns to river)= LRR*proportion 2SW of 0.4-0.6 for SFAs 12-14A & 0.1-0.2 for SFAs 3-11.
2SW-S (2SW spawners) = LS * proportion 2SW of 0.4-0.6 for SFAs 12-14A & 0.1-0.2 for SFAs 3-11.
2SW-R (2SW recruits) = LR * proportion 2SW of 0.4-0.6 for SFAs 12-14A& 0.1-0.2 for SFAs 3-11.

Appendix 5(iv). Small, large, and 2SW return and spawner estimates for SFA 15.

Year	Small salmon				Large salmon				2SW	2SW salmon			
	Returns		Spawners		Returns		Spawners		in large	Returns		Spawners	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	salmon	Min.	Max.	Min.	Max.
1970	3513	7505	1497	4418	24955	36452	1917	5548	0.65	16221	23694	1246	3606
1971	2629	5566	1116	3246	12096	17412	846	2335	0.65	7863	11318	550	1518
1972	2603	5537	1092	3235	10621	21963	4323	12085	0.59	6266	12958	2550	7130
1973	5146	9852	1589	4720	10588	21653	4184	11686	0.74	7835	16023	3096	8648
1974	2869	6007	1159	3422	13102	27353	5345	15221	0.73	9564	19968	3902	11112
1975	3150	6567	1262	3717	7229	13894	2413	6660	0.79	5711	10976	1906	5261
1976	11884	20582	2619	7647	12318	25396	5005	14313	0.76	9362	19301	3804	10878
1977	7438	14652	2606	7527	14011	28399	5728	15988	0.83	11629	23571	4754	13270
1978	5215	9595	1477	4244	9716	19224	3768	9917	0.75	7287	14418	2826	7437
1979	5451	11163	2223	6260	3655	6267	1114	2602	0.51	1864	3196	568	1327
1980	9692	18781	3164	9285	11473	22537	4577	11997	0.81	9294	18255	3708	9717
1981	11367	21188	3362	9669	12078	21265	3163	8305	0.47	5677	9995	1487	3903
1982	8889	16834	2736	7978	9431	15011	1810	4599	0.59	5565	8856	1068	2713
1983	3621	6207	799	2268	9281	14864	1654	4489	0.59	5476	8770	976	2648
1984	11861	18589	1646	4732	6924	12237	3603	7403	0.79	5470	9667	2847	5848
1985	8525	18272	3639	10801	9802	20224	7600	16096	0.63	6175	12741	4788	10140
1986	12895	27635	5490	16311	13324	27128	10333	21470	0.76	10126	20617	7853	16317
1987	11708	24768	4930	14408	9627	19058	6932	14401	0.64	6161	12197	4437	9217
1988	16037	34159	6796	20027	12796	26222	9932	20804	0.72	9213	18880	7151	14979
1989	7673	16088	3185	9249	9905	19797	7319	15185	0.57	5646	11284	4172	8655
1990	9527	19902	3975	11418	8125	16280	6066	12636	0.68	5525	11070	4125	8592
1991	5276	10962	2219	6270	6185	12207	4621	9388	0.50	3092	6104	2311	4694
1992	10529	22220	4462	12930	9530	19257	7125	14911	0.54	5146	10399	3848	8052
1993	6578	13541	2739	7643	4407	8742	3156	6647	0.40	1763	3497	1262	2659
1994	10446	21861	4390	12580	8493	17143	6379	13317	0.60	5096	10286	3828	7990
1995	3310	6832	1344	3830	5590	10880	3977	8132	0.65	3636	7077	2587	5290
1996	7468	15529	3259	9043	7796	15745	5902	12275	0.65	5067	10234	3836	7979
1997	7666	16238	3572	9898	5302	10602	4008	8295	0.65	3446	6891	2605	5392
1998	7657	18381	3710	12036	2871	7562	600	3976	0.65	1866	4916	390	2584
1999	5712	12785	3096	8614	3423	7350	2511	5706	0.65	2225	4778	1632	3709
2000	7659	12983	4581	9160	4782	7193	2805	4838	0.65	3108	4676	1823	3145
2001	7232	15183	3644	9750	4835	9691	3165	7018	0.65	3142	6299	2057	4562

Return and spawner estimates for SFA 15 are based on Restigouche River data, scaled up for SFA 15 using angling data.
Restigouche stock assessment is based on angling catch with assumed exploitation rates between 50% (min.) and 30% (max).
The proportion of 2SW in large salmon numbers is based on aged scale samples from angling, trapnets, and broodstock.
No scale samples were available for 1970-71, 1995-96: the mean value of 0.65 is used here.
Salmon in the Quebec portions of the Restigouche River were subtracted from the total for the watershed.
The returns and spawners estimates thus derived for the SFA 15 portion of the Restigouche were then multiplied by the minumum (1.117) and maximum (1.465) ratios of angling catch in SFA15:SFA 15 portion of Restigouche catch to obtain estimates for SFA 15.
For 2001, returns and spawners are based on previous five-year average, incomplete angling data were available.

Appendix 5(v)a. Returns of large salmon and 2SW salmon to SFA 16.

	2SW returns to SFA 16		Returns to the Miramichi River						Returns of large salmon to SFA 16	
			Large	0.8	1.33	Prop.	2SW Returns			
Year	Min.	Max.	returns	Min.	Max.	2SW	Min	Max	Min	Max
1971	19697	32746	24407	19526	32461	0.918	17924	29799	21457	35672
1972	24645	40972	29049	23239	38635	0.965	22427	37284	25538	42456
1973	22896	38065	27192	21754	36165	0.958	20835	34639	23905	39742
1974	33999	56523	42592	34074	56647	0.908	30939	51436	37444	62250
1975	21990	36558	28817	23054	38327	0.868	20011	33267	25334	42117
1976	17118	28459	22801	18241	30325	0.854	15578	25898	20045	33325
1977	43160	71753	51842	41474	68950	0.947	39275	65296	45575	75769
1978	18539	30822	24493	19594	32576	0.861	16871	28048	21532	35797
1979	5484	9117	9054	7243	12042	0.689	4991	8297	7960	13233
1980	30332	50426	36318	29054	48303	0.95	27602	45888	31928	53080
1981	9489	15775	16182	12946	21522	0.667	8635	14355	14226	23651
1982	21875	36368	30758	24606	40908	0.809	19907	33095	27040	44954
1983	19762	32854	27924	22339	37139	0.805	17983	29897	24549	40812
1984	12562	20884	15137	12110	20132	0.944	11431	19005	13307	22123
1985	15861	26369	20738	16590	27582	0.87	14434	23996	18231	30309
1986	23460	39003	31285	25028	41609	0.853	21349	35493	27503	45724
1987	13590	22594	19421	15537	25830	0.796	12367	20561	17073	28385
1988	15599	25933	21745	17396	28921	0.816	14195	23599	19116	31781
1989	9880	16426	17211	13769	22891	0.653	8991	14948	15131	25155
1990	15474	25725	28574	22859	38003	0.616	14081	23410	25120	41762
1991	15929	26482	29949	23959	39832	0.605	14495	24098	26329	43772
1992	20117	33444	37000	29600	49210	0.618	18306	30434	32527	54077
1993	21329	35460	35200	28160	46816	0.689	19410	32269	30945	51446
1994	15151	38979	27450	18278	47023	0.754	13788	35471	20086	51674
1995	18315	46697	32627	19747	50348	0.844	16667	42494	21700	55327
1996	13071	24396	24812	17443	32557	0.682	11894	22201	19168	35777
1997	9054	16567	18422	14183	25953	0.581	8239	15076	15586	28520
1998	3410	5684	9500	7500	12500	0.414	3103	5172	8242	13736
1999	6364	14386	16200	11900	26900	0.487	5791	13091	13077	29560
2000	6927	15261	18200	13300	29300	0.474	6304	13888	14615	32198
2001	13613	22884	20600	16300	27400	0.76	12388	20824	17912	30110

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 2001, min and max are 5th and 95th percentiles from the assessment.

Prop. 2SW are from scale ageing and have been corrected for 1992 to 2000 from previous year's table.

Prop. 2SW for 2001 are preliminary and based on length distributions.

Miramichi makes up 91% of total rearing area of SFA 16.

Returns to SFA 16 are Miramichi returns / 0.91 or (Min., Max.) 2SW returns to Miramichi / 0.91

Appendix 5(v)b. Large salmon and 2SW salmon spawners to SFA 16. Same procedure as for returns (Appendix 5(v)a)

				Escapements to the Miramichi River								
Escapement of 2SW to SFA 16					0.8	1.33	Prop.	capement of 2SW			Escapement of large salmon to SFA 16	
Year	Min	Max		Large	Min.	Max.	2SW	Min	Max		Min	Max
1971	3508	5832		4347	3478	5782	0.918	3192	5307		3822	6353
1972	14992	24924		17671	14137	23502	0.965	13643	22681		15535	25827
1973	17134	28486		20349	16279	27064	0.958	15592	25922		17889	29741
1974	27495	45711		34445	27556	45812	0.908	25021	41597		30281	50343
1975	16366	27209		21448	17158	28526	0.868	14893	24760		18855	31347
1976	10760	17889		14332	11466	19062	0.854	9792	16279		12600	20947
1977	27404	45560		32917	26334	43780	0.947	24938	41459		28938	48109
1978	8197	13627		10829	8663	14403	0.861	7459	12401		9520	15827
1979	2751	4573		4541	3633	6040	0.689	2503	4161		3992	6637
1980	15762	26204		18873	15098	25101	0.95	14343	23846		16592	27584
1981	2702	4492		4608	3686	6129	0.667	2459	4088		4051	6735
1982	9429	15676		13258	10606	17633	0.809	8581	14265		11655	19377
1983	5986	9951		8458	6766	11249	0.805	5447	9056		7436	12362
1984	12189	20264		14687	11750	19534	0.944	11092	18440		12912	21466
1985	15390	25586		20122	16098	26762	0.87	14005	23283		17690	29409
1986	22659	37670		30216	24173	40187	0.853	20619	34280		26564	44162
1987	12635	21006		18056	14445	24014	0.796	11498	19116		15873	26390
1988	15050	25021		20980	16784	27903	0.816	13696	22769		18444	30663
1989	8921	14831		15540	12432	20668	0.653	8118	13496		13662	22712
1990	14940	24838		27588	22070	36692	0.616	13595	22602		24253	40321
1991	15472	25721		29089	23271	38688	0.605	14079	23406		25573	42515
1992	19899	28933		35927	29281	42573	0.618	18108	26329		32176	46784
1993	21422	31147		34702	28282	41122	0.689	19494	28344		31079	45189
1994	14762	38590		27147	17808	46553	0.754	13433	35117		19569	51157
1995	17796	46178		32093	19188	49789	0.844	16195	42022		21086	54713
1996	12545	23870		23478	16741	31855	0.682	11416	21722		18397	35005
1997	8526	16039		17596	13357	25127	0.581	7759	14596		14678	27612
1998	3308	5513		9215	7275	12125	0.414	3010	5017		7995	13324
1999	6173	13954		15714	11543	26093	0.487	5618	12698		12685	28674
2000	6720	14803		17654	12901	28421	0.474	6115	13471		14177	31232
2001	13205	22197		19982	15811	26578	0.760	12016	20199		17375	29207

Assumes exploitation rates of 3% for large and 34% for small salmon for the years 1998 to 2001. These are average rates for 1993 to 1997 as per assessment.

Appendix 5(v)c. Returns of small salmon and 1SW salmon to SFA 16.

				Returns to the Miramichi River			Prop.	1SW Returns to Miramichi	
1SW returns to SFA 16					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
1999	22385	35275		25700	21000	32100		20370	32100
2000	31978	46264		35600	30000	42100		29100	42100
2001	24730	38242		28,200	23,200	34,800		22504	34800

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 2001, min and max are 5th and 95th percentiles from the assessment.
Prop. 1SW are from scale ageing. Proportions vary from 0.97 to 1.00. Ref. Moore et al. 1995.

Miramichi makes up 91% of total rearing area of SFA 16.
Returns to SFA 16 are Miramichi returns / 0.91 or (Min., Max.) 1SW returns to Miramichi / 0.91

Appendix 5(v)d. Small salmon and 1SW salmon spawners to SFA 16. Same procedure as for Appendix 5(v)c.

		Escapements to the Miramichi River							
							Escapement of 1SW		
Escapement of 1SW to SFA 16					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	19347	29736		21780	18150	27060		17606	27060
1999	14774	23281		16962	13860	21186		13444	21186
2000	21105	30534		23496	19800	27786		19206	27786
2001	16322	25240		18612	15312	22968		14853	22968
Assumes exploitation rates of 3% for large and 34% for small salmon for the years 1998 to 2001. These are average rates for 1993 to 1997 as per assessment.									

Table
Appendix 5(vi). Estimated Atlantic salmon returning recruits and spawners to the Morell River, SFA 17, 1970-2001.

	Small recruits		Small spawners		Large recruits		Large spawners		2SW recruits		2SW spawners	
Year	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1970	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0	0	0
1973	5	9	3	7	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0	0	0
1976	14	28	8	22	2	5	1	4	2	5	1	4
1977	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0
1979	2	5	1	4	5	9	3	7	5	9	3	7
1980	12	23	7	18	2	5	1	4	2	5	1	4
1981	259	498	151	390	40	77	36	73	40	77	36	73
1982	175	336	102	263	16	31	8	23	16	31	8	23
1983	17	32	10	25	17	32	15	30	17	32	15	30
1984	17	32	10	25	13	26	13	26	13	26	13	26
1985	113	217	66	170	8	15	8	15	8	15	8	15
1986	566	1088	330	852	5	11	5	11	5	11	5	11
1987	1141	2194	665	1718	66	128	66	128	66	128	66	128
1988	1542	2963	899	2320	96	185	96	185	96	185	96	185
1989	400	770	233	603	149	287	149	287	149	287	149	287
1990	1842	3539	1074	2771	284	545	284	545	284	545	284	545
1991	1576	3028	919	2371	188	361	188	361	188	361	188	361
1992	1873	3599	1092	2818	95	183	95	183	95	183	95	183
1993	1277	2454	745	1922	22	43	22	43	22	43	22	43
1994	209	383	117	291	168	309	165	306	168	309	165	306
1995	1058	1914	585	1441	85	154	81	151	85	154	81	151
1996	1161	2576	738	2154	158	351	154	347	158	351	154	347
1997	485	932	283	730	31	59	30	58	31	59	30	58
1998	635	1221	370	956	79	151	76	149	79	151	76	149
1999	379	728	221	570	23	45	20	41	23	45	20	41
2000	307	591	179	463	57	109	56	108	57	109	56	108
2001	432	830	252	650	58	111	55	108	58	111	55	108
70-89 X	213	410	124	321	21	40	20	40	21	40	20	40
90-01 X	936	1816	548	1428	104	202	102	200	104	202	102	200

Notes

Number of small retained salmon in 1993 was not recorded. The number given is the mean for 1986-1992

For 1970-1980, percent small is calculated from numbers of small and large salmon in the retained catch in each year. For 1981-1997 and 1999, percent small is calculated from numbers of small and large salmon taken at the Leard's Pond trap.
For 1998 and 2000-2001, percent small is taken from seining catches at Mooneys Pool.

Small recruits are calculated as small retained salmon/exploitation rate. Angler exploitation was calculated as 0.34, 0.347, and 0.264 of estimated returns in 1994, 1995, and 1996, respectively. For other years the mean of these values is used. The min and max max numbers of small recruits are calculated using exploitation + or - 0.1; e.g. 0.34 + or - 0.1 gives 0.24 and 0.44.

Small spawners = number of small recruits - number of small retained

Large recruits = (number of small recruits/(0.01*percent small))-number of small recruits

Large spawners = number of large recruits - number of large retained

It is asssumed that large salmon and 2SW salmon are equivalent

Appendix 5(vii). Total returns and spawners of small salmon and large salmon, and 2SW salmon returns and spawners to SFA 18.

	Small salmon				Large Salmon				2SW Salmon			
	Returns		Spawners		Returns		Spawners		Returns		Spawners	
Year	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
1970	279	1,094	176	859	6,257	7,819	817	2,616	4,818	6,803	629	2,276
1971	69	270	43	212	2,498	3,181	318	1,019	1,923	2,767	245	887
1972	138	541	87	424	6,142	6,905	338	1,083	4,729	6,007	261	942
1973	545	2,137	343	1,678	5,429	6,279	356	1,141	4,180	5,462	274	993
1974	197	772	124	606	7,166	7,944	396	1,265	5,518	6,911	305	1,101
1975	118	463	74	364	4,512	4,977	266	850	3,474	4,330	205	740
1976	315	1,236	198	970	3,614	4,209	332	1,062	2,783	3,662	256	924
1977	226	888	143	697	5,238	6,255	488	1,561	4,033	5,442	376	1,358
1978	82	322	52	253	6,025	7,173	635	2,028	4,639	6,241	489	1,765
1979	1,959	7,685	1,234	6,033	1,712	2,301	330	1,053	1,318	2,002	254	916
1980	548	2,150	345	1,688	4,909	5,926	618	1,976	3,780	5,156	476	1,719
1981	2,950	11,573	1,859	9,085	3,296	4,308	561	1,793	2,538	3,748	432	1,560
1982	2,267	8,896	1,429	6,983	5,450	6,751	690	2,205	4,196	5,874	531	1,919
1983	223	875	141	687	4,914	5,998	596	1,906	3,784	5,218	459	1,659
1984	486	1,904	192	1,234	3,159	4,085	368	1,216	2,433	3,554	283	1,058
1985	770	3,230	152	1,821	1,379	5,065	1,275	4,874	1,062	4,407	981	4,240
1986	1,017	3,930	68	1,766	3,405	12,978	3,212	12,624	2,622	11,291	2,473	10,983
1987	1,388	5,162	202	2,458	3,701	14,943	3,557	14,678	2,850	13,000	2,739	12,770
1988	2,032	8,057	965	5,624	1,599	5,698	1,421	5,372	1,231	4,958	1,094	4,673
1989	718	2,704	36	1,151	2,124	8,438	1,969	8,152	1,635	7,341	1,516	7,092
1990	1,141	14,052	353	12,256	4,329	18,126	4,162	17,819	3,333	15,769	3,205	15,503
1991	964	10,770	51	8,688	2,304	13,218	2,104	12,850	1,774	11,499	1,620	11,179
1992	1,527	6,695	851	5,154	6,062	21,420	5,872	21,071	4,668	18,636	4,522	18,332
1993	1,808	10,659	1,100	9,045	2,995	14,070	2,828	13,764	2,306	12,241	2,177	11,975
1994	696	3,047	314	2,178	2,922	10,282	2,747	9,960	2,250	8,945	2,115	8,665
1995	653	2,998	399	2,419	2,176	8,717	2,105	8,586	1,676	7,583	1,621	7,470
1996	1,550	8,193	1,135	7,246	2,753	9,254	2,488	8,767	2,120	8,051	1,916	7,627
1997	384	4,199	83	3,512	4,064	12,418	3,738	11,819	3,129	10,804	2,878	10,283
1998	424	4,498	153	3,880	2,839	8,678	2,629	8,292	2,186	7,550	2,024	7,214
1999	392	4,456	121	3,839	1,791	5,484	1,587	5,109	1,379	4,771	1,222	4,445
2000	271	3,786	102	3,402	1,232	3,765	965	3,274	949	3,276	743	2,849
2001	194	4,152	1	3,712	1,492	4,570	1,413	4,423	1,149	3,976	1,088	3,848

Appendix 5(viii). Total 1SW returns and spawners, SFAs 19, 20, 21, and 23, 1970-2001.

	RETURNS						***TOTAL RETURNS***		***SPAWNERS***						***TOTAL SPAWNERS***	
	River returns SFA 19-21		Comm-ercial	SFA 23			SFAs 19,20,21,23		angled	Spawners 19-21		SFA 23 H+W rtns		Harvest	19,20,21,23	
Year	MIN	MAX	19-21	Wild MIN	Wild MAX	Hatch	MIN	MAX	19-21	MIN	MAX	MIN	MAX		MIN	MAX
1970	8,236	16,868	3,189	5,206	7,421	100	16,731	27,578	3,609	4,627	13,259	5,306	7,521	1,420	8,513	19,360
1971	6,345	13,062	1,922	2,883	4,176	365	11,515	19,525	2,761	3,584	10,301	3,248	4,541	2,032	4,800	12,810
1972	6,636	13,354	1,055	1,546	2,221	285	9,522	16,915	2,917	3,719	10,437	1,831	2,506	2,558	2,992	10,385
1973	8,225	16,744	1,067	3,509	5,047	1,965	14,766	24,823	3,604	4,621	13,140	5,474	7,012	1,437	8,658	18,715
1974	14,478	29,385	2,050	6,204	8,910	3,991	26,723	44,336	6,340	8,138	23,045	10,195	12,901	2,124	16,209	33,822
1975	5,096	10,393	2,822	11,648	16,727	6,374	25,940	36,316	2,227	2,869	8,166	18,022	23,101	2,659	18,232	28,608
1976	12,421	25,398	1,675	13,761	19,790	9,074	36,931	55,937	5,404	7,017	19,994	22,835	28,864	5,263	24,589	43,595
1977	13,349	27,943	3,773	6,746	9,679	6,992	30,860	48,387	5,841	7,508	22,102	13,738	16,671	4,542	16,704	34,231
1978	2,535	5,241	3,651	3,227	4,651	3,044	12,457	16,587	1,113	1,422	4,128	6,271	7,695	2,015	5,678	9,808
1979	12,365	25,381	3,154	11,529	16,690	3,827	30,875	49,052	5,428	6,937	19,953	15,356	20,517	3,716	18,577	36,754
1980	16,534	33,825	8,252	14,346	20,690	10,793	49,925	73,560	7,253	9,281	26,572	25,139	31,483	5,542	28,878	52,513
1981	18,594	38,329	1,951	11,199	16,176	5,627	37,371	62,083	8,163	10,431	30,166	16,826	21,803	9,021	18,236	42,948
1982	10,008	20,552	2,020	8,773	12,598	3,038	23,839	38,208	4,361	5,647	16,191	11,811	15,636	5,279	12,179	26,548
1983	4,662	9,562	1,621	7,706	11,028	1,564	15,553	23,775	2,047	2,615	7,515	9,270	12,592	4,138	7,747	15,969
1984	12,398	25,815	0	14,105	20,227	1,451	27,954	47,493	4,724	7,674	21,091	15,556	21,678	5,266	17,964	37,503
1985	16,354	34,055	0	11,038	15,910	2,018	29,410	51,983	6,360	9,994	27,695	13,056	17,928	4,892	18,158	40,731
1986	16,661	34,495	0	13,412	19,321	862	30,935	54,678	6,182	10,479	28,313	14,274	20,183	3,549	21,204	44,947
1987	18,388	37,902	0	10,030	14,334	3,328	31,746	55,564	7,056	11,332	30,846	13,358	17,662	3,101	21,589	45,407
1988	16,611	33,851	0	15,131	21,834	1,250	32,992	56,935	6,384	10,227	27,467	16,381	23,084	3,320	23,288	47,231
1989	17,378	35,141	0	16,240	23,182	1,339	34,957	59,662	6,629	10,749	28,512	17,579	24,521	4,455	23,873	48,578
1990	20,119	41,652	0	12,287	17,643	1,533	33,939	60,828	7,391	12,728	34,261	13,820	19,176	3,795	22,753	49,642
1991	6,718	13,870	0	10,602	15,246	2,439	19,759	31,555	2,399	4,319	11,471	13,041	17,685	3,546	13,814	25,610
1992	9,269	18,936	0	11,340	16,181	2,223	22,832	37,340	3,629	5,640	15,307	13,563	18,404	4,078	15,125	29,633
1993	9,104	18,711	0	7,610	8,828	foot-	16,714	27,539	3,327	5,777	15,384	5,762	6,868	foot-	11,539	22,252
1994	2,446	4,973	0	5,770	6,610	note:"a"	8,216	11,583	493	1,953	4,480	4,965	5,738	note:"a"	6,918	10,218
1995	5,974	12,364	0	8,265	9,458		14,239	21,822	1,885	4,089	10,479	8,025	9,218		12,114	19,697
1996	9,888	20,791	0	12,907	15,256		22,795	36,047	2,211	7,677	18,580	11,576	13,892		19,253	32,472
1997	2,665	5,488	0	4,508	4,979		7,173	10,467	493	2,172	4,995	3,971	4,433		6,143	9,428
1998	7,567	15,680	0	9,203	10,801		16,770	26,481	0	7,567	15,680	8,775	10,348		16,342	26,028
1999	5,048	10,535	0	5,508	6,366		10,556	16,901	67	4,981	10,468	5,196	6,048		10,177	16,516
2000	6,201	12,890	0	4,796	5,453		10,997	18,343	0	6,201	12,890	4,455	5,087		10,656	17,977
2001	4,239	8,884	0	2,513	2,862		6,752	11,746	0	4,239	8,884	2,210	2,530		6,449	11,414

SFAs 19, 20, 21: Returns, 1970-1997, estimated as run size (1SW recreational catch / expl. rate [0.2 t0 0.45]; where MIN and MAX selected as 5th and 95th percentile values from 1,000 monte carlo estimates) + estimated 1SW fish in commercial landings 1970-1983 (Cutting MS 1984). For 1998-2000, see "a" below.

SFA 22: Inner Fundy stocks and inner-Fundy SFA 23 (primarily 1SW fish) do not go to the North Atlantic.

SFA 23: For 1970-'97, similar to SFAs 19-21 except that estimated wild 1SW returns destined for Mactaquac Dam, Saint John River, replaced values for recreational catch and estimated proportions that production above Mactaquac is of the total (0.4-0.6) river replaced exploitataion rates (commercial harvest, bi-catch etc., incl. in estimated returns); hatchery returns attributed to above Mactaquac only; 1SW production in rest of SFA (outer Fundy) omitted.

"a"- Revision of method, SFA 23, 1993-2001, estimated returns to Nashwaak fence raised by proportion of area below Mactaquac (0.21-0.30) and added to total estimated returns originating upriver of Mactaquac (Marshall et al. 1998); MIN and MAX removals below Mactaquac based on Nashwaak losses, Mactaquac losses are a single value and together summed and removed from returns to establish estimate of spawners. SFAs 19-21, estimate of returns 1998-2000 based on regression of LaHave wild counts on MIN and MAX estimates of total SFA 19-21 returns, 1984-1997, because there was no (1998 and 2000) & little (1999) angling in SFAs 20-21.

Appendix 5(ixa). Total 2SW returns to SFAs 19, 20, 21 and 23, 1970-2001.

	SFA 19		***SFA 20***		***SFA 21***			***SFA 23***				***TOTAL RETURNS SFAs 19,20,21,23***	
	MIN	MAX	MIN	MAX	MIN	MAX	Total Comm-ercial	Wild MIN	Wild MAX	Htch MIN	Htch MAX		
	2SW=0.7-0.9		2SW=0.6-0.9		2SW=0.5-0.9			2SW= 0.85-0.95		2SW= 0.85-0.95			
Year	Exp. rate=0.2-0.45		Exp. rate=0.2-0.45		Exp. rate=0.2-0.45		19-21	p. abv= 0.4-0.6				MIN	MAX
1970	1,170	2,537	658	1,535	597	1,525	2,644	8,540	12,674	0	0	13,609	20,915
1971	600	1,266	344	802	481	1,199	2,607	7,089	10,463	66	73	11,187	16,410
1972	735	1,614	421	1,002	454	1,198	4,549	7,362	10,809	507	559	14,028	19,731
1973	726	1,571	665	1,532	546	1,437	4,217	3,773	5,559	432	477	10,359	14,793
1974	1,035	2,225	691	1,588	548	1,397	8,873	8,766	12,790	1,989	2,198	21,902	29,071
1975	376	824	149	343	882	2,321	9,430	11,217	16,490	1,890	2,088	23,944	31,496
1976	791	1,672	346	822	441	1,146	5,916	12,304	18,106	1,970	2,175	21,768	29,837
1977	999	2,152	660	1,509	873	2,354	9,205	14,539	21,420	2,330	2,575	28,606	39,215
1978	810	1,739	429	995	655	1,706	6,827	6,059	8,903	2,166	2,391	16,946	22,561
1979	532	1,169	431	978	508	1,288	2,326	4,149	6,084	1,016	1,123	8,962	12,968
1980	1,408	3,051	746	1,714	1,483	3,989	9,204	16,500	24,041	2,556	2,824	31,897	44,823
1981	886	1,856	926	2,133	1,754	4,475	4,438	8,696	12,690	2,330	2,577	19,030	28,169
1982	917	1,990	316	746	682	1,756	5,819	8,266	12,198	1,516	1,673	17,516	24,182
1983	477	1,030	641	1,475	552	1,434	2,978	8,718	12,793	944	1,043	14,310	20,753
1984	828	1,768	638	1,500	766	2,004	0	14,753	21,573	953	1,054	17,938	27,899
1985	1,495	3,132	2,703	6,355	2,102	5,469	0	15,793	23,002	748	826	22,841	38,784
1986	3,500	7,541	2,561	5,987	2,150	5,312	0	9,210	13,507	681	754	18,102	33,101
1987	2,427	5,237	1,066	2,527	1,114	2,872	0	6,512	9,590	410	453	11,529	20,679
1988	2,635	5,724	1,914	4,464	1,105	2,945	0	3,936	5,836	780	861	10,370	19,830
1989	2,236	4,810	1,512	3,485	1,631	4,086	0	6,159	8,994	401	443	11,939	21,818
1990	2,406	5,178	1,085	2,515	1,271	3,260	0	4,994	7,375	492	543	10,248	18,871
1991	1,890	4,050	965	2,200	421	1,071	0	6,739	9,902	598	661	10,613	17,884
1992	1,788	3,923	631	1,488	480	1,236	0	6,213	9,074	665	735	9,777	16,456
1993	876	1,897	1,006	2,321	564	1,498	0	4,318	5,371	foot-		6,764	11,087
1994	833	1,845	242	561	305	773	0	2,999	3,729	note:"a"		4,379	6,908
1995	759	1,582	666	1,565	518	1,339	0	3,042	3,831			4,985	8,317
1996	1,231	2,692	604	1,404	894	2,293	0	4,498	5,665			7,227	12,054
1997	607	1,299	170	387	301	1,026	0	2,567	3,210			3,645	5,922
1998	>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>				1,103	3,888	0	1,625	2,115			2,728	6,003
1999	>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>				1,230	4,324	0	2,252	2,783			3,482	7,107
2000	>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>				1,086	3,816	0	952	1,263			2,038	5,079
2001	>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>				1,374	4,720	0	1,725	2,182			3,099	6,902

SFAs 19, 20, 21: Returns, 1970-'97 estimated as run size (MSW recreational catch * prop. 2SW [range of values]/ expl. rate [range of values]; where MIN and MAX selected as 5th and 95th percentile values from 1,000 monte carlo estimates) + estimated 2SW fish in commercial landings 1970-1983 (Cutting MS 1984). For 1998-2001 see "a" below.

SFA 22: Inner Fundy stocks do not go to north Atlantic.

SFA 23: For 1970-1997 Similar approach as for SFAs 19-21 except that estimated wild MSW returns destined for Mactaquac Dam, Saint John River, replaced values for recreational catch; and estimated proportions that production above Mactaquac is of the total river replaced exploitation rates (commercial harvest,bi-catch etc., incl. in estimated returns) + est. 0.85-0.95* MSW hatchery returns to Mactaquac; 2SW production in rest of SFA omitted.

"a": Revsion of method, SFA 23, 1993-2001, estimated MSW returns to Nashwaak fence raised by prop. of area below Mactaquac (0.21-0.30) * prop. 2SW (0.7 & 0.9) and added to estimated MSW hatchery and wild returns * (Marshall et al. MS 1998) (0.85-0.95; 2SW) originating upriver of Mactaquac. MIN & MAX removals below Mactaquac based on Nashwaak losses: Mactaquac losses were a single value and together summed and removed from MSW returns (prevously) to estimate spawners. SFAs 19-21, estimate of 2SW returns for 1998-'01, based on regression of LaHave wild counts on MIN and MAX estimates of total SFA 19-21 MSW returns and 5th and 95th percentile values of MIN-MAX (0.5 & 0.9 2SW fish among MSW salmon).

Appendix 5(iXb). Total 2SW spawners in SFAs 19, 20, 21 and 23, 1970-2001.

	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
1999	>>>>>>>>>>>>>>>>>>>>>>>>>>>				1,230	4,324			1,230	4,324	2,252	2,783	441	459	3,041	6,648
2000	>>>>>>>>>>>>>>>>>>>>>>>>>>>				1,086	3,816			1,086	3,816	952	1,263	183	202	1,855	4,877
2001	>>>>>>>>>>>>>>>>>>>>>>>>>>>				1,374	4,720			1,374	4,720	1,725	2,182	239	271	2,860	6,631

Spawners = returns minus removals where: "returns" are from previous Appendix as are outlines of revisions to methods for SFAs 19-21, 1998-2000, and SFA 23, 1993-2000. "Removals" of 2SW fish in SFAs 19-21 have been few, largely illegal and unascribed since the catch-and-release angling regulations in 1985; removals in SFA 23, 1985-1997, had been in total, the assessed losses to stocks originating above Mactaquac. The revised method, 1993-2000, incorporates 5th and 95th percentile values for losses noted on the Nashwaak raised to the total production area downstream of Mactaquac as well as the previously assessed and used values for stocks upstream of Mactaquac.

Appendix 5(x). Estimated numbers of salmons recruits and spawners for Québec, 1969-2001.

Year	Recruit of small salmon			Recruit of large salmon			Spawner of small salmon			Spawner 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	24,495	29,398	34,301	33,368	38,487	43,605	16,743	21,237	25,730	19,506	23,068	26,629
1999	25,880	31,279	36,679	34,815	40,496	46,178	18,969	23,889	28,808	23,631	28,124	32,618
2000	27,212	33,710	40,208	34,036	40,905	47,773	19,527	25,265	31,003	22,818	27,993	33,168
2001	19,346	23,905	28,463	35,450	42,331	49,213	13,244	17,122	21,000	23,305	28,491	33,677
Mean 84-01	**29,919**	**35,846**	**41,774**	**56,455**	**65,039**	**73,623**	**19,609**	**24,849**	**30,089**	**27,141**	**32,975**	**38,809**

APPENDIX 6

Computation of Catch Advice for West Greenland

The North American Spawning Reserve (SpT) for 2SW salmon of 152,548 fish remains the same as in 2001.

This number must be divided by the survival rate of the fish from the time of the West Greenland fishery to the 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 = 0.03)

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] Sampling data from the 1995-99 fishery at West Greenland were used to update the forecast values by exponential smoothing of the proportion of North American salmon in the catch (PropNA), weights by continent [WT1SWNA, WT1SWE], and the age correction factor [ACF].

APPENDIX 7

TECHNICAL MINUTES OF ACFM REVIEW OF THE REPORT OF THE WORKING GROUP ON NORTH ATLANTIC SALMON

23-25 April, 2002, ICES, Copenhagen

1 INTRODUCTION

The meeting was attended by the WGNAS Chair Niall Ó Maoiléidigh, the ACFM Chair Tore Jakobsen, the reviewer Denis Rivard and the WGBAST Chair Tapani Pakarinen.

Minutes of the ACFM meeting are compiled as two separate papers following the decision made at the May 1996 ACFM meeting. The first paper is called "Minutes of ACFM Meeting" and is made available to a broad audience as an "A:" paper at the Annual Science Conference. The other paper is called "Technical Minutes of ACFM Meeting" and is for use internally in ACFM and in its Assessment Working Groups.

The "Minutes of the ACFM Meeting" records general topics discussed and especially decisions taken on such general issues. The "Minutes" furthermore records revised assessments if such were done during the ACFM plenary.

The "Technical Minutes of ACFM Meeting" (the present one) records the technical considerations related to specific assessment Working Groups, i.e. Advisory Committee on Fishery Management's review of the Working Group reports. The "Technical Minutes" includes new VPA and projection runs, etc. where such new runs were presented to ACFM. The "Technical Minutes" paper is mainly the outcome of the ACFM Sub-group meetings.

The text related to the various Working Groups has in general been written by the respective Working Group chairs, who participated in the ACFM Sub-Group meetings. In a few cases it has been necessary to add or edit the minutes made by the Working Group chairs in order to clarify the text and in situations where errors in the assessment were discovered after the ACFM Sub-group meetings.

At the present meeting the report of the Working Group of North Atlantic Salmon (WGNAS) was dealt with.

2 GENERAL POINTS

No points.

3 WORKING GROUP ON THE NORTH ATLANTIC

The report was presented by the WG Chair Niall Ó Maoiléidigh.

The Working Group was commended for the report.

Generally the technical parts of the report were accepted. There are no major changes to the previous procedures. It was noted by the review group that while NASCO had formally adopted the "Precautionary Approach to Fishing" for salmon stocks in the North Atlantic, there was little mention of the PA or the implications of the PA within the text of the report itself.

Section 2.1.2 (Extract Section 1.1.2). The Review Group noted the assumption that all catch and release salmon survived and requested information in next years report on whether this assumption was correct or not, and how it might affect subsequent assessments in the report.

Section 2.3 (Extract Section 1.2) New values of natural mortality, M, have been used by the Working group in the assessments this year. It had been noted previously that the previously assumed value of M was probably higher than the 1% per month (~0.12 per year) for 1SW and MSW salmon. The Working group presented new analyses (Inverse Weight method and Maturity Schedule method) to illustrate why the previous value was too low and adopted a new value of 3% per month. The Working Group also presented an analysis describing the effects of using the new value on estimates of pre-fishery abundance (PFA), Conservation Limits (CL) and Spawning Escapement Reserve (SER). The Review Group sought further clarification and justification for this change and these were provided and included in the final version of the Extract of the WGNAS report.

Section 2.5 (Extract Section 1.3.6). The Review Group noted the Working Groups decision to use S_{msy} as the conservation limit for North Atlantic salmon but to advise a higher level of probability of attainment of this limit (at least 75%) than currently used by NASCO (50%). However, the Review Group stressed the need to define a biological reference point below which the stock would suffer serious or irreversible harm. For example, this could be defined in terms of acceptable recovery times for stocks severely below their CL given the characteristics (including uncertainties) of the stock-recruit relationship.

Section 3.4 (Extract Section 2.4). The Review Group noted the large differences between estimates of CL for Northern and Southern maturing and non-maturing salmon stocks from last year. It was stressed that the reasons for such changes need to be clearly outlined in the report particularly if quantitative catch advice was to be provided for either Faroes or West Greenland based on PFA forecast values for North East Atlantic stocks.

Section 4.4 (Extract Section 3.3). The absence of specific information on how conservation limits in North America were derived (e.g. in some cases it is based on individual river CLs based on stock and recruitment data while in other areas it was based on assumed egg deposition rates per unit of habitat) was noted. It was not clear from Table 4.4.1 (not in Extract) which methods had been used to establish the regional CLs. The inclusion of a table outlining the inputs to the overall North American CL would be helpful. It would also be useful to document the basis for reference points in the context of the implementation of the precautionary approach if the PA reference points simply end up being a direct transposition of CLs.

Section 5.4.1 (Extract Section 4.2). The section could be enhanced if the percentage of the CL accounted for by the numbers of salmon returning to home waters (provided no fishery took place at West Greenland) was indicated (Table 5.4.1, Extract text table in Section 4.2).

Extract general comment. The Review Group suggested that the Extract would be enhanced if a brief introduction and map of the relevant countries and fisheries were included in Extract Section 1.1.