NORTH ATLANTIC SALMON CONSERVATION ORGANIZATION

ORGANISATION POUR LA CONSERVATION DU SAUMON DE L'ATLANTIQUE NORD

NASCO

Council

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Report of the ICES Advisory Committee on Fishery Management

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EXTRACT OF THE REPORT

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THE ADVISORY COMMITTEE ON FISHERY MANAGEMENT

NORTH ATLANTIC SALMON STOCKS

TO

THE NORTH ATLANTIC SALMON CONSERVATION ORGANIZATION

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1 ATLANTIC SALMON IN THE NORTH ATLANTIC AREA

1.1 Catches of North Atlantic Salmon

1.1.1 Nominal catches of salmon

Nominal catches of salmon reported by country in the North Atlantic (including ranched salmon in Iceland) for 1960-99 are given in Table 1.1.1.1. Reported catches (in tonnes), in four North Atlantic regions are illustrated in Figure 1.1.1.1, and those for NASCO Commission Areas, 1994-1998 are shown below.

Area	1994	1995	1996	1997	1998	1999
NEAC	3569	3282	2749	2074	2225	2054
NAC	358	261	294	231	159	145
WGC	0	85	92	59	11	19
Total	3927	3628	3135	2364	2395	2218

The catch data for 1999 (Table 1.1.1.1) are provisional, but the total nominal catch of 2,218 t is the lowest on record. Catches in most counties remain below the averages of the 5- and 10-years period. Some of the reduction in catches in recent years may be accounted for by management plans, which have reduced fishing effort in several countries.

Where data were available, the nominal catch (in tonnes) of wild fish in 1999 was partitioned according to whether the catch was taken by coastal, estuarine or riverine fisheries. These are shown below for the NEAC and NAC Commission Areas. The proportions accounted for by each fishery varied considerably between countries. In total, however, coastal fisheries accounted for 52% of catches in North East Atlantic countries compared to 7% in North America, whereas in-river fisheries took 41% of catches in North East Atlantic countries compared to 67% in North America. The breakdown by country is shown in Table 1.1.1.2.

Area	Coast Weight	%	Estuary Weight	%	River Weight	%	Total Weight
NEAC	1045	52	141	7	839	41	2025
NAC	10	7	38	26	98	67	145

1.1.2 Catch and release

Catch and release data for the 1990s have been provided by 6 countries. In 1999, the proportion of the total rod catch that was released ranged from 100% in USA to 10% in Iceland. Other catch and release rates were 77% , 49%, 44% and 29% for Russia, Canada, UK (England & Wales) and UK (Scotland), respectively. In most of these countries, rates in 1999 are among the highest in each time series.

1.1.3 Unreported catches of salmon

The total estimate of unreported catch within the NASCO Commission Areas in 1999 was 1,027 t (Table 1.1.1.1), or 32% of the total of reported and unreported catch. The estimate for 1999 is a decrease of 15% compared with 1998 (1,210 t) and a decrease of 6% compared to the 1994–1998 mean of 1,099 t. After 1994 there are no data available on salmon catches in international waters. Limited surveillance flights, which were the basis of past estimates of catches in international waters, have not reported any salmon fishing. Estimates (in tonnes) of unreported catches for the Commission Areas are given below:

Area	1993	1994	1995	1996	1997	1998	1999
NEAC	1471	1157	942	947	732	1108	881
NAC	161	107	98	156	90	91	133
WGC	12	12	<20	<20	5	11	12
International waters	25-100	25-100	n/a	n/a	n/a	n/a	n/a

Where available, data are presented by country for 1999 (Table 1.1.3.1). The individual inputs to the total North Atlantic catch range from 0% to 13.5 %. While this broadly indicates the level of non-reporting 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 (see Section 2.3). The non-reporting rates range from 2% to 71% of the total national catch in each country.

1.1.4 Production of farmed and ranched salmon

The worldwide production of farmed Atlantic salmon in 1999 was 825,915 t. This was the highest production in the history of the farming industry (Figure 1.1.4.1) and represented a further 19% increase compared to 1998 (695,492 t) and a 50% increase on the 1994-98 average (550,406 t). The worldwide production of farmed Atlantic salmon in 1999 was over 370 times the reported nominal catch of Atlantic salmon in the North Atlantic.

In 1999, the production of farmed Atlantic salmon in the North Atlantic area was 620,415 t, which was a further 19% increase compared to 1998 (523,035 t) and a 40% increase on the 1994-98 average (442,779 t). The countries with the largest production were Norway and Scotland, which accounted for 67% and 18% of the North Atlantic total, respectively. Production outside the North Atlantic area reached 205,500 t in 1999, 25% of the world production of farmed salmon. The areas with the largest production were Chile and the West Coast of Canada which, as in 1998, accounted for 73% and 19% of the non North Atlantic production, respectively.

The total production of ranched Atlantic salmon in the North Atlantic was 33 t in 1999, 13 t less than in 1998 and the lowest value since 1984. The majority (79%) of the ranching is conducted in Iceland where production has continued to decline and is now less than one quarter of the nominal catch of wild fish.

1.2 Evaluation of methods for estimating unreported catch with advice on improvements

Unreported catches consist of harvests which are caught and retained. They do not include catch and release mortality arising from nets or angling gear or fish retained by public or private agencies for broodstock purposes destined for enhancement. A summary of methods was last presented in 1996 (ICES 1996/Assess:11) wherein values were generally termed "guess-estimates", indicating that they were not derived from annual surveys of fisheries or analyses of catch data. Guess-estimates were and are usually supported, in part at least, by observations of landings, knowledge of legal and illegal fishing activity, recoveries of illegal fishing gear, prosecutions, etc.

The current summary depicts a general trend by most countries to introduce some structuring (annual surveys of fishers via mail questionnaires or interviews, test fisheries, carcass tagging, better documentation of illegal catches etc.) to their methods of determining unreported catch. Thus, more national submissions of unreported catch than in 1996 have a structured approach to determination, and together with generally declining catches, are more frequently ascribed as "estimates" rather than "guess-estimates". Several countries have suggested possibilities of improving the estimate or guess-estimate of unreported catch, (Table 1.2.1).

1.3 Data requirements and methods to evaluate bird and marine mammal predation

The impacts of predators upon prey populations are determined by estimating the number of the prey eaten by the predator population, then dividing it by estimates of the prey population. The standard approach to estimating the quantity of prey consumed by a predator population consists of multiplying estimates of food consumption per predator (on a daily or other specified time period basis), times estimates of the number of predators, times the fraction of the food consumed that is composed of the prey of interest. Predator and prey population sizes are estimated using a variety of standard methods.

Because of the rare occurrence of salmon in the stomachs of marine predators, sampling needs to be scaled up greatly to obtain measurable rates of predation upon Atlantic salmon at sea. Only if concentrations of predators can be identified in areas where salmon are likely to be present may predation be measurable at affordable cost.

In certain places, environmental constrictions may provide salmon with little opportunity to avoid detection or escape predation and may favour hunting success by predators. Frequently, these constrictions result from human habitat manipulations, such as dams and their associated reservoirs. Natural constrictions are found in estuaries or narrow river channels. In constrictions, predation impacts could be measurable and quite severe.

New research could provide indicators of the impacts of predators upon salmon, for both freshwater and ocean areas. Studies in freshwater may be more tractable but the need to account for recent increases in marine mortality add importance to quantifying predation at sea. The research areas include:

- *The development of predation indices based on the frequency of body scars on returning salmon.* Times series are available for the frequency of scarring from some counting facilities. The number of scars present on fish bodies needs to be related to the fraction of fish attacked and scarred, but which survived. This is technically difficult, and restrictions on experimentation with marine mammals have prevented some attempts to do this.
- *The determination of salmon mortality rates in constricted areas.* This may be relatively easy to accomplish by following the success of sonic or radio-tagged fish in passing through constrictions.
- *Use of chemical signatures to trace salmon into predator tissue.* Serological or other techniques like stable isotope ratios are possibilities, however, the rarity of salmon in the diets of seabirds and seals means that chemical indicators of salmon may not be detectable in their tissues.
- The ICES Working Group on Seabird Ecology developing a relational database (SEABDIET) to provide rapid access to what is known of seabird diets. It will be updated regularly, and may provide a mechanism to determine if salmon become more common in seabird diets.

1.4 Recent Research Developments

1.4.1 Infectious Salmon Anaemia (ISA) detected in escaped farmed salmon, and wild salmon.

The Infectious Salmon Anaemia (ISA) has been reported from salmon farms as early as 1984 from Norway and more recently from farms in Canada (1996), and Scotland (1999), the Faroe Islands (2000) and from a coho salmon farm in Chile (2000). The first ISA reports from escaped farmed Atlantic salmon and wild Atlantic salmon came from the Bay of Fundy region of New Brunswick, Canada in 1999. The virus can spread rapidly among farms, and caused average mortality in cages in Canada of 12.2%, and in a severe case at one site in Norway it reduced smolt survival from an average of 86%, to 18%. Clinical and disease symptoms of ISA include the fish becoming lethargic or moribund, lifting of scales off of the body, a protuberance of the eyes, skin lesions, pale gills, swollen livers, petechiae, agglutination of the red blood cells, anaemia, necrosis and/or hemorrhages in the pyloric caecae, intestine, liver and kidneys. There are no known cures or therapeutants for the disease as yet.

Infected fish can pass the virus on to uninfected fish. However, in tests on salmon, the virus was not transmitted from infected parents to their offspring through the gametes. Asymptomatic hosts that can serve as a source of the virus include rainbow trout and brown trout. The European eel has also recently been identified as a carrier.

1.4.2 Migration of kelts in relation to sea water temperatures

Data storage tags recording temperatures were applied to 75 Atlantic salmon grilse kelts at the River Imsa, SW Norway. The fish were tagged and released downstream the trap at the mouth of the river in December 1998 and January 1999. Immediately after release one fish was observed to have lost the tag, and this tag continued to record temperature in the river until 1 September. Three fish returned to the trap between 264-296 days after release. In all four tags recovered, temperatures were recorded by hour.

The differences in the temperatures between the individual fish during their marine journey suggest that their geographical distributions were different, and the steep increase in temperature that occurred from the beginning of July in all fish suggests the initiation of active homing migration. The frequency distributions of water temperatures on individual fish from sea entry to estimated time of active homeward migration (beginning of July) showed a range of temperatures from 2.5 to 9°C. Further analyses of the data suggest that these tags may be a helpful tool to investigate the timing of sea entry of kelts, the movement patterns of previous spawners of salmon in the NE Atlantic, the timing of active homeward migration, as well as the timing of freshwater entry.

1.4.3 Retention of run-timing characteristics in salmon transferred between locations within a river catchment.

Adult fish were obtained from two widely separated tributaries in the Tay catchment, the Rivers Almond and Tummel and breed in captivity. Their progeny were transplanted into a third tributary, the River Braan and the juveniles subsequently microtagged. Recaptures of returning adults in the coastal and estuarine net fisheries were used as indicators of run-timing.

Capture dates of native 1SW and 2SW Tummel fish were both significantly earlier than for the equivalent sea age class of Almond fish. The same relationships were evident in the transferred fish. Comparing between native and transferred fish, neither sea-age class of Almond fish showed significant differences in their capture dates. Although capture dates for both sea-age classes of Tummel fish showed statistically significant differences, the range of weeks during which native and transferred fish were taken in the net fisheries were broadly similar.

The study indicates that run-timing characteristics may be retained when salmon are transferred between locations, suggesting that run-timing has a heritable component. The results extend the concept of inter-population differences in run-timing between rivers to a within-catchment scale. This is consistant with observations relating run-timing to spawning distributions and suggests that the relationship between sub-catchment populations and their adult run-timing may provide a link between variations in the performance indicators of local populations and changes in the seasonal performance of the fisheries.

1.4.4 Causes of post-smolt mortality in the early marine phase

A new device (Fish Lift) for obtaining live fish in good condition from trawl catches, was used on two cruises in May 1999 in fjords in SW Norway resulting in a sample of 944 post-smolts. The sea lice (*Lepeophtheirus salmonis* Krøyer) infection rate on 22 fish captured in the mouth of the Sognefjord ranged from 8- 268 (mean 104, SD 68.7), while the infestation of post-smolts (n= 30) from the mouth of the Nordfjord ranged from 9 –94 (mean 31.4, SD 17.54). In both fjords the number of lice per fish decreased at stations with increasing distance inland from the coastline, evidently due to decreasing salinity in the upper water layers .

A trawl catch of 288 post-smolts was taken with the Fish Lift at a site in the outer Nordfjord, of these 69 fish were randomly selected for establishing the initial sea lice infestation, and the rest were transported to the laboratory of the IMR in Bergen. 30 post-smolts examined at capture all carried larval stages of sea lice ranging from 7 – 85 lice per fish. After being held in a large tank to account for possible post-capture and transport mortality, 200 fish were weighed and measured and divided in 10 groups of 20 fish each. These fish were distributed into 250 l aquariums (day 0 of experiment). At the end of the experiment, a difference in mortality of 65% (95% confidence interval, 48.5% - 81.5%) was recorded between the untreated (11 surviving fish) and the treated group (76 survivors) which may be attributed to the lice infestation. There was also a considerable difference in the mean number and the stages of lice recorded on the fish that died, and on the 11 fish surviving the experiment period. Additionally, growth differences were observed between untreated and treated fish.

While a direct extrapolation of these mortality rates to wild populations may not be appropriate the results indicate the need to have more information on the fate of post-smolt salmon passing through areas where aggregations of sea louse larvae are likely to occur.

1.4.5 Density and temperature effects on length-at-age of juvenile salmon

Returns of both small and large salmon to the Miramichi River (SFA 16 Canada) peaked during 1991 and 1992 at almost 200,000 fish and subsequently declined during 1997 to 1999 to about 50,000 fish, the lowest levels since 1971. The declines occurred despite increased escapements of salmon to the river and egg depositions, which met or exceeded the conservation requirements. Densities of juvenile salmon have increased in the Miramichi River during the period of study, 1971 to 1999. Mean size-at-age, standardized to a common sampling date (August 31), shows important annual variations with size-at-age declining since 1995 to the lowest of the time series. Two factors suspected to affect juvenile salmon growth in the Miramichi, density of juveniles and water temperatures, were examined in detail. A negative relationship between size-at-age and density of juveniles in the Miramichi River was shown.

There are two possible mechanisms that would explain the association between parr size and abundance of cohort as adults. Parr to smolt survival may decrease with decreasing parr size at-age, possibly during the winter. Alternatively, parr-to-smolt survival may be independent of parr size and density but smaller parr may produce smaller smolts resulting in reduced sea survival. Both effects may also be occurring. Warm water temperatures during the growing season may have constrained further the growth and condition of juveniles which could have affected their survival in freshwater and/or survival at sea. As temperature and parr density changes occurred simultaneously differentiating their relative influence on the association is not yet possible.

1.4.6 Length-at-age of adult salmon reflecting marine growth opportunities

Annual variations in length-at-age of 1SW and 2SW salmon returning to four rivers of eastern Canada were examined. Since these age groups segregate at sea at some stage, an analysis of length can provide insights into the extent of variability in growth conditions and may lead to inferences on the assumption of common feeding areas or common conditions in different marine areas in the Northwest Atlantic.

Although length may be a weak surrogate measure of response to growth opportunity, it has been readily collected over a wide range of rivers and over a large number of years. 1SW and 2SW salmon in the Miramichi River in 1999 were exceptionally large. These large bodied survivors were however of low abundance. This can either be explained by exceptional growth conditions in the marine environment in the last two years or by a very strong size-dependent survival in the ocean. The general agreement between predicted growth responses and observed size-at-age of 1SW and 2SW salmon assuming similar feeding areas or growth conditions suggests broad-scale marine conditions which effect these age groups in similar ways. The exceptions to the general predictions of response to growth suggest that in some years, the marine environment may be more structured (less homogeneous, patchy).

1.5 Estimates of escapement from marine salmon farms and impact on estimates of escapees in fisheries and stocks.

Escapes of salmon from farms are inevitable and are usually a result of storms, predator damage, equipment failures, accidental human error or vandalism. Overall, weather and predator attacks have been the most evident contributors to fish escapes. Escapes may occur as either large scale, one-time events, or as "leakage" of small quantities of salmon over extended periods of time. Additionally, escapes are reported to occur during harvest operations. Escapes of salmon and other species from aquaculture sites are required to be reported in some countries. For example, in Norway salmon farmers reported that about 500,000 salmon escaped in 1998 and 1999, while escapes from Irish fish farms have ranged from 1,500 to more than 70,000 since 1996 (Table 1.5.1). The numbers of salmon reported to have escaped in Norway and Ireland include both smolts and adults. For most countries in the North Atlantic however, there is no information available pertaining to the number of salmon that escape annually from fish farms because there is no legal requirement to report such occurrences. Although the incidence of farmed salmon in catches is often high (e.g., in Norway), the total catch of farmed salmon in the wild represents a very small fraction of the aquaculture production in most countries. Furthermore, despite the rapid expansion of the salmon farming industry, the percentage of escaped farmed salmon taken in commercial catch shows a downward trend over time. This is thought to be due to improved containment measures and technological improvements in equipment and monitoring throughout the industry in recent years.

Escapes of salmon (parr or smolts) from freshwater rearing facilities have been documented in many areas. Since there is no way to readily identify these fish as adults in the wild, the annual contribution of those fish to fisheries and stocks is largely unmeasured. There is a general lack of knowledge about the migration, survival and behavior of escaped salmon in other areas of the North Atlantic. ICES recommends that NASCO and its contracting parties establish standardised reporting guidelines and improved monitoring procedures for documenting escapes of salmon from marine salmon farms and freshwater rearing facilities. Furthermore, ICES recommends that additional research into the behavior, movements and survival of escaped salmon in the salmon farming industry in all areas of the North Atlantic be conducted. A universally applied marking system that would allow escapees to be readily identified when captured in fisheries and/or stock assessment programs would be beneficial, since the relatively few farmed salmon observed in scanned catches and at monitoring facilities in many areas makes inferences over large geographical areas impossible at this time.

1.6 Review of developments in setting conservation limits

ICES and NASCO need to continue the dialogue on both the use and terminology of reference points in the management of salmon fisheries.

NASCO and its Contracting Parties have agreed that the application of the Precautionary Approach to salmon fishery management requires, among other things, 'that conservation limits and management targets be set for each river and combined as appropriate for the management of different stock groupings defined by managers' and that 'stocks be maintained above conservation limits by means of management targets', (NASCO, 1998). ICES has defined conservation limits and encourages NASCO to specify targets for the management of fisheries that ensure an adequate probability of exceeding conservation limits. Targets could also incorporate other objectives of management such as socio-economic factors.

Risks of not achieving targets or falling below conservation limits should be incorporated in the assessments. As a first step, ICES proposes to develop case studies to illustrate the options for analysing risk and the applying limits and targets in salmon management.

1.7 Compilation of Egg Collections and Juvenile Releases for 1999

Data summaries for 1999 of artificially spawned eggs and egg and juvenile releases are presented in Table 1.7.1. These data were provided to estimate the effects of egg collection on wild production and to characterise the overall scale of enhancement work by ICES member countries. Although all countries except Finland artificially spawn eggs to support enhancement activities, only six countries reported summaries of artificially spawned egg numbers for 1999. Where possible, the number of eggs collected from each of these sources is reported. Data on egg collections and juvenile releases by Norway are no longer available as of 1998.

The number of eggs collected from wild stocks for enhancement purposes was compared with the total estimated egg deposition at the national level in order to determine the relative amount of potential egg deposition required to meet hatchery needs. Only five to six countries of the 14 countries currently collecting eggs have reported juvenile releases during any year of the 1990-1999 period.

A total of about 35.3 million eggs were taken from sea run salmon in 1996 for use in hatcheries. This number is equivalent to 0.5% of the estimated total egg deposition for those countries of 7,590 million in 1966. With the exception of the US, the relative proportion of eggs diverted for hatchery use was consistently low among the individual countries (range 0.1% - 1.3%). The US diverted a significant portion of eggs available from sea run fish, equivalent to 95% of estimated deposition from natural spawning. The numbers of artificially spawned eggs reported in 1996 are consistent with numbers reported in other years, indicating that relatively few eggs are being diverted from wild spawning to hatchery use with the exception of the US.

The information contained in the current database is incomplete and the impact of these egg deposits is limited with the exception of USA. Therefore its value to the understanding of salmon population dynamics does not warrant its continued compilation.

1.8 Compilation of Tag Releases and Finclip Data by ICES Member Countries in 1999

Data on releases of tagged, fin-clipped, and marked salmon in 1999 are compiled as a separate report (Annex to ICES CM 2000/ACFM:13). A summary of Atlantic salmon marked in 1999 is given in Table 1.8.1. About 4.43 million salmon were marked in 1999, a 71% increase from the 2.59 million fish marked in 1998. The increase was due largely to Canadian tagging. Primary marks are summarised in four classes: coded wire tag (i.e., microtag), external tag, adipose clip (without other external marks or fin clips), and other visible clip or mark. Secondary marks (primarily adipose clips on fish with coded wire tags) are also presented. The adipose clip was the most used primary mark (3.49 million), with coded wire tags (0.70 million) the next most used primary mark. Secondary marks (primarily adipose fin clips) were applied to 0.60 million fish. Most marks were applied to hatchery-origin juveniles (4.40 million), while 57,669 wild juveniles and 15,935 adults were marked.

2 ATLANTIC SALMON IN THE NORTH-EAST ATLANTIC COMMISION AREA

2.1 Events of the 1999 Fisheries and Status of Stocks

2.1.1 Fishing in the Faroese area 1999/2000 commercial fishery

In the period 1991-98 inclusive the Faroese salmon quota was bought out. However, the Faroese Government continued sampling inside the 200 mile EEZ during most years. No buyout was arranged for 1999 and 2000. No fishing took place in 1999 and the commercial fishery resumed in 2000.

The vessel M/S "Túgvusteinur" undertook 2 commercial fishing trips between late January and early April 2000. A total of 35 sets caught 7.6 t (1990 salmon) including discards. The average catch rate (CPUE) in 2000 was 34.3 salmon per 1000 hooks employed. The fishery was severely hampered by bad weather during the fishing period. Furthermore, this vessel has not fished for salmon since 1991. The CPUE is below the range of 36 to 84 fish per 1,000 hooks for the fishery 1981 through 1995, but is the same as "Polarlaks" obtained in winter 1998.

Composition of the catch: The sea-age distribution is similar to that of the previous fishing seasons with the 2SW salmon dominating (78.4%) and with 1SW (11.3%) and 3+SW (10.3%) caught in lower proportions. The sea-age was determined by using length-splits previously applied to the average lengths.

The proportion of discards in the catch (i.e., salmon <60 cm) was approximately 14%, which is close to the maximum of the range of 1.8 to 15.6. However, the fishery only took place during the latter part of the season (January to April) at which time there is usually a lower proportion of discards compared to the earlier part of the season.

Origin of the catch: Three Norwegian tags were recovered from the fishery in January-March 2000 with "Túgvusteinur". No coded wire tags were found. Despite the small sample size, the recovery of Norwegian tags is consistent with previously estimated proportions of tagged fish from other countries.

2.1.2 Homewater fisheries in the NEAC area

In the NEAC area there has been a general reduction in catches, fishing capacity (gear units, season length) and effort since the 1980s, reflecting management actions and lower value of commercially caught salmon. Lower proportions of 1SW salmon were apparent compared to previous years in Northern and Southern Europe. Exploitation rates have increased in some areas.

Gear and effort: There were no reports of significant changes in fishing gear from the other NEAC countries in 1999. There was a general decline in number of gear units licensed but in homewater fisheries, there are no consistent trends among effort indices in the rod-fishery.

Catches: Provisional catch figures showed declines compared to 1998 and both the 5- and 10-year averages. All countries except Finland showed decreases in their 1999 catches compared to the previous 10-year averages.

CPUE: CPUE values do not show any general trend. The values for the net and rod fisheries show differences between countries and areas. For the net fishery in UK (Scotland) there was a downward trend while no trend was detected for UK (England and Wales). In the rod fishery significant increase in CPUE was observed for rivers in the White Sea but a decreasing trend for the Barents Sea Rivers in Russia. CPUE is affected greatly by the type of gear, weather and water discharges. The lack of consistency in CPUE trends may be partly attributable to the imprecise nature of the effort indices.

Composition of catches: Clear differences in the sea-age composition between countries in Northern and Southern Europe are apparent. The proportion of 1SW fish in the 1999 catch was lower than both long term indices in each of the southern European countries and, where data were available, it appeared that the changes in the proportion of 1SW fish in the 1999 catch were driven by a reduction in 1SW catches rather than increases in the number of MSW fish taken. In contrast, the proportion of 1SW fish in the 1999 catches of northern European countries (Finland, Sweden, Russia and Norway) was greater than both the 1994-98 and 1989-1998 averages.

In general, the incidence of farmed salmon in catches in homewater countries remained low and at levels lower than those in 1998 despite the continuing increase in the aquaculture industry. However, in Norway farmed salmon still comprise approximately 25% of the nominal catches. Furthermore, farmed salmon are recorded at higher levels in spawning stocks than in fishery catches.

Origin of catch: Some new information on tag recoveries was made available. These support previous conclusions on the interception of salmon of other countries in homewater fisheries of their neighbouring countries. Such coastal fisheries occur especially in West coast of Ireland, parts of UK (N. Ireland), North East coast of UK (England and Wales) and Norway.

Of the Swedish salmon catch in 1999, less than 10% was estimated to have originated from the Danish experimental smolt releases in the Baltic Sea.

Exploitation rates: While reduced catch and fishing capacity would be expected to reduce exploitation rates, these appear to have increased over the last decade in most of Europe (except the Barents Sea and White Sea areas of Russia). This is likely to be indicative of low stock abundance.

2.1.3 Status of stocks in the NEAC area

There are over 1,500 rivers supporting salmon in the NEAC area, but for most of these there is no information on the status of stocks. In this Section, stock status is described for around 40 monitored rivers of which many are of small size and contribute a proportionately small quantity of the salmon production in the NEAC area. Stock status assessments as inferred from summed estimates of national Pre-fishery Abundance (PFA) and spawning escapement are presented in Section 2.3.

Attainment of conservation requirements: Analysis of attainment of conservation limits (CLs) indicated that the recovery of salmon stocks observed in 1998, from a period of low attainment (1994-1997), did not continue in 1999 (Figure 2.1.1). The proportion of rivers with an egg deposition above their CL was smaller in 1999 than in 1998. The general pattern indicates that the difference in CL attainment values between those rivers previously showing a high level of attainment compared to those showing lower rates of attainment has increased in 1999.

Adult returns to rivers: Measures of adult returns back to the rivers showed that of the rivers examined in 1999, approximately half showed increased counts and half decreased counts. A classification analysis, based on the last 10 years count information, identified two groups of rivers; one showing declining counts over the period and the other revealing no trend. The majority of the Northern European rivers were classified in the declining group whereas the Southern rivers were split equally between the two groups.

Marine survival indices: Returns to homewaters are likely to present a clearer picture of marine survival than returns to freshwater, because of variation in exploitation in coastal fisheries. For most rivers where information is available, returns to homewaters were below both the previous 5 and 10 year means for 1SW and 2SW fish. In particular, marine survival showed a sharp decline for many 1SW Southern European stocks in 1999. Overall, there has been a significant decline in marine survival to homewaters over the last 10 years for 1SW and 2SW stock components, throughout the NEAC area. Although return rates of hatchery fish may not always reflect survival of wild fish, downward trends in marine survival for 1SW and 2SW hatchery fish over the last 10 years and over the past 5 year period for 2SW hatchery fish were noted. These trends in marine survival are of concern, as they imply further decline in future stock abundance if survival at sea remains low or worsens.

Measures of juvenile abundance: The trends in smolt output from 17 rivers were not consistent between rivers or regions. About half of the smolt counts in 1999 were higher than those of the previous year and the 5-year mean, whereas in some rivers the present values were less than a half of those in the previous year. There was a significant decreasing trend in smolts during the last 10 years both for southern and northern rivers. In contrast, juvenile abundance data on parr and/or fry stages showed an increase in 1999 compared to the previous year and the 5-year means, which was consistent over the countries where data were available.

2.2 Evaluation of the Effects on Stocks and Homewater Fisheries of Significant Management Measures Introduced Since 1991.

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

Between 1991 and 1998 the Faroese fishermen agreed to suspend commercial fishing for the salmon quota set by NASCO, in exchange for compensation payments. The number of fish spared as a result of this suspension is the catch that would have been taken if the fishery had operated, minus the catch in the research fishery. The increase in returns to homewaters is then estimated by subtracting the fish that would have died on their homeward migration. Most fish would be expected to return to European rivers. As for last year, the analysis was based on the assumption that the full quota would have been taken, had commercial fishing taken place. Thus, the maximum catch that would have been taken in 1998/99 would have been 330 t.

Year	Quota (t)	Estimated increased returns to home waters in Europe			
		1SW	%	MSW	%
1992	550	2,842	0	70,809	6
1993	550	11,429	1	106,307	10
1994	550	21,078	1	134,159	11
1995	550	12,949	1	138,533	13
1996	470	10,573	1	122,196	12
1997	425	9,578	0	105,368	14
1998	380	19,699	1	103,169	13
1999	330	17,261	1	99,130	12

The calculated additional returns represent between 6% and 14% of MSW fish and up to 1% of 1SW fish returning to homewaters between 1992 and 1999. However, about 65% of MSW salmon caught in the Faroes fishery would return to Scandinavian countries, Finland and Russia. If this were the case, they might have represented from 8% to 19% of MSW returns and up to 2% of 1SW returns to northern European homewaters in those years. These returns were estimated from PFA analysis, (section 2.3). If stocks and fisheries had remained stable, total catches would have been expected to increase by approximately the same proportions in respective areas. However, examination of trends in catches in NEAC countries suggests that any expected increase may have been masked by other factors such as changes in marine survival and/or management measures in homewaters.

2.2.2 Evaluation of the effects of management measures introduced in homewaters since 1991.

There were significant reductions in net licences issued in most countries in the NEAC area. Additional measures have been taken in some countries. Although licence numbers may not reflect effort exactly (as effort varies in response to many additional factors, such as fishing conditions and perceptions about stock abundance), it is likely that the overall reductions in gear units observed represent a significant cumulative reduction in fishing pressure in homewaters on NEAC stocks.

These changes would be expected to lead to detectable reductions in homewater catches, and the analysis carried out in section 2.1.2 indicated significant reductions in catches for 1SW salmon in both Northern and Southern Europe, during the period 1992-1999 (compared to a baseline 1987-1991). Although no detectable change was noted for MSW catches in Northern Europe over the same time period, MSW catches were significantly lower for Southern Europe. However, it is not possible to attribute the decline in catches specifically to management measures taken in homewaters or distant water fisheries, or to declines in stock abundance. Given continuing poor marine survival affecting many stocks and the variation across countries in management measures taken, the precise impact of these measures on spawning stocks will be difficult to judge, especially in the short term.

2.3 Expected Abundance of Salmon in the North East Atlantic

NEAC - PFA model: No changes were made to the model used in 1999 to estimate pre-fishery abundance of salmon in the NEAC area. Data inputs were reviewed and updated. No new information was provided to modify the way that stocks are grouped. The pre-fishery abundance estimates are therefore divided into Northern Europe (all Nordic countries plus Russia and Iceland) and Southern Europe (Ireland, UK and France) groups (Figures 2.3.1 and 2.3.2).

Trends in PFA for NEAC stocks: Figure 2.3.1 suggests that there has been no overall trend in the recruitment of maturing 1SW salmon (potential grilse) in the Northern European stock complex, although the numbers have fluctuated quite widely and fell to their lowest levels during the mid 1990s. Numbers of non-maturing 1SW recruits (potential MSW returns) for Northern Europe are estimated to have fluctuated around 900,000 between 1970 and 1985, but subsequently fell to about 500,000 in the late 1990s. The numbers of MSW spawners, however, show no significant trend over the time series.

In the Southern European stock complex (Figure 2.3.2), the numbers of maturing 1SW recruits are estimated to have fallen substantially since the 1970s. Recruitment was at its lowest during the 1990s, although there is no evidence of a trend in this period. However, there has been a sharp drop in the estimated recruitment in 1999, resulting from a similar proportional reduction in all the Southern European countries. The number of non-maturing 1SW recruits in the Southern Europe has declined steadily over the full time series.

Forecasting PFA for NEAC stocks: In order to use the PFA estimates to provide quantitative catch advice, a forecast will be required of PFA recruits in the year of the fisheries. This means that it will be necessary to forecast the PFA two years forward from the latest estimate. The model used to forecast PFA for North American stocks is based upon both environmental (thermal habitat in the North-West Atlantic) and biological (lagged spawners) parameters. ICES has considered similar approaches for the NEAC area, but there is as yet insufficient information to develop such a model. There is still limited information on the factors affecting the distribution and survival of salmon during the marine phase of the life-cycle. ICES considers that inclusion of environmental parameters in a model must be based upon justifiable hypotheses concerning the impacts on freshwater and/or marine survival.

2.4 Development of Age-Specific Conservation limits

Conservation limits have been set for all salmon rivers in France and UK (England & Wales) although some of these are still provisional; in addition conservation limits in UK (England & Wales) are not set for separate age classes. Progress has also been reported in developing conservation limits in Norway, where work is in progress to estimate the area of freshwater habitat available for smolt production in a number rivers and in Ireland and UK (Northern Ireland) where provisional conservation limits have been set for all rivers.

In order to provide catch advice, ICES has previously developed a lagged egg deposition model for estimating preliminary national conservation limits. This approach generates pseudo-stock-recruitment relationships, i.e. plots of lagged eggs (stock) against 1SW adults in the sea (recruits) for national stocks. ICES evaluated the most appropriate conservation limit options to use (Table 2.4.1) based on the nature of the 'pseudo-stock-recruitment relationship' and local knowledge.

The selected options have been summed for the appropriate stock groups. These are then increased to take account of the natural mortality between recruitment and the time of return in order to provide Spawning Escapement Reserves (SERs) for maturing and non-maturing 1SW salmon from the Northern and Southern Europe. The SERs are shown as horizontal lines in Figures 2.3.1 and 2.3.2. The SERs are not shown on the total NEAC data (Figure 2.3.3) because evaluation of stocks against conservation limits is thought to be inappropriate at that level. Because of inadequate historic data, stock status relative to SER levels cannot be evaluated prior to 1980.

2.5 Catch Options or Alternative Management Advice

ICES 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. ICES reiterates its concerns about applying TACs to mixed stock fisheries, particularly when many individual river stocks and sub-river populations are known to be at unsatisfactorily low levels. Annual adjustments in TACs based on changes in the mean status of the stocks is unlikely to provide adequate protection to the individual river stocks that are most heavily exploited by the fishery or are in the weakest condition.

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

In view of the uncertainties expressed above about the most appropriate stock groupings and the preliminary nature of the conservation limit estimates, ICES considers that it would be inappropriate to provide quantitative catch options at this stage. However, ICES feels that the following qualitative catch advice was appropriate based upon the PFA data and estimated SERs shown in Figures 2.3.1 and 2.3.2:

Northern European 1SW stocks: ICES considers that the spawning escapement of 1SW salmon from the Northern European stock complex have been within but close to safe biological limits in recent years and is supported by escaped farmed salmon. Although there is evidence of a small upturn in stocks in the past three years, the increase is not significant. ICES considers that overall exploitation of the stock complex at the current rate is acceptable, but it is recognised that the status of individual stocks varies considerably and nearly half of the rivers have been below their conservation limits. **Since very few 1SW 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. Conservation would be best achieved by fisheries in estuarine and in-river harvests targeting stocks, which have been shown to be above biologically-based escapement requirements.**

Northern European MSW stocks: These are the main stocks that have contributed to the fisheries in the Norwegian Sea in past years. The PFA of non-maturing 1SW salmon from Northern Europe has been declining since the mid 1980s and the exploitable surplus has fallen from over 800,000 recruits in the 1970s to around 250,000 recruits in recent years. ICES considers the Northern European MSW stock complex to be within but close to safe biological limits, although it is recognised that the status of individual stocks will vary considerably and nearly half of the river stocks for which there are data are below conservation limits. **ICES therefore considers that great caution should be exercised in the management of these stocks particularly in mixed stock fisheries and exploitation should not be permitted to increase. ICES 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 estuarine and in-river harvests targeting stocks, which have been shown to be above biologically-based escapement requirements.**

Southern European 1SW stocks: The spawning escapement for the whole stock complex has fallen below the conservation limit in most of the past 10 years. Moreover, recruitment of maturing 1SW salmon in the Southern European stock complex has been below any previously observed value all of the 1990s and for the first time, in 1999 recruitment before exploitation was below the escapement reserve. **ICES considers that reductions in exploitation rates are required for as many stocks as possible and that mixed stock fisheries present particular threats to conservation. Since nearly all exploitation of 1SW salmon takes place in homewater fisheries, management of**

these stocks should be based on local assessments of the status of river or sub-river stocks. Conservation would be best achieved by fisheries in estuarine and in-river harvests targeting stocks, which have been shown to be above biologically-based escapement requirements.

Southern European MSW stocks: This stock complex includes the main European stocks contributing to the West Greenland fishery. The PFA of non-maturing 1SW salmon from Southern Europe has been declining steadily since the 1970s and the spawning escapement for the whole stock complex has been close to or outside safe biological limits for the past 30 years. Moreover, the upper 95 % confidence limit for PFA of spawners has been below the conservation limit for the past three years. Also the mean predicted recruitment, i.e. before exploitation has been below the PFA conservation limit since 1996 and in 1998, the upper 95 % confidence limit fell below the conservation limit. Qualitative projection of these estimates suggests that the PFA is likely to remain below the conservation limit in 2000. **ICES considers that reductions in exploitation rates are required for as many stocks as possible and that mixed stock fisheries present particular threats to conservation. Management of single stock fisheries should be based upon local assessments of the status of river and sub-river stocks. Conservation would be best achieved by fisheries in estuarine and in-river harvests targeting stocks, which have been shown to be above biologically-based escapement requirements.**

2.6 Catches of Post-Smolts in the North East Atlantic

2.6.1 Post-smolt surveys in 1990- 1999

New data were provided from 9 Norwegian research cruises in 1999, two of which were specifically aimed at salmon investigations along the SW- and mid-Norwegian coast and SW Norwegian fjords. 406 surface trawl hauls yielded 984 post-smolts and 24 salmon, most of which were captured in the fjords or at the coast during the special salmon cruises. For the first time since the sampling programme began, a few post-smolts and salmon were captured in the Barents Sea and adjacent fjords. In 1999 fewer post-smolts than in previous years were captured on the feeding grounds in the Norwegian Sea. As there were differences in the sampling times, and the cruises were aimed mainly at sampling herring and mackerel, it is not possible to estimate whether the low catches are a result of low number of post-smolts present or sub-optimal timing of the sampling. The lower smolt ages (1-2 years) predominate in the catches in the Norwegian Sea while the higher ages are found along the Norwegian coast and in the fjords. The age difference, and a concentration of post-smolt catches in two separate areas (along the coast of Norway and in the Norwegian Sea) indicate a separation in time or in space of stocks from southern areas (south- and mid-Europe including south Norway) and the more northerly Norwegian and the Russian stocks. It is documented from the Faroese research fishery that both the southern and the northern stocks are present north of the Faroes between November and April. Consequently, there is still insufficient information on the migration and the distribution of the northern post-smolt stocks.

No investigations of salmon in the sea have been undertaken by other NEAC countries in 1999.

2.6.2 By-catch of post-smolts in pelagic fisheries

Only one country (Faroe Islands) implemented a dedicated sampling of post-smolts in its pelagic fisheries and reported that no by-catch of salmon was found. The Portuguese pelagic trawl and artisanal fisheries reported some small salmon landings near one Portuguese river in 1986 - 98, otherwise no catch of salmon was reported. It is unclear whether these catches near the Portuguese river are made in the sea or if they come from the estuary. There was no surveillance programme in other countries with pelagic fisheries in the Northeast Atlantic.

Limited Norwegian data provides further support for the proposal (ICES 1999/ACFM:14), that a simple precautionary measure against post-smolt catches in commercial fisheries might be to operate pelagic trawl with the float line at a minimum 5 m below the surface.

2.7 Data Deficiencies, Monitoring Needs and Research Requirements in the NEAC Area

More research into the biology of salmon in the marine phase is required. This includes the need to monitor trends in marine mortality for a wider range of stocks than at present, and identify causes for mortality. The use of electronic tags will significantly improve the information on the marine life history of salmon.

Research on post-smolts in the early marine phase should be continued and expanded to include sea areas not previously sampled. Post-smolt studies should also encompass competitive interactions with other marine species, interaction with parasites and diseases and by-catches of post-smolts in marine fisheries for other species. To improve the understanding of the impact of sea lice on post-smolts, ongoing studies on wild fish in the natural environment should be continued.

It is recommended that a research fishery at Faroe Islands should be resumed and that material gained during the previous studies should continue to be worked-up. DNA analyses of fish sampled at Faroe Islands should be performed to assess continent of origin.

The quality of data used to set conservation limits should continue to be improved and the PFA model should continue to be developed. Efforts should be made to provide additional data on 1SW/MSW composition in catches and spawning stocks, to facilitate more comprehensive stock assessment.

Assessment methods for juvenile salmon and for freshwater habitat parameters should continue to be developed and the interaction between freshwater and marine life histories should be investigated further.

3 ATLANTIC SALMON IN THE NORTH AMERICAN COMMISSION AREA

3.1 Events of the 1999 fisheries and status of stocks

3.1.1 Fisheries in the NAC area

Gear and effort: Restrictions on commercial and recreational fisheries introduced in Canada in 1992 remained in force in 1999. In addition, the commercial fishery in Labrador remained closed in 1999, as in 1998. Commercial fisheries occurred only in zone Q9 as the commercial quota normally fished by Native peoples' in Ungava Bay, Québec (Zone Q11), was closed (Figure 3.1.1.1). The quota for Q9 in 1999 was reduced from 1998 through a voluntary buyback of licences which started in 1997.

In the recreational fishery, some areas of New Brunswick and Nova Scotia were closed to fishing and hook-and-release regulations for small salmon were extended to some rivers in Québec. The retention of large salmon continued only in Québec and northern Labrador. Following river-specific in season reviews of returns, non-retention of salmon regardless of size and in some cases, complete closure, was imposed.

In USA there is no commercial fishery for salmon and angling (catch-and-release only) for sea-run salmon in 1999 was permitted only in the State of Maine.

Commercial and recreational fishing using gillnets continued in Saint-Pierre et Miquelon (France) in 1999 and effort was similar to the average of the previous four years.

Catch: The provisional landings for Canada in 1999 were 143 t, a decrease of 9% by weight from 1998 (Table 1.1.1). The landings of small salmon in numbers (45,732) and large salmon (11,290) represented decreases of 11% and 15%, respectively, from those of 1998. Recreational fisheries exploited the greatest number of small salmon in each province, accounting for 84% of the total small salmon harvests in eastern Canada. Aboriginal fisheries took the largest share of large salmon (53% by number). Commercial fisheries harvested 2 % (by number) of the total small salmon and 4% of the total large salmon in eastern Canada. Unreported catch for the NAC area was estimated at 133 t, up about 46% from 1998.

In 1999, about 44,000 salmon (21,000 large and 23,000 small) were caught and released. This was a 23% decrease from the number released in 1998. Most of the fish released were in New Brunswick (47%), followed by Newfoundland (39%), Québec (7%), Nova Scotia (6%), and Prince Edward Island (< 1%). Expressed as a proportion of the fish caught, that is, the sum of the retained and released fish, the highest percentage (84%) was released in Nova Scotia, followed by Prince Edward Island (65%), New Brunswick (56%), Newfoundland (50%),) and Québec (25%).

In USA the estimated number of salmon caught and released in 1999 was 211 fish - 23% lower than in 1998 and 41% and 65% below the 5- and 10-year means. In December of 1999, the State of Maine instituted a regulation closing all Maine rivers to Atlantic salmon fishing until further notice.

In Saint-Pierre et Miquelon (France) the harvest was 2.3 t, the same as in 1998 and among the highest values since 1994.

Composition and origin of catch: No external tagged fish of USA origin were reported from Canadian fisheries in 1999. In Canada, returns to the majority of rivers in Québec, Newfoundland and Labrador are comprised exclusively of wild salmon. Hatchery-origin fish were most abundant in returns to rivers in the outer Bay of Fundy and along the Atlantic coast of Nova Scotia. Aquaculture escapees were sampled from the St. Croix, Magaguadavic and Saint John rivers in the outer Bay of Fundy.

In USA, most salmon caught and released originated from hatchery-reared salmon released to the Penobscot River as part of an ongoing restoration program. It is possible that some salmon that were caught in eastern Maine (11 fish reported) in 1999, originated from aquaculture operations in Maine or New Brunswick.

3.1.2 Status of stocks in the NAC area

Returns, recruits and spawners: Estimated (mid-point) 1SW and 2SW returns, as well as spawners, spawner thresholds and in the case of Newfoundland, recruits, in 1999 are shown for five of six regions in North America in Figures 3.1.2.1 and 3.1.2.2. Labrador returns and thus total North American returns have been unavailable in both 1998 and 1999. Returns of 2SW fish in 1999 were similar to or slightly higher than the low values in 1998 and remain among the lowest of the series. 1SW returns increased slightly over those of 1998 in Newfoundland, Québec, and USA but declined in the Gulf of St Lawrence and Scotia Fundy.

The rank of the estimated returns in 1999 within the 1971–1990 time series and the estimated total spawning escapement of 2SW salmon in each region expressed as a percentage of the spawning threshold for each region (except Labrador) follows. The closer the rank of 1999 returns is to 1, the better the relative performance of the stock.

	Rank of 1999 returns in 1971–1999 time series (1=highest)		Mid-point estimate of 2SW spawners as proportion of escapement requirement
Region	1SW	2SW	(%)
Newfoundland	2	2	194
Québec	13	29	68
Gulf (Mainland)	27	27	50
Scotia-Fundy	26	27	20
USA	13	28	4

No estimate for Labrador is provided because there was no data available to carry out the analysis.

In all regions except Newfoundland the returns of 2SW fish are near the lower end of the 29-year time series However, Newfoundland comprises only a small proportion of total salmon production. Returns of 1SW salmon were at the high end of the time series in Newfoundland, at the mid point in Québec and USA and at the low point in Gulf and Scotia-Fundy.

The North American run-reconstruction model was used to update the estimates of pre-fishery abundance of non-maturing and maturing 1SW salmon from 1971–1999. The projected numbers of potential 2SW spawners that could have returned to North America in the absence of fisheries can be computed from estimates of the pre-fishery abundance taking into consideration the 11 months of natural mortality at 1% per month. These values, termed "potential 2SW recruits", along with total North American 2SW returns and spawners (1971–1998) and requirements are shown in Figure 3.1.2.3, and indicate that the overall North American spawner requirement could not have been met in any of the years 1993–1998 even in the absence of all fisheries.

The changes made to the calculations that determine pre-fishery abundance of non-maturing 1SW salmon for 1997 were continued for the determination of pre-fishery abundance in 1998. They included the addition of a new parameter to define the fraction of the Lake Melville catches that are immature and, in the absence of a commercial fishery in Labrador, the development of a raising factor to estimate 2SW returns to Labrador from a series of Labrador recruit estimates and pre-fishery abundance data from 1971-96. A raising factor was also developed to include Labrador returns in the maturing component of pre-fishery abundance 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

A change was made in 1999 to the estimation of salmon returns to Newfoundland. 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 1998, for SFAs 3–12 and 14A, angling catch data was derived from the licence stub return system 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.

For 1999, the method used in previous years was modified to take into consideration the changes implemented in the 1999-2001 Salmon Management Plan for Newfoundland and Belle Isle shores in Labrador which had the intent to alter exploitation for rivers in the various classes in the management plan

- Class I: Large rivers with season bag limit of 6 fish
- Class II: Smaller rivers with seasonal bag limit of 4 fish
- Class III: Rivers with a season bag limit of 2 fish
- Class IV: Rivers with catch and release only
- Special class: Rivers with various management plans

Thus it was necessary to model the estimation procedure for returns and spawners individually for each of four classes of rivers. Also, rivers that were completely closed to angling or that were not included in the river classification scheme were individually dealt with if there was assessment information. Class I rivers included Humber and Gander and for these rivers returns and spawners were derived from their assessments. Since catch statistics were not available separated by river class, classes II and III were combined and returns and spawners estimated based on exploitation rates from five assessed Class II/III rivers. Most of the Class IV rivers are in Bay St. George area of SFA 13 and the entire area returns and spawners were estimated based on assessments for 7 rivers expanded to the total drainage based on their proportionate contribution. Landings for these rivers were subtracted from those of the other Class II/III rivers.

The estimate of pre-fishery abundance of 81,861 non-maturing 1SW salmon for 1998 was the lowest on record (Figure 3.1.2.4), and 15% below the previous year. The most recent two years year are shown with hollow symbols to denote the use of a raising factor for Labrador. For maturing 1SW salmon, there was a 32% increase from 1997 in the 1998 estimate (422,517) of pre-fishery abundance. An estimate of 435,502 maturing 1SW fish in 1999 is 3% greater than that of 1998 but the seventh lowest in the 29-year time series. The total Northwest Atlantic population of 1SW recruits (maturing and non-maturing) originating in North America in the Northwest Atlantic has varied but generally trended downwards since the 1970s, and the abundance recorded 1993–1999 was the lowest in the time series (Figure 3.1.2.5). During 1993 to 1997, the total population was about one-half million fish, 45% of the average abundance 1972 to 1990. The decline has been more severe for the 2SW salmon component than for maturing 1SW salmon which have risen from about 45% of the total at the beginning of the 1970s to between 65 and nearly 85% in the last five years.

The estimated 2SW returns (1,168 salmon) to USA rivers in 1999 represent 4% of the spawner requirements for all rivers. This was 23% below the 1998 estimate and 32% and 48% below the 5-year and 10-year averages, respectively.

Egg depositions: Egg depositions in 1999 exceeded or equalled the river specific conservation requirements in 37 of the 67 assessed rivers (55%) and were less than 50% of conservation requirements in 15 other rivers (Figure 3.1.2.6). Large deficiencies in egg depositions were noted in the Bay of Fundy and Atlantic coast of Nova Scotia where nine of the 12 rivers assessed had egg depositions which were less than 50% of conservation requirements. Proportionally fewer rivers in Gulf (7%) and Québec (0%) had egg depositions less than 50% of conservation. Only 66% of the Gulf rivers and 72% of the Québec rivers had egg depositions which equaled or exceeded conservation (Figure 3.1.2.6). In Newfoundland, 64% of the rivers assessed met or exceeded the conservation egg requirements and almost all the others (23%) had egg depositions which were less than 50% of requirement. The deficits occurred in the southwest rivers of Newfoundland (SFA 13) and in Labrador.

Smolt production: It is not possible to estimate how many smolts in total leave the rivers of Atlantic Canada for any given year. However, juvenile abundance indices were considered as surrogates of smolt production from eastern Canada. To allow for the combined analysis of smolt counts and juvenile abundance surveys from all the rivers, the individual river surveys were divided by the average within river abundance for the period 1995 to 1998.

The index of smolts from North America was obtained by weighting the annual river indices by the relative proportion of the conservation egg requirements of the SFA or Zone to the total conservation egg requirements of the zones under consideration. An alternative weighting incorporated the relative contribution to the 2SW spawner requirements of the six main areas 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. The number of rivers with available data has increased from two in 1971 to 25 or more rivers since 1995. The proportion of the indexed areas represented by the index rivers has increased from 11% in 1971 to more than 25% since 1995.

The relative index weighted by the area-index proportions suggests relative smolt production at two levels, the first in the 1970s with smolt production being less than 1/3 of the production in the 1990s through the 1980s smolt production was highly variable but increased steadily to the levels seen in 1990s.

The relative index for 2SW recruitment (excludes the Newfoundland areas which do not produce 2SW salmon or weights all areas according to the 2SW spawner requirements by area) suggests an overall similar trend. The index corresponds to the documented status of many other rivers. Smolt production from Newfoundland rivers has approximately doubled over the 1971 to 1999 time period. The Gulf smolt index is at its highest in the 1990s. The Québec smolt index has declined between 1983 and 1999. The relative index for Scotia-Fundy peaked 1986-88 and has since declined.

Survival rates to 1SW and 2SW fish have been variable in recent years. In 1998 and 1999 there has generally been an increase in survival rates from the low values observed throughout eastern Canada in 1997. Return rates to most rivers of Newfoundland generally recovered in 1998 and 1999 above conservation limits although survival rates generally remain low. Considering that the historical survival rates (prior to 1992) represent survival to the river after commercial fisheries, for the rest of eastern Canada the recent survival rates and in particular the low rates in 1997 are dismal. Despite major reductions in marine exploitation, marine survival rates are still low and sea survival of the salmon populations has not increased as expected.

For USA, induced freshwater habitat constraints are substantial in some areas and productive capacity has been reduced. Causes include physical, chemical and biological induced constraints. Documented losses include hydropower development, acidification, and siltation. Suspected losses include interactions caused by the introduction of competitive or predator species, chemicals that disrupt endocrine development and localised effects associated with aquaculture. Mitigation of these losses has, for the most part, been insufficient. Stock and rebuilding programmes have generally been unsuccessful, USA salmon stocks exhibit the same downward trend that has been shown for many Canadian salmon stocks, especially those located in the Bay of Fundy and along the Atlantic coast of Nova Scotia.

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

ICES re-considered the impact of the closure of the Newfoundland commercial fishery in 1992 on the Newfoundland stocks. An index of salmon returns to illustrate the impact of the commercial salmon fishery moratorium on Newfoundland stocks was based on the difference between the returns in 1984-91 when there was a commercial fishery to those in the years since the commercial fishery closed (1992-97). The average commercial fishing exploitation rate was 44% on small salmon and 75% on large fish. No analysis was presented to evaluate the effects of quota management and commercial closures elsewhere.

Moreover, within Newfoundland, the commercial fishery closure has resulted in increased escapements of both small and large salmon to many 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. The expected benefits to the spawning escapements were not realised. However, in the absence of the measures the spawning escapement would have been even lower at current low marine survival.

3.3 Age-specific stock conservation requirements

Spawning requirements are now considered as threshold reference points, and are defined as the conservation requirement. The conservation requirements for North America have been revised downwards in terms of the number of 2SW fish required for all production areas of North America. Requirements for USA (29,199) and Canadian (123,349) rivers now total 152,548 North American 2SW fish, an overall reduction of 17%. This adjustment resulted from new estimates of productivity of rivers in Québec. Previous estimates of the numbers of spawners required for Québec were based on work in New Brunswick rivers, which are south of the distribution of salmon in Québec. The new conservation threshold was determined following stock-recruitment analysis for six Québec rivers. The conservation threshold was defined as the Sopt value (equivalent to the spawner abundance which would provide for MSY) at the 75% cumulative probability level calculated by Bayesian analysis. A relationship between conservation thresholds and habitat production units was applied to all rivers after calculating production units for each river by means of aerial photography and a Québec specific habitat suitability index (HSI). Only self-sustaining rivers, or parts of rivers which had been fully restored or were under restoration, were included. An egg conservation threshold was calculated then transformed for each river into numbers of 1SW, 2SW and other fish (this last category containing 3SW and older fish and repeat spawners). Salmon population characteristics (age, sex ratio) were also updated based on new information.

Overall, the conservation threshold is 61% (expressed in terms of eggs) of that previously used for Québec salmon rivers. The drop was most noticeable for northern rivers and very large rivers. This is due to the new HSI's, that downgraded the production potential in river sections that exceeded 18 m in width and in rivers where the growing season was shorter. The new conservation threshold for 2SW spawners is 48% of that used previously for Québec salmon rivers (to 29,446 from 60,750). This reduction is proportionally larger than the reduction in egg requirement mainly due to the updating of stock characteristics.

The application of these new conservation thresholds in Québec will lead to reduced retention of large salmon on rivers where it is forecast that conservation thresholds will not be met. As a consequence of these new thresholds, it is anticipated that large salmon retention will be prohibited on forty Québec rivers in year 2000 and quotas for large salmon will be imposed on twenty other rivers. The number of rivers affected in this way could vary in the future dependent upon changes to the forecasted returns.

3.4 Catch options or alternative management advice with an assessment of risks

It is possible to provide catch advice for the North American Commission area for two years. The first is a revised estimate for 2000 for 2SW maturing fish based on improved estimates of the 1999 pre-fishery abundance and accounting for fish which were already removed from the cohort by fisheries in Greenland and Labrador in 1999. The second is an estimate for 2001 based on the pre-fishery abundance forecast for 2000. 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.

3.4.1 Catch option for 2000 fisheries on 2SW maturing salmon

A revised forecast of the pre-fishery abundance for 1999 is provided in Table 3.4.2.1. This value of 66,663 is lower than the value forecast last year at this time of 79,450. A pre-fishery abundance of 66,663 in 1999 can be expressed as 2SW equivalents by considering natural mortality of 1% per month for 10 months resulting in 60,319 2SW salmon equivalents. There have already been harvests of this cohort as 1SW non-maturing salmon in 1999 for both the Labrador (203) and Greenland (5,374) fisheries (Tables 3.4.1.2 and 3.4.1.3) for a total of 5,046 2SW salmon equivalents already harvested, when the mortality factor is considered.

Table 3.4.1.4 uses the probability density projections for the revised pre-fishery abundance estimate of 66,663 (at 50% probability) and subtracts the spawning reserve (170,286) and the harvests in Greenland and Labrador of 1SW non-maturing fish in 1999, and converts the remainder to 2SW salmon equivalents. Catch options values = [PFA_i - spawning reserve - harvest in Greenland and Labrador in 1999 of 1SW non-maturing fish] * exp[-(0.01 *10 months)] where PFA_i = values from 25–95% and spawning reserve = 170,286.

Results indicate that there are no harvest possibilities at forecasted levels which would be considered risk-neutral or risk-averse, that is, at probability levels of 50% and below. It should be clear from the above that the numbers provided for catch options refer to the composite North American fisheries. As the biological objective is to have all rivers reaching their conservation requirements, it is obvious that river-by-river management is necessary. On individual rivers, where spawning escapement requirements are being achieved, river catches corresponding to surplus escapement can proceed.

Regional assessments in some areas of eastern North America provide a more detailed consideration of expectations for 2000, taking into consideration the contribution of all sea ages of salmon to the spawning population. By area, these are:

Labrador: salmon returns in the year 2000 will be from a higher number of spawners than in recent years, although the lack of long-term monitoring facilities in Labrador makes it difficult to define forecasts or the current status of these stocks.

Newfoundland: the number of spawners has been relatively high in recent years, however, smolt output from all monitored rivers (with the exception of Highlands River in SFA 13) declined in each of the past two years. In the absence of any improvement in marine survival rates, returns of small salmon in 2000 will be lower and there is no prospect of reopening retention fisheries until these conditions improve.

Québec: Returns of large salmon are expected to be insufficient for attainment of conservation requirements on the following rivers in 2000 and large salmon fisheries are not expected to occur in these rivers (Betsiamites, Cap-Chat,du Grand Pabos, du Petit Pabos, Godbout, Malbaie (Q7), Mingan, Nouvelle, Petite Cascapedia, and Rimouski). In addition, twenty-nine additional small rivers will be either closed to all exploitation or restricted to small salmon retention only .

Gulf: In SFA 15, returns in 2000 should be similar to the last 5 years, approximately at conservation requirements and current levels of harvest have not been limiting stock conservation. In SFA 16, a lower return of large salmon is expected with little to no chance of meeting the conservation requirement in the Southwest Miramichi, the Miramichi River overall and the Buctouche River while there is a modest chance of reaching conservation on the Northwest Miramichi and an expectation of exceeding requirements on the Tabusintac River. In SFA 18, Northumberland Strait and Cape Breton rivers, including the Margaree, are expected to exceed conservation requirements in 2000.

Scotia-Fundy: In SFAs 19-23, salmon returns (both large and small) in 2000 are not expected, with few exceptions, to be sufficient to meet conservation requirements, including those receiving hatchery stocking.

USA: Salmon returns (both large and small) in 2000 are not expected to be sufficient to meet conservation requirements in any river, including those receiving hatchery stocking.

Catch advice for the NAC Area is included in the section relevant to West Greenland (Section 4.6).

3.4.2 Catch option for 2001 fisheries on 2SW maturing salmon

The advice for 2001 (Table 4.6.3.1), as an example, assumes a 40% Greenland/60% North America division of the surplus for harvest (after reserving the spawner requirement of 170,286) and expresses catch options as 2SW salmon equivalents (by considering 10 months of mortality at 1% per month). As noted in a later section of the report, the forecast is very uncertain. Risk adverse approaches would use probabilities much lower than 50%. The calculation is as follows:

$$[[PFA_i - \text{spawning reserve}] * \exp[-(0.01 \times 10 \text{ months})] * 0.60$$

From Table 3.4.2.1, it is clear that there are no harvest possibilities at forecasted levels that would be considered risk-averse, that is, below probability levels of 50%. At the 50% level, a catch option of 5,218 2SW salmon equivalents is forecast. This is less than half of the most recent catch estimate of 11,057 fish harvested as 2SW equivalents in 1999. It should be clear from the above that the numbers provided for catch options refer to the composite North American fisheries. As the biological objective is to have all rivers reaching their conservation requirements, river-by-river management will be necessary. On individual rivers, where spawning requirements are being achieved, river catches corresponding to surplus escapement can proceed.

3.5 Data deficiencies, monitoring needs and research requirements

While some progress was made on research needs identified last year, particularly in the areas of refinement of spawner requirements and the initiation of some wild smolt sampling programs (Miramichi) and adult enumeration programs in Labrador, further work is required, and accordingly last year's recommendations is reiterated together with new research requirements.

1) There is a critical need to maintain and augment monitoring of salmon returns and develop habitat-based spawner requirements in Labrador, and to monitor salmon returns in the Ungava regions of Québec.
2) There is a need to investigate changes in the biological characteristics (mean weight, sex ratio, sea-age composition) of returns to rivers, spawning stocks, and the harvest in aboriginal fisheries in Labrador. These data and new information on measures of habitat and stock recruitment are necessary to reevaluate existing estimates of spawner requirements in Canada and USA and for use in the run reconstruction model.

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

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

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

6) A consistent approach to estimating returns is needed, to incorporate broodstock, if offspring from such broodstock are stocked back into the management area from which their parents originated.

7) Update the smolt age distributions of 2SW salmon in the six stock areas of North America and assess the effects of annual changes of smolt age distribution in the calculation of lagged spawners, and other measures of spawning stock variables, used in PFA forecast modeling.

4 ATLANTIC SALMON IN THE WEST GREENLAND COMMISSION AREA

4.1 Events in the 1999 fisheries and status of stocks

4.1.1 Fishery in the WGC area

Catch: In 1999, the West Greenland Commission of NASCO agreed on a multi-year approach for conservation of the salmon stocks occurring in Greenland, and therefore for 1999 and 2000 the catch at West Greenland in each of the years should be restricted to that amount used for subsistence in Greenland, which in the past has been estimated at 20 t. The Greenland authorities subsequently set the TAC for 1999 at 20 t. The fishery began on August 18 and was closed October 14 as the reported catch had passed 18 t. The nominal catch totalled 19 t. No landings went to fish plants in 1998 and 1999. Regulations required that private sales and catches by food fishermen be recorded. With reporting being the responsibility of individual fishermen and the fishery being more scattered than before, unreported catches are estimated to be relatively larger than when most landings went to fish plants (1977 and earlier). The unreported catch in 1999 is estimated to be approximately 10-15 t.

Gear and effort: No new information was available on fishing gear and effort. However, only 98 licensed fishermen (out of 412 issued licences) reported having fished in 1998. In total, 103 licensed and non-licensed fishermen (food fishermen) reported catches. Landings to local markets accounted for the largest part of the reported catches.

Origin of catches: Based on discriminant analysis of characteristics from scales sampled in the fishery, 91 % of fish in 1999 were of North American origin, the highest proportion in record. The catch at West Greenland in 1999 was estimated to consist of 17.8 t (5 700 salmon) of North American origin and 1.8 t (600 salmon) of European origin. These values represent an increase of 84 % of the North American and a reduction of 33 % of the European components, respectively, of the landings in 1998.

The 1999 analysis was based on 532 scales collected in NAFO Div.1B, 1C, 1D, and 1F, in the period August 23 to September 25. Samples of muscle tissue were also collected for identification of continent of origin based on nuclear DNA (microsatellites). The period of sampling was limited to the first half of the fishing season, corresponding to approximately 54 % of the reported landings. Apart from landing sites in Div 1E there was a better sampling coverage in 1999 than in the year before, and ICES noted that there had been a considerable improvement in the sampling success.

This was the fourth year that nuclear and mitochondrial DNA had been collected from the fishery and analysed. For the DNA analysis, the overall percent North American in 1999 was 86.6 %, a difference of 0.9 % from the samples determined by scale analysis. The close correspondence between the DNA technique and the scale interpretations is indicative of the good classification results.

Biological characteristics of the catch: One-sea-winter fish of North American and European origins comprised 96.8 % and 100.0 %, respectively, of the catch samples from West Greenland in 1999, and were among the highest proportions of a 13-year data set. Two-sea-winter fish comprised very low proportions (1.2 % North American and 0.0 % European) of the data series; previous spawners comprised the remainder.

Mean lengths of 63.9 cm and 63.3 cm for respective North American and European 1SW fish at West Greenland, increased slightly over lengths in 1998. Fish of North American origin were larger than observed in the 1990s while European origin fish were within the range of those values observed in the 1990s. Mean weights (3.1 and 3.0 kg for NA and European fish, respectively) of 1SW fish increased slightly over those of 1998, and reached thus the highest values observed in the 1990s.

Percentage river ages among fish sampled at West Greenland in 1998 were:

	River age					
Salmon origin	**1**	**2**	**3**	**4**	**5**	**6+**
N American	0.0	15.5	57.6	23.5	3.4	0.0
European	24.6	68.8	6.5	0.0	0.0	0.0

All but the 6.5 value for river-age-3 European fish were within the range of values 1968–1998. However, for the 1990s, North American river-age-1 and -2 fish had the lowest values, river-age 3 and -4 had the highest and the second highest values. The pattern among the percentage European river ages in 1999 relative to those of the 1990s was the opposite. River-age 1 and -2 had the highest and second highest values, respectively, while river-ages 3 and 4 had the lowest values.

4.1.2 Status of stocks in the WGC area

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

Stocks originating in the Northeast Atlantic: Run-reconstruction estimates of pre-fishery abundance of non-maturing 1SW salmon from southern areas (Figure 2.3.2) have been volatile over the period 1971–1998. Three distinct periods are noted leading to an overall decline over the past 14 years. In 1996-1998, it was estimated that even in the absence of all fisheries, the numbers of non-maturing recruits from the southern area were below the proposed spawning escapement reserve (SER). Non-maturing 1SW salmon from northern stocks (Figure 2.3.1) have declined since 1985, particularly in 1986-1987. The recovery of the stocks that was indicated in 1998 did not seem to continue in 1999.

Measures of adult returns back to the rivers within the NEAC area showed that of the rivers examined in 1999, approximately half showed increased counts and half decreased counts. A classification analysis, based on the last 10 years count information, identified two groups of rivers; one showing declining counts over the period and the other revealing no trend. The majority of the Northern European rivers were classified in the declining group whereas the Southern rivers were split equally between the two groups.

Analysis of attainment of conservation limits (CL) indicated variable status of salmon stocks in different rivers of the NEAC area. Some rivers have never or seldom reached their CL over the last 10 years, whereas others have been consistently above their CL. Many rivers that have reached their CL in most years show a decreasing trend in escapement, however, and no tendency to recover was observed for rivers with low escapement values.

Stocks originating in North America: The run-reconstruction estimate of pre-fishery abundance of non-maturing 1SW salmon for 1998 was 96 057 fish, 20 % higher than that of 1997, these estimates being the second lowest and lowest on record, respectively (Figure 3.1.2.4). In addition to the steady decline in non-maturing and maturing 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 between 65 and 84 % in the last five years.

Total returns of 2SW fish to Labrador and thus Canada could not be estimated in 1998 and 1999. However, with the exception of insular Newfoundland where 2SW salmon are only a small proportion of the total salmon production, returns to the important Gulf, Québec and Scotia-Fundy production areas were either the lowest or second lowest of the 29-year time series, 1971–1999 (Figure 3.1.2.2). The estimated 2SW returns and spawners to USA rivers in 1999 were 23 % below the 1998 estimate and 32 % and 52 % below the previous 5-and 10-year averages, respectively. Returns to most USA rivers are hatchery-dependent. Spawning escapements remained low compared to conservation requirements.

Egg depositions exceeded or equalled the specific conservation requirements in only 37 of the 67 rivers (55 %) that were assessed in Canada and were less than 50% of requirements in 15 other rivers (22%). Large deficiencies in egg depositions were noted in the Bay of Fundy and Atlantic coast of Nova Scotia where 9 of the 12 rivers assessed had egg depositions that were less than 50% of requirements (Figure 3.1.2.6).

North American salmon stocks remain low relative to the 1970s. The steady decline over the last twelve years is alarming (Figure 3.1.2.5). The 1SW non-maturing component continues to be depressed with river returns and total production amongst the lowest recorded. In addition, returns in 1999 of maturing 1SW salmon (grilse) to North American rivers were very low. This being the case, improvement in 2SW salmon returns and spawners is unlikely in 2000.

Thus, despite some improvements in 2SW returns to some rivers in European and North American areas, the overall status of stocks contributing to the West Greenland fishery is low compared to earlier.

4.2 Effects on European and North American stocks of the West Greenland management measures since 1993

There have been two significant changes in the management regime at West Greenland since 1993. First, NASCO adopted a new quota allocation model to derive TACs based upon ICES assessment of the PFA of non-maturing 1SW North American salmon and the spawner requirements for these stocks. This resulted in a substantial reduction in the TAC in 1993 from that of 1992, and further reductions in subsequent years. The second change in management was the suspension of fishing in 1993 and 1994 for compensation payments.

The estimated numbers of salmon returning to home waters in the absence of a fishery, 1993–1994, or had the fishery in 1995–1999 not taken place, are:

Year	Quota T	Grnl TAC (t)	Catch t	EU Fish	NA Fish
1993	89	89	0	12,425	13,973
1994	137	137	0	19,126	21,510
1995	77	77	83	8,724	19,881
1996	174	0	92	7,293	20,206
1997	57	0	58	2,722	16,656
1998	20	0	11	712	2,758
1999	20	0	19	503	4,854

Estimation of TACs for 1993 and 1994 was based on the NASCO model, biological parameters (mean weights, proportions of NA fish, and age correction factors etc.) were assumed to the same as those of 1992. For the remaining years, estimates of fish that would have returned to home waters had there not been a fishery were based on same year biological characteristics and a natural mortality between Greenland and home waters of 0.10. The mean number of potential returns per ton caught at Greenland is 204 and 105 North American and European salmon, respectively.

The exploitation rate by year is shown in Figure 4.2.1. In the years 1972–1992, exploitation rates in Greenland of the North American component of the salmon stock averaged about 30% but varied between 10 and 45%. No commercial fishery operated in 1993 and in 1994. When commercial fishery reopened in 1995 exploitation rates were around 15 %. Measures banning sales to commercial fish plants introduced in 1998 reduced the exploitation rate to below 5 %

These calculations assume that natural mortality of salmon at sea has remained unchanged. As highlighted in several places in this document, marine survival has declined markedly, particularly for salmon of North American origin. Increased natural mortality, i.e. lower marine survival, implies lower estimates of sustainable yields. Methods are being explored for including a downward trend in survivorship in this and various other calculations.

4.3 Changes to the model used to provide catch advice

The models (see Section 4.5) used to predict pre-fishery abundance of the North American non-maturing stock complex and subsequent quota levels for West Greenland were unchanged from the 1999 assessment. The same independent variables used previously were found to provide an improved fit over last year's model. However, some of the input data were modified to reflect new information. These included: improvement of the catch reporting system in the Province of Newfoundland and Labrador by inclusion of catch statistics from Aboriginal fisheries in northern Labrador;

data from an estimation procedure for returns to Labrador in lieu of commercial catches (see Section 3.1.2), improvements in the procedure used to estimate continent of origin in Greenland and the addition of another year of data to all data series. In summary, the 1999 catch advice of 0 t would not have been different if the 1999 assessment had been done with the revised input data and models from this year.

4.4 Age-specific stock conservation limits for all stocks occurring in the WGC area

Sampling of the fishery at West Greenland since 1985 has shown that both European and North American stocks harvested there are primarily (greater than 90%) 1SW non-maturing salmon that would mature as either 2SW or 3SW salmon, if surviving to spawn. Usually less than 1% of the harvest are salmon which have previously spawned and a few percent are 2SW salmon which would mature as 3SW or older salmon, if surviving to spawn. In 1998, 96.8 and 99.4% of the sampled catch was 1SW salmon of North American and European origins, respectively. For this reason, conservation limits defined for North American stocks (see Section 3.3) have been limited to 2SW salmon that may have been at Greenland as 1SW non-maturing fish. The total requirement is 152,548 fish, with 123,349 and 29,199 prescribed for Canadian and USA rivers, respectively; the reserve spawner requirement (includes 10 months of mortality at 1%) is 170,286 fish.

Tagging information and biological sampling indicates that the majority of the European salmon caught at West Greenland originate from the southern group of stocks. Estimates of provisional conservation limits for MSW salmon in Europe are based on the methods developed in 1998 and revised in 1999 and 2000. The provisional conservation limit for southern European MSW stocks is now approximately 530,000 fish with a spawner escapement reserve equalling about 630,000 fish (see Section 2.4).

4.5 Catch options or alternative management advice with an assessment of risks

4.5.1 Overview of provision of catch advice

Concerns of the implications of applying TACs to mixed stock fisheries are still relevant to catch advice. In principle, adjustments in catches in mixed-stock fisheries provided by means of an annually adjusted TAC would reduce mean mortality on the contributing populations. However, there is no assurance that reductions in exploitation will affect those stocks that are not meeting conservation requirements, and benefits that might result for particular stocks would be difficult to demonstrate, in the same way that impact on individual stocks are difficult to identify.

The procedures to develop catch advice, an evaluation of the models, and vulnerabilities in the existing procedures were presented in the 1997 and 1999 assessments. The processes remain unchanged in 2000 although some of the input data were modified to reflect new information (Section 4.3).

North American run-reconstruction model: The model is used 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. Region-specific estimates of 2SW returns are shown in Figure 3.1.2.2. 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, returns for Labrador were unknown in 1998-99 but 1998 pre-fishery numbers were estimated from a raising factor 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 1971–1996 (see Section 3.1.2).

Update of thermal habitat: Thermal habitat has been updated to include 2000 data. Two periods of decline in the available habitat are identified (1980–1984 and 1988–1995) in the February index (Table 3.4.1.1). Available habitat for February declined from 1,741 units in 1999 to 1,634 units in 1999, a decrease of 6%. The 2000 February value is an average level and continues the return to the high values experienced in the 1970s. The variable "February habitat" in the 1999 and 2000 forecast models of pre-fishery abundance now, however, accounts for less of the variability than it did previously (see Section 4.6.2).

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

The model employed in 1998 using thermal habitat for February and lagged spawners [sum of lagged spawners from Labrador, Newfoundland, Scotia-Fundy and Québec] was updated to reflect the addition of the new data. The linear fit to the 2000 model of pre-fishery abundance versus February thermal habitat and lagged spawners (SNLQ) produced a significant relationship between observed and predicted values at less than the 5% level (R^2=0.83). The model parameters are all significant, with lagged spawners accounting for most (66%) of the total sum of squares (February habitat accounting for 17%). Individually, the two predictor variables used are also significantly related to pre-fishery abundance.

The forecast of pre-fishery abundance for 2000 using simulation methods and the February thermal habitat and lagged spawner model is estimated at 179,897 fish at the 50% probability level (Table 3.4.1.1). Application of the 2000 forecast model to forecast the 1999 value results in a forecast of 66,663 which is 16% less than the previous estimate of 79,450 fish. Table 3.4.1.1 shows the deterministic PFA values (mid) and the simulated forecast values of the same parameter (jackknife prediction).

4.5.3 Development of catch options for 2000

The spawning requirement for all North American rivers is currently set at 152,548 2SW-fish which is the equivalent of 170,286 pre-fishery recruits (spawning reserve) prior to natural mortality between Greenland and home waters. The procedure for estimating the quota for West Greenland is summarised in Appendix 2. Forecast parameter values for the proportion of the stock at West Greenland which is of North American origin [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] used in the procedure are given in Table 4.6.3.1.

Greenland quota levels for the forecast of pre-fishery abundance were computed with the revised model and are shown in Table 4.6.3.1. For the point estimate and the stochastic regression estimate using NN1, the quota options are 0 t at all probabilities less than 50%. For the FNA used in recent management measures for the West Greenland Commission (at the 0.4 allocation rate), the quota is 14 t at the 50% risk.

4.5.4 Risk assessment of catch options

The provision of catch advice in a risk framework involves the incorporation of the uncertainty in factors used to develop the catch options. An analysis of the probability of not meeting the conservation requirements in the six stock areas of North America was conducted by incorporating the uncertainty in all the parameters used to evaluate the spawning escapement to North America. They included i) the conservation requirement risk plot ii) the uncertainty in many of the pre-fishery abundance forecast, and iii) uncertainty in the biological parameters used to translate catches (proportion North American origin, weight of 1SW North American origin, weight of 1SW European origin, age correction factor) into numbers of North American origin salmon.

Under the assumption of recruitment in direct proportion to the spawner requirement, just over 170,000 fish are required to escape to North America to produce a 50% probability of achieving the spawner requirement concurrently in all six stock areas. This value is higher than the 152,548 fish point estimate of total requirements to North America because it incorporates the annual variation in the proportion of females.

The pre-fishery abundance of salmon in 2000 is expected to be low, Figure 4.6.4.1. There is a high risk (almost 50% probability) that the returns of 2SW salmon to North America in 2001 will be below the conservation requirement in at least one of the six stock areas, even in the absence of any fisheries-induced mortality on this age group in Greenland in 2000 (Figure 5.6.4.2). There is a low (11% chance) but real probability that at least one of the six stock areas will be severely under-escaped (by 50%). The risk profile is shallow over the range of catch options illustrated (0 to 1000 t) which reflects the degree of uncertainty in the expected abundance relative to the catch options considered.

Considering the status of the stocks, i.e. downward trend in abundance, poor marine survival and small potential returns relative to spawning escapement requirements, a risk adverse approach to managing both of the Greenland and North American salmon fisheries is advised.

Even if fisheries are restricted to harvests, which provide a 50% probability that the overall escapement requirements are achieved, it is likely that some stocks will fail to meet their individual spawner requirements while others will exceed requirement levels. This unequal achievement of escapement goals may result from random variation between years or from systematic differences in the patterns of exploitation on fish from different rivers or regions. In the latter case, adoption of a risk neutral (50% probability) may result in some stocks failing to meet requirements over several consecutive years if the full TAC is harvested. This would be likely to result in a long-term decline in those stocks.

4.5.5 Impact in Regional Estimates of Returns

Uncertainty in regional estimates of returns: The pre-fishery abundance used to develop catch options for the fishery at West Greenland incorporates estimates of 2SW returns from six North American regions, as well as catch information from the West Greenland fishery. The methodology used to estimate returns varies considerably among regions, and the proportion of the estimate based on enumerated fish returns (weir counts, commercial and recreational landings and experimentally verified assessment techniques) varies among regions and through time. Closure of Canadian commercial and recreational fisheries and significant reductions in the quota and landings in the West Greenland fishery have significantly reduced enumeration of salmon from these sources. This has resulted in concerns that estimation of the 2SW returns has become increasingly reliant on estimation techniques, assumptions and raising factors (e.g., weir counts on a single or set of rivers used to calibrate returns for an entire region). The increasing dependence on estimation techniques is important because although returns enumerated by catch and escapement monitoring programmes have some uncertainty whose magnitude depends on the enumeration method, returns based on estimation algorithms are expected to be much more uncertain.

An index of the proportion of estimated 2SW returns based directly on various enumeration methods rather than estimation algorithms was developed for each region and for the fishery in West Greenland. This index was the ratio of the enumerated returns to the total annual estimates of 2SW returns. Changes to these region-specific indices of the relative data content of each annual 2SW return estimate corresponded well to known changes in fisheries and assessment programs.

To develop an overall index for the North American 2SW return estimate, indices from each region were weighted by their relative contributions to the total 2SW return estimate. The index began above 0.9 in the early 1970's reflecting the very large proportions of 2SW salmon either taken in monitored catches or returned to enumerated rivers and subsequently declined gradually through the 1980's (Figure 4.5.5.1). The index exhibited a sharp decline between 1992 and 1993 in response to the 1993 buyout of the Greenland fishery, and continued to decline to approximately 0.5 in response to closure of Canadian fisheries and restricted catches in the West Greenland fishery. Although additional work is required to standardize the inputs into the calculation of the index, the preliminary results demonstrate the relative impact of losses of information sources of non-maturing 1SW catches and enumerated returns of 2SW salmon to homewaters have on the estimation of returns and PFA estimates for North America.

Degree of measurement error on PFA estimates and impact on forecast: The impact of uncertainty in the lagged spawners (SNLQ) and Pre-Fishery abundance (PFA) estimates on predicted 2SW returns was also explored. Uncertain input values for SNLQ and PFA can have disruptive effects on model fitting and increase the uncertainty of the predictions. As the input variables become more uncertain they become less informative about future PFA. Monte Carlo estimates of PFA become more variable with the centre of the distribution approaching the mean of the time series. The uncertainty in the PFA and SNLQ was estimated for the 1977 to 1998 time series. The uncertainty , expressed as half the range relative to the midpoint value, was generally less than 20% for the PFA between 1978 and 1992 but increased to between 25% and 30% afterwards, corresponding to the pattern seen in the index in Figures 4.5.4.1. The SNLQ variable had much higher relative uncertainty at about +/- 40% between 1978 and 1989 and decreasing to about 30% for the subsequent years. The inclusion of the uncertainty in the forecast model increased the median predicted PFA in 1999 from 179,000 to 307,000 fish and also increased the spread of the distribution. These changes reflect the growing influence of the overall average conditions as recent values of PFA and SNLQ are treated as less informative about conditions in 1999. A combination of increased uncertainty in the estimates and a decrease in the reliability of the model would suggest that management should be more risk averse and that more conservative measures are required to maintain a given level of risk.

4.5.6 Catch advice

Although a large proportion of the examined North American stocks meet conservation targets, Figure 3.1.2.6, many are failing to meet targets or are only barely doing so. Estimate of pre-fishery abundance in 2000 is only slightly higher than the spawning escapement reserve. Despite complete closures of mixed and single stock fisheries the very small surplus over spawning requirements and the uncertainty in the estimates make a strong case for even more conservative management measures.

ICES considers this stock complex to be outside safe biological limits and recommends that there should be no exploitation of the 1998 smolt cohort as non-maturing 1SW fish in North America or at Greenland in 2000, and also recommends that the cohort should not be exploited as mature 2SW fish in North America in 2001. Exceptions are in-river harvests from stocks, which can be shown to be above biologically-based spawning escapement requirements. Further, exploitation rate on this cohort should be minimised in the North American Commission and in the West Greenland Commission Areas by controlling by-catch in other fisheries. From a precautionary perspective, in light of uncertainties in changing maturity schedules and spatial distributions, ICES advises that there should be no exploitation of the 1999 smolt cohort as maturing 1SW fish in North America, except for in-river harvests from stocks which have been shown to be above biologically-based escapement requirements, consistent with existing conservation measures.

4.6 Data deficiencies, monitoring needs and research requirements in the WGC area

1) The mean weights, sea and freshwater ages and continent of origin are essential parameters to provide catch advice for the West Greenland fishery. As these parameters are known to vary over time, the Working Group recommends that the sampling programme, which occurred in 1995-99, be continued and improved to spatially and temporally cover as much of the landings as possible.
2) Efforts should be made to improve the estimates of the annual catches of salmon taken for local consumption in Greenland.
3) The catch options for the West Greenland fishery are based almost entirely upon data taken from North American stocks (with the current exclusion of Labrador, see Section 4.6). In view of the evidence of a long-term decline in the European stock components contributing to this fishery (southern European non-maturing 1SW recruits) the Working Group emphasised the need for information from these stocks to be incorporated into the assessments as soon as possible.
4) The Working Group recommends that an evaluation be conducted on the present reliability of the PFA estimate. An initial approach is to determine what fraction of the PFA estimate is directly based on catches and assessed returns (hard data), and what fraction results from less certain information such as scaling factors for potential productive habitat.
5) It is recommended that the extent of the measurement error inherent in the run-reconstruction model should be estimated to describe the potential bias in the model and the description of uncertainty associated with the forecast.
6) The inclusion of measurement error in the forecast model increases the uncertainty of the forecast, and under increased uncertainty alternative risk levels to the 50 % point should be considered, consistent with the precautionary approach.
7) Other indices of adult salmon abundance should be examined and used as prior information to constrain the plausible range of abundance levels.
8) Alternative models should be explored (for example different predictive variables, model formulations, univariate time series, non-parametric change-of-state analyses) to provide some index of plausibility of the quantitative forecasts.

5 SOURCE OF INFORMATION

Report of the Working Group on North Atlantic Salmon, April 2000 (ICES Doc. CM 2000/ACFM:13).

APPENDIX 1 REQUEST FOR SCIENTIFIC ADVICE FROM NASCO TO ICES (JULY 1999)

CNL (99)46

1. with respect to Atlantic salmon in the North Atlantic area:
   1.1. 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 1999,
   1.2. describe and evaluate methods currently used for estimating unreported catch by country and advise on improvements to these methods where appropriate,
   1.3. advise on the data requirements and methods for the scientific evaluation of bird and marine mammal predation on Atlantic salmon,
   1.4. report on significant developments which might assist NASCO with the management of salmon stocks,
   1.5. provide compilation of egg collections and juvenile releases and of tag releases, by country, in 1999,
   1.6. provide estimates of escapement from marine salmon farms by country and assess the reliability and comparability of estimates of salmon farm escapees in fisheries and stocks;

2. with respect to Atlantic salmon in the North-East Atlantic Commission area:
   2.1. describe the events of the 1999 fisheries and the status of the stocks,
   2.2. evaluate the effects on stocks and homewater fisheries of significant management measures introduced since 1991,
   2.3. further develop the age-specific stock conservation limits where possible based upon individual river stocks,
   2.4. further develop methods to estimate the expected abundance of salmon in the Commission area,
   2.5. determine the most appropriate stock groupings for the provision of catch options or alternative management advice,
   2.6. provide catch options or alternative management advice with an assessment of risks relative to the objective of exceeding stock conservation limits,
   2.7. provide an estimate of the by-catch of salmon post-smolts in the pelagic fisheries,
   2.8. identify relevant data deficiencies, monitoring needs and research requirements;

3. with respect to Atlantic salmon in the North American Commission area:
   3.1. describe the events of the 1999 fisheries and the status of the stocks,
   3.2. 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, with special emphasis on the Newfoundland stocks,
   3.3. update age-specific stock conservation limits based on new information as available,
   3.4. provide catch options or alternative management advice with an assessment of risks relative to the objective of exceeding stock conservation limits,
   3.5. identify relevant data deficiencies, monitoring needs and research requirements;

4. with respect to Atlantic salmon in the West Greenland Commission area:
   4.1. describe the events of the 1999 fisheries and the status of the stocks,
   4.2. critically evaluate, and provide sensitivity analyses of, the effects on European and North American stocks of the Greenlandic quota management measures and compensation arrangements since 1993,
   4.3. provide estimates of uncertainty and evaluate apparent recent changes in the proportion of continent of origin detected in the West Greenland fishery catches,
   4.4. 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,
   4.5. provide age-specific stock conservation limits for all stocks occurring in the Commission area based on best available information,
   4.6. provide catch options or alternative management advice with an assessment of risks relative to the objective of exceeding stock conservation limits,
   4.7. identify relevant data deficiencies, monitoring needs and research requirements.

6 APPENDIX 2. COMPUTATION OF CATCH ADVICE FOR WEST GREENLAND

The North American Spawning Reserve (SpT) for 2SW salmon has been revised to 152,548 fish in 2000.

This number must be divided by the survival rate for the fish from the time of the West Greenland fishery to their return of the fish to home waters (11 months) to give the Spawning Target Reserve (SpR). Thus:

Eq. 1. $SpR = SpT * (exp(11*M)$ (where $M = 0.01$)

The Maximum Allowable Harvest (MAH) may be defined as the number of non-maturing 1SW fish that are available for harvest. This number is calculated by subtracting the Spawning Target Reserve from the pre-fishery abundance (PFA).

Eq. 2. $MAH = PFA - SpR$

To provide catch advice for West Greenland it is then necessary to decide on the proportion of the MAH to be allocated to Greenland (f_{NA}). The allowable harvest of North American non-maturing 1SW salmon at West Greenland NA1SW) may then be defined as

Eq. 3. $NA1SW = f_{NA} * MAH$

The estimated number of European salmon that will be caught at West Greenland (E1SW) will depend upon the harvest of North American fish and the proportion of the fish in the West Greenland fishery that originate from North America [PropNA] [1]. Thus:

Eq. 4. $E1SW = (NA1SW / PropNA) - NA1SW$

To convert the numbers of North American and European 1SW salmon into total catch at West Greenland in metric tonnes, it is necessary to incorporate the mean weights (kg) of salmon for North America [WT1SWNA][1] and Europe [WT1SWE][1] and age correction factor for multi-sea winter salmon at Greenland based on the total weight of salmon caught divided by the weight of 1SW salmon [ACF][1]. The quota (in tonnes) at Greenland is then estimated as

Eq. 5. $Quota = (NA1SW * WT1SWNA + E1SW * WT1SWE) * ACF/1000$

[1] New sampling data from the 1995-99 fishery at West Greenland were used to update the forecast values of the proportion of North American salmon in the catch (PropNA), mean weights by continent [WT1SWNA, WT1SWE] and the age correction factor [ACF] in 1996.

Table 1.1.1.1 Nominal catch of SALMON by country (in tonnes round fresh weight), 1960-1999. (1999 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.Ireland (6,9)	UK (Scotland)	USA	Other (10)	Total Reported Catch	Unreported catches NASCO Areas	Unreported catches International waters (11)
1960	1636	-	-	-	-	-	60	100		743	1659	1100	33	-	40	283	139	1443	1	-	7237	-	-
1961	1583	-	-	-	-	-	127	127		707	1533	790	20	-	27	232	132	1185	1	-	6464	-	-
1962	1719	-	-	-	-	-	244	125		1459	1935	710	23	-	45	318	356	1738	1	-	8673	-	-
1963	1861	-	-	-	-	-	466	145		1458	1786	480	28	-	23	325	306	1725	1	-	8604	-	-
1964	2069	-	-	-	-	-	1539	135		1617	2147	590	34	-	36	307	377	1907	1	-	10759	-	-
1965	2116	-	-	-	-	-	861	133		1457	2000	590	42	-	40	320	281	1593	1	-	9434	-	-
1966	2369	-	-	-	-	-	1370	104	2	1238	1791	570	42	-	36	387	287	1595	1	-	9792	-	-
1967	2863	-	-	-	-	-	1601	144	2	1463	1980	883	43	-	25	420	449	2117	1	-	11991	-	-
1968	2111	-	5	-	-	-	1127	161	1	1413	1514	827	38	-	20	282	312	1578	1	403	9793	-	-
1969	2202	-	7	-	-	-	2210	131	2	1730	1383	360	54	-	22	377	267	1955	1	893	11594	-	-
1970	2323	-	12	-	-	-	2146	182	13	1787	1171	448	45	-	20	527	297	1392	1	922	11286	-	-
1971	1992	-	-	-	-	-	2689	196	8	1639	1207	417	16	-	18	426	234	1421	1	471	10735	-	-
1972	1759	-	9	32	34	-	2113	245	5	1804	1578	462	40	-	18	442	210	1727	1	486	10965	-	-
1973	2434	-	28	50	12	-	2341	148	8	1930	1726	772	24	-	23	450	182	2006	2.7	533	12670	-	-
1974	2539	-	20	76	13	-	1917	215	10	2128	1633	709	16	-	32	383	184	1628	0.9	373	11877	-	-
1975	2485	-	28	76	25	-	2030	145	21	2216	1537	811	27	-	26	447	164	1621	1.7	475	12136	-	-
1976	2506	-	40	66	9	<1	1175	216	9	1561	1530	542	21	2.5	20	208	113	1019	0.8	289	9327	-	-
1977	2545	-	40	59	19	6	1420	123	7	1372	1488	497	19	-	10	345	110	1160	2.4	192	9414	-	-
1978	1545	-	37	37	20	8	984	285	6	1230	1050	476	32	-	10	349	148	1323	4.1	138	7682	-	-
1979	1287	-	119	26	10	<0.5	1395	219	6	1097	1831	455	29	-	12	261	99	1076	2.5	193	8118	-	-
1980	2680	-	536	34	30	<0.5	1194	241	8	947	1830	664	47	-	17	360	122	1134	5.5	277	10127	-	-
1981	2437	-	1025	44	20	<0.5	1264	147	16	685	1656	463	25	-	26	493	101	1233	6	313	9954	-	-
1982	1798	-	606	54	20	<0.5	1077	130	17	993	1348	364	10	-	25	286	132	1092	6.4	437	8395	-	-
1983	1424	-	678	58	16	<0.5	310	166	32	1656	1550	507	23	3	28	429	187	1221	1.3	466	8755	-	-
1984	1112	-	628	46	25	<0.5	297	139	20	829	1623	593	18	3	40	345	78	1013	2.2	101	6912	-	-
1985	1133	-	566	49	22	7	864	162	55	1595	1561	659	13	3	45	361	98	913	2.1	-	8108	-	-
1986	1559	-	530	37	28	19	960	232	59	1730	1598	608	27	2.5	54	430	109	1271	1.9	-	9255	315	-
1987	1784	-	576	49	27	<0.5	966	181	40	1239	1385	564	18	2	47	302	56	922	1.2	-	8159	2788	-
1988	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
1991	711	3.3	95	70	13	4	472	130	345	404	876	215	11	1.2	38	200	55	462	0.8	-	4106	1682	25-100
1992	522	10	23	77	20	5	237	175	460	630	867	167	11	2.3	49	186	91	600	0.7	-	4133	1962	25-100
1993	373	9	23	70	16	-	-	160	496	541	923	139	8	2.9	56	248	83	547	0.6	-	3696	1644	25-100
1994	355	6	6	49	18	-	-	140	308	804	996	141	10	3.4	44	249	91	649	-	-	3869	1276	25-100
1995	260	3.1	5	48	9	2	83	150	298	790	839	128	9	0.8	37	295	83	588	-	-	3628	1060	n/a
1996	292	1.7	-	44	14	<0.5	92	122	239	687	787	131	7	1.5	33	183	77	427	-	-	3138	1123	n/a
1997	229	1.3	-	45	8	1	58	106	50	570	630	111	3	1.5	19	146	93	296	-	-	2368	827	n/a
1998	157	1.3	6	48	9	-	11	130	34	624	740	131	4	2.3	15	125	78	279	-	-	2395	1210	n/a
1999	143	0.5	0	63	11	<0.5	19	119	26	515	811	102	6	2.3	13	152	53	182	-	-	2218	1027	n/a
Means																							
1994-1998	259	3	6	47	12	2	61	130	186	695	798	128	7	2	30	200	84	448	-	-	3080	1099	-
1989-1998	495	5	105	56	14	3	196	140	265	670	849	184	8	2	35	227	89	537	1	-	3816	1495	-

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 no fishery took place.
3. Includes catches made in the West Greenland area by Norway, Faroes, Sweden and Denmark in 1965-1975.
4. From 1994, includes increased reporting of rod catches.
5. Catch on River Foyle allocated 50% Ireland and 50% N. Ireland.
6. Before 1966, sea trout and sea charr included (5% o[illegible]l).
7. Figures from 1991 onwards 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 based on mean wt. from R. Asturias.
9. Not including angling catch (mainly 1SW).
10. Includes catches in Norwegian Sea by vessels from Denmark, Sweden, Germany, Norway and Finland.
11. Estimates refer to season ending in given year.
12. Data for 1993-98 altered from previou[illegible]ports to take account of catch & release

Table 1.1.1.2 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	27	98	68	143
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
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
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
Ireland	1995	566	72	123	16	101	13	790
	1996	440	64	115	17	131	19	686
	1997	379	66	85	15	106	19	570
	1998	433	69	82	13	109	17	624
	1999	335	65	82	16	98	19	515
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
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
St Pierre et Miquelon	1995	1	100	0	0	0	0	1
	1996	2	100	0	0	0	0	2
	1997	2	100	0	0	0	0	2
	1998	2	100	0	0	0	0	2
	1999	2	100	0	0	0	0	2
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

Table 1.1.1.2: continued

Country	Year	Catch: Coast Weight	Coast %	Estuary Weight	Estuary %	River Weight	River %	Total Weight
Sweden	1999	5	37	0	0	8	63	13
UK	1995	193	66	53	18	49	17	295
(England &	1996	77	42	49	26	58	31	183
Wales)	1997	76	54	31	22	35	24	142
	1998	62	50	23	19	38	31	123
	1999	97	64	28	19	26	17	151
UK (N. Ireland)	1999	44	83	9	17	0	0	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	22	28	10	191	68	279
	1999	34	18	16	9	133	73	182
Totals								
North East Atlantic [2]	1999	1045	52	141	7	839	41	2025
North America [3]	1999	10	7	38	26	98	67	145

[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

[2] data not available from Denmark

[3] includes Canada & St Pierre et Miquelon

Table 1.1.3.1 Estimates of unreported catches in tonnes by country within national EEZs in the North-East Atlantic, North America and West Greenland Commissions of NASCO, 1999, (NA = not available).

1999 Commission Area	Country	Unreported Catch t	Unreported as % of Total North Atlantic Catch (Unreported + Reported)	Unreported as % of Total National Catch (Unreported + Reported)
NEAC	Finland	10	0.3	14
NEAC	Iceland	2	0.1	2
NEAC	Ireland	122	3.8	19
NEAC	Norway	437	13.5	35
NEAC	Russia	246	7.6	71
NEAC	UK (E & W)	35	1.1	19
NEAC	UK (Scotland)	29	0.9	14
NAC	Canada	133	4.1	48
NAC	USA	0	0.0	0
WGC	West Greenland	12.5	0.4	40
	Total Unreported Catch	1027	31.6	
	Total Reported Catch of North Atlantic salmon	2218		

Table. 1.2.1. Description and evaluation of national methods used for estimating legal and illegal unreported catches of Atlantic salmon.

Commission Area	Country	Method	Evaluation	Possibilities for Improvement
NAC	Canada	Legal: No legal unreported catches are submitted as unreported catches by Canada. All legal salmon fisheries are licenced & with one exception have a condition of requirement to report catch to respective federal or provincial licencing agencies.	Methods are structured & systematic.	
		The Province of New Brunswick (NB) issues recreational salmon licences without condition of reporting. Survey estimates of recreational catches by licence holders in NB are included in reported catches of Canada.	NB licences offer a structured and systematic method of estimating catches but must include a provision to report catches or must be followed up with a mail survey.	Make mandatory, the annual reporting of catches, or conduct annual mail surveys of licence holders.
		Illegal: (unlicenced)		
		Québec – based on previously undeclared proportions of angling, native & commercial fisheries determined by regional biologists in each fishing area.	Structured and somewhat systematic in Québec.	
		Newfoundland &Labrador – largely based on annual Fishery Officer observations, unconfirmed occurrence reports, & anecdotal information relating to poaching & recreational & native fisheries.	Largely unstructured.	Provision of information and instructions to fishery Officers on systematic methods of annually raising observed illegal catches to a district/ area total estimate.
		New Brunswick (NB), Nova Scotia (NS) & Prince Edward Island (PEI) – based on guess-estimates by regional enforcement staff or a previously estimated proportion of the assessed run-size. (Design surveys and estimates of the unreported catch by licenced recreational fishers in NS & PEI (technically illegal) are like those of NB (legal), included in reported catches for Canada.)	Largely unstructured in NB, NS & PEI. NS & PEI rod catches estimates are structured and systematic.	
	USA	Legal: No legal catch is permitted. Native American Indians do not exercise their sustenance fishing rights. Discussions with fishery officers & anglers on Maine salmon rivers.	Not evaluated.	N/A
		Illegal: Discussions with fishery officers and anglers on Maine salmon rivers.	Not evaluated.	Unknown
NEAC	Faroes	Legal: *Sea fisheries* – Licenced. Assumed that all catches are reported.	No evaluation.	
		River fishery – Unlicenced, reporting not required and unreported.		
		Illegal: *Sea fisheries* - Assumed to be none.	No evaluation	

Commission Area	Country	Method	Evaluation	Possibilities for Improvement
	Finland	Legal:- *Net & rod fisheries* – These are licenced but without requirement to report catch. Estimated by extrapolating the information from reported catch statistics. These estimated catches are submitted as reported catches.	Systematic.	Increase the coverage of catch inquiries (mailing). Cross check with other methods, e.g., a sample of telephone inquiries, personal interviews.
		Illegal:- Guess-estimated.	Not evaluated	Very difficult.
	France	Legal:- Data provided in ICES unreported catches are both legal & illegal. Illegal catches are generally assessed wherever they are thought to be significant. Unreported catches from legal fisheries are accorded to unreported catches		
		Illegal:- *Rod catches* – Guess-estimates made by fishery officers. except in Brittany and Normandy (75% of total rod catch), where two additional methods are used to improve the accuracy of the estimate 1) comparison by fishery officers of the declared catches and the catches they know, which allows them to estimate a report rate on a river-by-river basis; 2) a comparison between the declared catches and the number of carcass "tags" provided to anglers where anglers begin with a single tag and should get another as soon as they have caught one fish.	Largely structured and systematic.	
		Net catches – Surveys in nine estuaries of Brittany where salmon catches could have been significant in 1998 & 1999, involving a survey of netting activity and an evaluation of the catch per unit effort of the nets. Also, field surveys in the Adour estuary in order to assess the reporting rate.	Largely structured although less systematic than methods employed in rod catches.	An assessment should be made of unreported catches in the Garonne estuary as they are suspected of representing a significant part of a stock under restoration.
	Iceland	Legal:- All legally caught fish are supposed to be recorded in log books that are delivered to the authorities. If log books are not returned the fisheries associations or landowners are contacted. If information is not available, average catch for previous years is used as an estimate. The catch not reported is low & recorded in unreported catches.	Reasonably effective.	Unknown
		Illegal:- Guess-estimate. Very few incidences of illegal fishing is reported or observed by fishery officers. The number of illegally caught fish is thought to be low & included in the unreported catches.	Not evaluated.	Unknown

Commission Area	Country	Method	Evaluation	Possibilities for Improvement
	Ireland	Legal: *Commercial fishing* – Generally, licenced fisherman are obliged to sell fish only to a licenced salmon dealer and as such, sales should be recorded in a dealer register. However, fishermen can sell fish directly to the public. Therefore for the commercial fishery any fish not recorded in the dealers' register are accounted for in the estimates of illegal unreported catch.	Reasonably effective in some regions	
		Angling – The method of reporting rod catches was greatly improved in 1995 and consists of reports from angling clubs supplemented by reports from private and public fisheries and estimates of individual angling catches which are not included in either the reported or unreported catch statistics.	Reasonably effective.	
		Illegal: *Commercial fishing* - Estimated from local evaluations at ports and fish processors and by regional and district fisheries inspectors. Some use of reported illegal net and fish seizures may be used in the evaluation. Legislation of monofilament nets has led to a reported reduction in unreporting since 1996.	Not systematic & varies in quality by year and fishing district.	A salmon carcass tagging and logbook system is proposed for salmon fisheries in Ireland. Catches will be estimated directly from logbook returns and issue of carcass tags. This should facilitate the identification and enumeration of illegal catches & significantly reduce the level of unreported catch nationally.
		Angling – The method of reporting rod catches was greatly improved in 1995. Licenced anglers catch the vast majority of rod caught salmon. While the level of illegal rod catch is considered low relative to the national catch, the exact proportion is unknown. Unreported illegal angling is included in the reported catch if it is significant.	Not evaluated	
	Norway	Legal:- *By-catch in marine fisheries.* Test fishing with e.g., mackerel nets.	Occasional test fishing.	Test fishing screening fisheries.
		Marine troll & angling: No reporting system; occasional surveys & questionnaire.	Occasional test fishing.	More systematic surveys.
		Other marine – Logbooks & questionnaires.	Occasional evaluation.	
		Freshwater- Studies from several rivers, questionnaires & deposit on fishing licences.	Occasional evaluation.	
		Illegal:- *Marine fisheries* – Circulation of a questionnaire among the surveillance inspectors, fishermen & local managers.	Occasional reports from surveillance inspectors.	More systematic surveys.
		Angling – Based on occasional surveillance reports.	Occasional surveillance reports.	
	Sweden	Legal:- All legal fisheries are licensed & all catch is assumed to be reported.		
		Illegal:- Guess-estimated proportion of legal catch based on the general abundance of salmon.	Has some structure.	

Commission Area	Country	Method	Evaluation	Possibilities for Improvement
	Russia	Legal:- *Coastal fisheries* – Estimates based on local knowledge of fisheries, logbook data & catch statistics data.	Structured and systematic.	More detailed recording.
		In-river net fishery – In Arhangelsk region the unreported catch is assessed by comparing catch survey results with reported catch. For Kola peninsula the estimates are made using log book data.	Structured and systematic.	Further sampling. A reduction of fishing stations in Archangelsk region.
		In-river rod fishery. – the estimate is obtained by comparing catch statistics for local anglers with the more accurate catch statistics from foreign anglers.	Structured and systematic.	Further sampling.
		Illegal:- *Coastal fishery, inriver rod fishery and poaching* – guess-estimates based on local knowledge of fisheries.	No structure and not systematic.	A salmon carcass tagging system &/ or sampling of anonymous questionnaires.
	UK(E & W)	Legal:- *Nets*- Overall estimate of 8% applied based upon three sample studies.	*Nets* - Semi rigorous; assessment based upon sampling, but not adjusted every year.	Additional sampling of rod & net catches is being considered.
		Rods:- Overall estimate of 10% calculated from study of catch returns from repeat reminders.	*Rods* - Semi- rigorous; based upon national assessment but not adjusted every year.	
		Illegal:- Guess-estimates in each Region based upon enforcement activities combined to give overall estimate of the percentage of illegal catch	Not rigorous; based upon subjective evaluation in each Region.	More detailed recording and evaluation of enforcement activities would be possible but is not planned.
	UK (N.I.)	Legal:- *Net catches* - Estimates based on observation of catches by staff engaged in microtag recovery programmes.	Not systematic. but staff often observe catches being processed at points of capture.	Discussions have taken place between fishery authorities in NI and the Republic of Ireland. about the introduction of an all Ireland salmon tagging scheme. Agreement in principle has been reached & the regulatory framework & practical arrangements are being pursued. This should significantly improve reporting of rod catches, in particular.
		Rod catches - No data available.		
		Illegal:-Guess-estimates based upon local knowledge of fisheries.	Not systematic, but based on experience of fishery officers.	
		Rod catch: - No data available.		
	UK(Scotland)	Legal:- Estimates by local management groups in late 1980s; estimates include a fixed component and a component that varies with catch.	Subjective. Estimates not available for all areas.	Repeat survey so that estimates reflect current situation. Expand survey.
		Illegal:- Estimates by local management groups in late 1980s; estimates include a fixed component and a component that varies with catch.	Subjective. Estimates not available for all areas.	Repeat survey so that estimates reflect current situation. Expand survey.

Commission Area	Country	Method	Evaluation	Possibilities for Improvement
WGC	Greenland	Legal:- Guess-estimate of local consumption. Illegal:- Fishing not thought to occur outside of the salmon fishing seasons.	Fishery officer observations.	

Table 1.5.1 Farmed Atlantic salmon production (t) and estimated catches (t) of farmed salmon in the Atlantic area. Note: - indicates no data available.

Country	Year	Farmed Production	Farmed in Catches	Total Farmed	Min % Escapees	Reported No. of Escapees
North East Atlantic Area						
Norway	1989	124,000	195	124,195	0.16%	-
	1990	165,000	214	165,214	0.13%	-
	1991	155,000	189	155,189	0.12%	-
	1992	140,000	203	140,203	0.14%	-
	1993	170,000	209	170,209	0.12%	-
	1994	215,000	205	215,205	0.10%	-
	1995	295,000	183	295,183	0.06%	-
	1996	305,000	222	305,222	0.07%	-
	1997	331,367	198	331,565	0.06%	-
	1998	344,645	209	344,854	0.06%	537,924
	1999	415,399	198	415,597	0.05%	500,000
UK-Scotland	1991	40,593	14	40,607	0.03%	-
	1992	36,101	31	36,132	0.09%	-
	1993	48,691	31	48,722	0.06%	-
	1994	64,066	5	64,071	0.01%	-
	1995	70,060	2	70,062	0.00%	-
	1996	83,121	<1	83,121	0.00%	-
	1997	99,197	<1	99,197	0.00%	-
	1998	115,483	<1	115,483	0.00%	-
	1999	111,918	<1	111,918	0.00%	
Faroes	1990	13,000	84.8	13,084.8	0.65%	-
	1991	15,000	10.6	15,010.6	0.07%	-
	1992	17,000	5.9	17,005.9	0.03%	-
	1993	16,000	1.2	16,001.2	0.01%	-
	1994	14,789	1.2	14,790.2	0.01%	-
	1995	9,000	0.2	9,000.2	0.00%	-
	1996	18,600	0.0	18,600.0	0.00%	-
	1997	22,205	0.0	22,205.0	0.00%	-
	1998	20,362	-	20,362.0	-	-
	1999	37,000	-	37,000.0	-	-
Ireland and UK-No. Ireland	1991	9,583	2.0	9,585.0	0.02%	-
	1992	9,431	3.4	9,434.4	0.04%	-
	1993	12,466	1.3	12,467.3	0.01%	-
	1994	11,716	3.1	11,719.1	0.03%	-
	1995	12,070	1.2	12,071.2	0.01%	-
	1996	14,363	1.8	14,364.8	0.01%	24,000
	1997	14,250	1.2	14,251.2	0.01%	40,000
	1998	14,974	2.1	14,976.1	0.01%	73,732
	1999	18,234	3.0	18,237.0	0.02%	1,500
Iceland	1991	2,680	3	2,683.0	0.11%	-
	1992	2,100	tr.	2,100.0	0.00%	-
	1993	2,348	-	2,348.0	-	-
	1994	2,588	-	2,588.0	-	-
	1995	2,880	-	2,880.0	-	-
	1996	2,772	-	2,772.0	-	-
	1997	2,554	-	2,554.0	-	-
	1998	2,686	-	2,686.0	-	-
	1999	3,133	-	3,133.0	-	-
Eastern North America Area						
Canada and USA[1]	1991	13,955	-	-	-	-
	1992	16,230	0.4	16,230.4	0.00%	-
	1993	17,870	0.4	17,870.4	0.00%	-
	1994	18,571	2.7	18,573.7	0.01%	-
	1995	22,570	1.7	22,571.7	0.01%	-
	1996	27,725	0.7	27,725.7	0.00%	-
	1997	31,494	0.3	31,494.3	0.00%	-
	1998	29,584	0.6	29,584.6	0.00%	-
	1999	34,731	0.6	34,731.6	0.00%	-

[1] Catches of live salmon in fish counting facilities at one NB, Canada river and four Maine, USA rivers.

Table 1.7.1 **Eggs taken and juvenile Atlantic salmon and eggs stocked (excluding private commercial sea ranching) during 1999.**

Country	Total Eggs Artificially Spawned (1)	Eggs Stocked (rounded to nearest 1,000)			No. Fry Stocked (rounded to nearest 1,000)			No. Parr Stocked (rounded to nearest 100)				No. Smolts (rounded to nearest 100)		
		Green	Eyed	All	Unfed	Fed	All	0+	1 & 1+	2 or >	All	1	2 or more	All
Total	44137000	1286000	1787000	3073000	21717000	1746000	23463000	5662300	465200	98600	6226100	3134200	1072400	4213600
Belgium	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Canada	7648000	1226000	215000	1441000	560000	452000	1012000	1364700	33100	0	1397800	791800	199300	991100
Denmark	-	0	0	0	0	0	0	1200	2000	0	3200	1100	100	1200
Finland	-	0	0	0	0	0	0	0	0	0	0	0	0	0
France	-	0	254000	254000	89000	159000	248000	1788200	151700	0	1939900	68000	5600	73600
Iceland	-	0	0	0	120000		120000	461000	0	0	461000	636000	8500	644500
Ireland	9000000	0	0	0	4228000	115000	4343000	256700	0	0	256700	610100	700	610800
Norway	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Russia	2072000	0	0	0	0	0	0	215000	12700	98600	326300	0	706100	706100
Spain	950000	0	0	0	0	0	0	639000	141000	0	780000	49000	0	49000
Sweden (2)	1140000	-	-	-	0	0	0	0	0	0	0	129500	70300	199800
UK - (England & Wales)	-	0	38000	38000	0	687000	687000	526400	118800	0	645200	123000	79800	202800
UK - (Northern Ireland)	-	60000	0	60000	1046000	0	1046000	0	0	0	0	37000	2000	39000
UK - (Scotland)	-	0	1280000	1280000	3092000	333000	3425000	0	0	0	0	0	0	7000
USA -1999 (3)	23327000	0	0	0	12582000	0	12582000	410100	5900	0	416000	688700	0	688700

(1) Includes eggs artificially spawned in fall of 1999 and winter of 1999/2000

(2) Includes 260000 collected for compensatory smolt production. Disposition of balance uncertain.

(3) USA eggs include 2502000 taken from reconditioned sea run kelts and 16988000 hatchery-reared broodstook

Table 2.9.1. Summary of the number of coded wire tags, fin clips, and external tags applied to Atlantic salmon in the North Atlantic, 1999. 'Hatchery' and 'Wild' refer to smolts or parr; 'Adult' refers to wild and/or hatchery fish. Data from Belgium were not available. Fish were not tagged in Finland.

		Primary Tag or Mark				
Country	Origin	Coded wire tag	External tag	Adipose clip1	Other visible clip or mark	Secondary Mark2
Canada	Hatchery	12089	9175	2209362	0	17089
	Wild	0	11538	888	0	877
	Adult	0	7937	0	0	2
	Total	12089	28650	2210250	0	17968
Denmark	Hatchery	0	1300	0	0	0
	Wild	0	0	0	0	0
	Adult	0	0	0	0	0
	Total	0	1300	0	0	0
France	Hatchery	0	0	320037	0	21600
	Wild	0	0	0	945	566
	Adult	0	0	0	0	0
	Total	0	0	320037	945	22166
Iceland	Hatchery	123387	0	0	0	123387
	Wild	3816	0	0	0	0
	Adult	0	1665	0	0	52
	Total	127203	1665	0	0	123439
Ireland	Hatchery	306870	0	150000	0	297832
	Wild	4402	0	0	0	2975
	Adult	0	0	0	0	0
	Total	311272	0	150000	0	300807
Norway	Hatchery	0	91495	0	0	0
	Wild	0	11749	0	0	0
	Adult	0	230	0	0	0
	Total	0	103474	0	0	0
Russia	Hatchery	0	1000	514100	0	0
	Wild	0	0	207	0	0
	Adult	0	1436	0	0	0
	Total	0	2436	514307	0	0
Spain	Hatchery	52580	0	164159	0	0
	Wild	0	0	0	0	0
	Adult	0	0	0	0	0
	Total	52580	0	164159	0	0
Sweden	Hatchery	46673	0	0	0	0
	Wild	0	0	0	0	0
	Adult	0	0	0	0	0
	Total	46673	0	0	0	0
UK (England & Wales)	Hatchery	95344	0	84509	0	95344
	Wild	0	0	0	0	0
	Adult	0	1190	0	0	0
	Total	95344	1190	84509	0	95344
UK (N. Ireland)	Hatchery	20969	0	14249	0	20969
	Wild	1394	0	160	0	1394
	Adult	0	0	160	0	0
	Total	22363	0	14569	0	22363
UK (Scotland)	Hatchery	14145	0	7900	0	0
	Wild	16784	2558	38	2343	21489
	Adult	0	0	0	0	0
	Total	30929	2558	7938	2343	21489
USA	Hatchery	0	0	21287	91009	0
	Wild	0	0	695	152	0
	Adult	0	3289	0	28	0
	Total	0	3289	21982	91189	0
All Countries	Hatchery	672057	102970	3485603	91009	576221
	Wild	26396	25845	1988	3440	27301
	Adult	0	15747	160	28	54
	Total	698453	144562	3487751	94477	603576
Grand total marked =		4425243				

[1] Fish without other external marks or coded wire tags.

[2] Typically adipose fin clip.

Table 2.4.1 **Conservation limit options for NEAC stock groups from lagged egg deposition analysis (options 1-3) and river specific assessments (option 4)**

Option	Individual countries										European stock groupings	
	Finland	France	Iceland	Ireland	Norway	Russia	Swed'n	UK(EW)	UK(NI)	UK(Sc)		
Choice	3	4	1	1	1	1	4	4	3	3	Southern	Northern
1SW												
Opt. 1	6,028	19,972	20,139	265,111	129,168	69,831	674	38,482	13,171	445,193	781,929	205,700
Opt. 2	6,756	23,985	20,153	226,224	106,578	62,291	1,018	59,331	12,065	524,111	845,715	176,643
Opt. 3	9,018	43,902	27,792	407,315	149,574	79,029	1,436	72,718	15,812	592,471	1,132,218	239,057
Opt. 4	0	17,400	0	0	0	0	2,720	53,000	0	0		
Chosen	**9,018**	**17,400**	**20,139**	**265,111**	**129,168**	**69,831**	**2,720**	**53,000**	**15,812**	**592,471**	**943,794**	**210,736**
MSW												
Opt. 1	3,622	2,914	5,017	17,808	76,166	75,307	324	17,529	4,601	365,568	408,420	155,419
Opt. 2	4,059	3,500	5,020	15,196	62,845	67,177	490	27,027	4,214	430,371	480,307	134,571
Opt. 3	5,418	6,406	6,923	27,360	88,199	85,227	690	33,125	5,523	486,505	558,918	179,534
Opt. 4	0	5,100	0	0	0	0	830	17,500	0	0		
Chosen	**5,418**	**5,100**	**5,017**	**17,808**	**76,166**	**75,307**	**830**	**17,500**	**5,523**	**486,505**	**532,436**	**157,721**

Spawner escapement reserve:

	Southern	Northern
1SW	**1,017,300**	**228,287**
MSW	**631,099**	**186,947**

Table 3.4.1.1. Pre-Fishery abundance estimates, thermal habitat index for February based on sea surface temperature, lagged spawner index for North America excluding Gulf and US spawners (SNLQ), results of a jackknife cross-validation of the forecast model, and simulated forecasts.

	Pre-Fishery Abundance			Thermal Habitat	Lagged Spawners			Jackknife Cross-Validation	
Year	Low	High	Mid	February	Low	High	Mid	Prediction	Residuals
1971	578,955	726,765	652,860	2,011					
1972	557,789	733,257	645,523	1,990					
1973	672,662	867,805	770,234	1,708					
1974	623,993	800,853	712,423	1,862					
1975	710,244	904,589	807,417	1,827					
1976	610,837	826,861	718,849	1,676					
1977	506,934	667,818	587,376	1,915					
1978	288,809	371,796	330,103	1,951	35,441	81,978	58,710	445,428	-115,325
1979	630,107	831,432	730,770	2,058	42,640	94,840	68,740	633,922	96,848
1980	549,070	729,402	639,236	1,823	43,222	97,219	70,221	578,884	60,352
1981	527,385	684,598	605,992	1,912	43,287	97,645	70,466	612,032	-6,040
1982	439,899	567,157	503,528	1,703	43,393	98,396	70,895	549,523	-45,995
1983	236,421	337,454	286,938	1,416	40,425	91,991	66,208	383,129	-96,191
1984	245,428	347,774	296,601	1,257	37,658	84,098	60,878	249,212	47,389
1985	399,013	539,313	469,163	1,410	39,305	83,265	61,285	305,981	163,182
1986	435,092	575,933	505,512	1,688	39,891	89,038	64,464	446,393	59,119
1987	398,157	528,089	463,123	1,627	36,298	87,453	61,875	386,708	76,415
1988	317,617	423,939	370,778	1,698	37,061	83,602	60,331	386,594	-15,816
1989	241,038	346,158	293,598	1,642	41,944	86,394	64,169	426,674	-133,076
1990	218,194	296,533	257,364	1,503	40,952	81,826	61,389	338,299	-80,935
1991	249,702	349,750	299,726	1,357	37,575	73,152	55,364	198,067	101,659
1992	143,913	216,437	180,175	1,381	35,591	71,572	53,582	178,789	1,386
1993	95,337	179,546	137,441	1,252	38,381	79,473	58,927	217,772	-80,331
1994	109,491	213,457	161,474	1,329	38,395	75,957	57,176	216,480	-55,006
1995	118,415	197,098	157,757	1,311	36,738	70,104	53,421	153,201	4,556
1996	103,507	161,955	132,731	1,470	33,488	61,737	47,612	117,062	15,669
1997	67,047	125,591	96,319	1,594	29,823	55,178	42,500	79,985	16,334
1998	56511	107212	81861	1,849	25,593	50,477	38,035	96,057	-14,196
1999				1,741	25,587	52,506	39,047	*66,663* [1]	
2000				1,634	32,077	64,932	48,505	*179,897* [1]	

1. Simulated forecast values.

Table 3.4.1.2 Fishing mortalities of 2SW salmon equivalents by North American fisheries, 1972-
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Only mid-points of the estimated values have been used.

Year	CANADA										USA	Total	
	MIXED STOCK				TERMINAL FISHERIES IN YEAR i								
	NF-LAB Comm 1SW (Yr i-1) b	% 1SW of total 2SW equivalents	NF-LAB Comm 2SW (Yr i) b	NF-Lab comm total	Labrador rivers (a)	Nfld rivers (a)	Quebec Region	Gulf Region	Scotia - Fundy Region	Canadian total	Yr i		Terminal Fisheries as a % of Total
1972	27874	11	156881	184755	314	640	27417	22389	6801	242317	346	242662	24
1973	24016	8	223603	247619	719	904	32751	17915	6680	306588	327	306916	19
1974	32828	9	240676	273504	593	547	47631	21429	12734	356438	247	356685	23
1975	32316	9	242398	274715	241	535	41097	15675	12375	344637	389	345026	20
1976	47846	13	261770	309616	618	414	42139	18088	11111	381986	191	382177	19
1977	36777	10	246090	282867	954	962	42301	33433	15562	376079	1355	377434	25
1978	37200	14	160477	197677	580	566	37421	23802	10781	270827	894	271721	27
1979	18825	13	93918	112742	469	148	25234	6298	4506	149398	433	149831	25
1980	27923	8	221596	249520	646	709	53567	29828	18411	352679	1533	354212	30
1981	46088	14	205403	251492	384	491	44375	16326	13988	327055	1267	328322	23
1982	45894	18	137132	183026	473	438	35204	25707	12353	257200	1413	258613	29
1983	34348	15	113815	148163	313	448	34472	27094	13515	224005	386	224391	34
1984	25969	18	84479	110448	379	239	24408	6041	3971	145487	675	146162	24
1985	19578	14	80351	99929	219	16	27483	2745	4930	135323	645	135968	27
1986	26504	15	107010	133514	340	40	33846	4583	2824	175147	606	175752	2[illegible]
1987	33629	16	134879	168508	457	21	33807	3796	1370	207957	300	208258	[illegible]
1988	42874	26	82769	125643	514	30	34262	3923	1373	165744	248	165992	24
1989	29665	20	82998	112663	337	9	28901	3513	265	145687	397	146084	23
1990	26163	22	58518	84682	261	25	27986	2847	593	116395	696	117091	28
1991	16102	18	41250	57352	66	17	29277	1942	1331	89985	231	90216	36
1992	13336	18	25616	38952	581	70	30016	4303	1114	75036	167	75204	48
1993	4315	9	13540	17856	273	64	23153	3010	1110	45466	166	45632	61
1994	2859	7	12179	15038	365	82	24052	2368	756	42661	1	42662	65
1995	1660	5	8852	10511	420	93	23331	2041	330	36727	0	36727	71
1996	1437	4	5760	7197	320	109	22413	2586	766	33391	0	33391	78
1997	1296	5	5499	6795	175	139	18574	2196	581	28460	0	28460	76
1998	1544	9	1909	3453	268	133	11256	2336	322	17768	0	17768	81
1999	239	2	912	1151	268	86	7410	1692	450	11057	0	11057	90
2000	203	-	-	-	-	-	-	-		-	-	-	-

NF-Lab comm as 1SW = NC1(mid-pt) * 0.904837
NF-Lab comm as 2SW = NC2 (mid-pt) * 0.99005
Terminal fisheries = 2SW returns (mid-pt) - 2SW spawners (mid-pt)
a - starting in 1993, includes estimated mortality of 10% on hook and released fish
b - starting in 1998, there was no commercial fishery in Labrador; numbers reflect size of aboriginal fish harvest in 1998-99

Table 3.4.1.3 History of fishing-related mortalities of North American salmon as 2SW 1972-98.

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	242317	346	242662	0.14	260296	502958	48
1973	306588	327	306916	0.11	181677	488592	63
1974	356438	247	356685	0.07	218512	575197	62
1975	344637	389	345026	0.11	199593	544619	63
1976	381986	191	382177	0.05	252304	634481	60
1977	376079	1355	377434	0.36	141060	518495	73
1978	270827	894	271721	0.33	171656	443376	61
1979	149398	433	149831	0.29	107543	257374	58
1980	352679	1533	354212	0.43	181023	535234	66
1981	327055	1267	328322	0.39	170108	498431	66
1982	257200	1413	258613	0.55	206056	464668	56
1983	224005	386	224391	0.17	176185	400576	56
1984	145487	675	146162	0.46	30077	176239	83
1985	135323	645	135968	0.47	35213	171180	79
1986	175147	606	175752	0.34	125983	301736	58
1987	207957	300	208258	0.14	155401	363659	57
1988	165744	248	165992	0.15	157158	323150	51
1989	145687	397	146084	0.27	105655	251739	58
1990	116395	696	117091	0.59	54917	172008	68
1991	89985	231	90216	0.26	66152	156367	58
1992	75036	167	75204	0.22	100147	175351	43
1993	45466	166	45632	0.36	37872	83504	55
1994	42661	1	42662	0.00	0	42662	100
1995	36727	0	36727	0.00	0	36727	100
1996	33391	0	33391	0.00	19310	52701	63
1997	28460	0	28460	0.00	19856	48316	59
1998	17768	0	17768	0.00	15214	32982	54
1999	11057	0	11057	0.00	2738	13795	80

Greenland harvest of 2SW equivalents = NG1 *

Table 3.4.1.4 Catch options for 2000 North American Fisheries

Catch Options for 2000 North American Fisheries (Probability levels refer to probability density function estimates of pre-fishery abundance)		
Probability %	**Pre-fishery Abundance Forecast**	**Catch Options in 2SW Salmon Equivalents (no.)**
25	0	0
30	14,130	0
35	28,146	0
40	41,334	0
45	54,100	0
50	66,663	0
55	79,170	0
60	91,971	0
65	105,146	0
70	119,103	0
75	134,154	0
80	150,956	0
85	170,585	0
90	195,448	17,721
95	232,526	51,271

Table 3.4.2.1: Catch options for 2001 North American fisheries

Catch Options for 2001 North American fisheries (probability levels refer to probability density function estimates of pre-fishery abundance)		
Probability (%)	**Pre-fishery Abundance Forecast**	**Catch Options in 2SW Salmon Equivalents (no.)**
25	118,888	0
30	132,507	0
35	145,043	0
40	157,014	0
45	168,478	0
50	179,897	5,218
55	191,176	11,341
60	202,661	17,576
65	214,497	24,002
70	227,141	30,866
75	240,703	38,229
80	255,978	46,522
85	273,746	56,169
90	296,133	68,323
95	329,550	86,465

Figure 1.1.1.1 Nominal catches of salmon in four North Atlantic regions 1960-99.

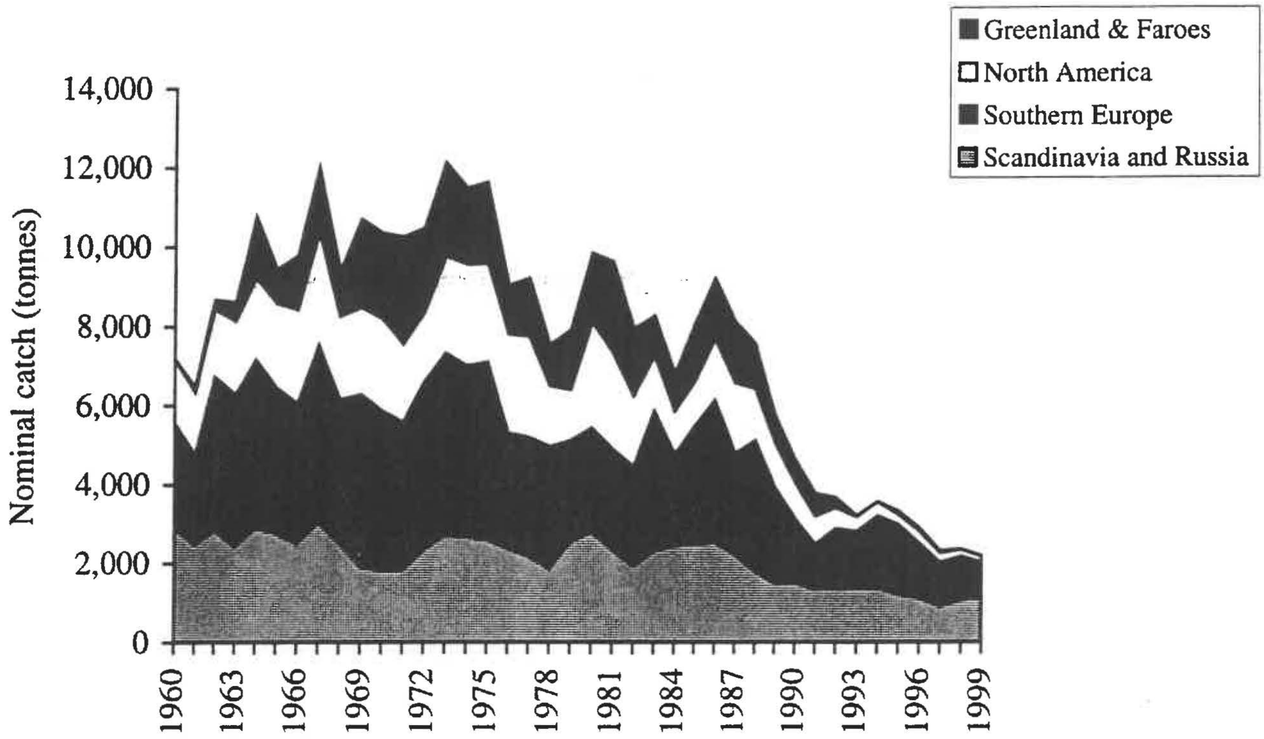
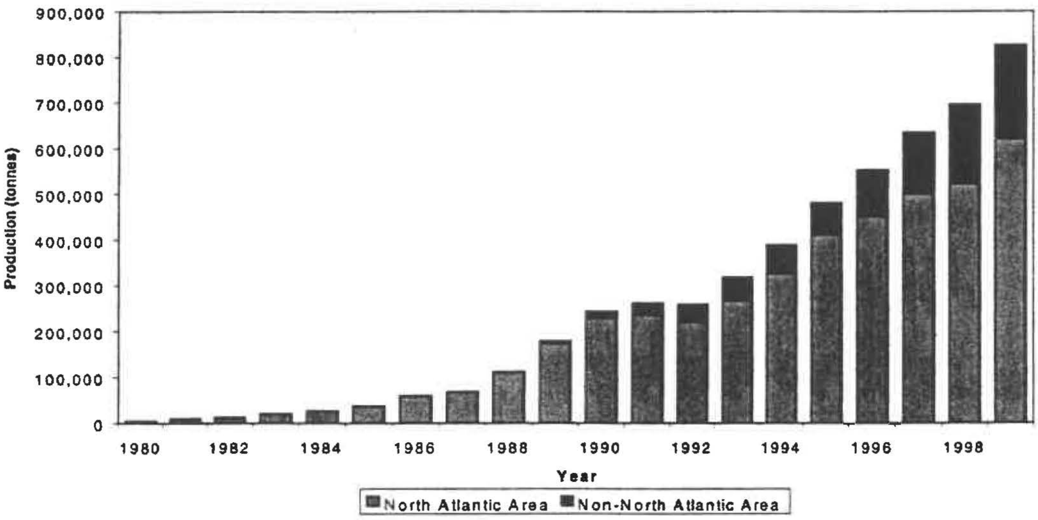


Figure 1.1.4.1. Worldwide farmed Atlantic salmon production, 1980-1999.



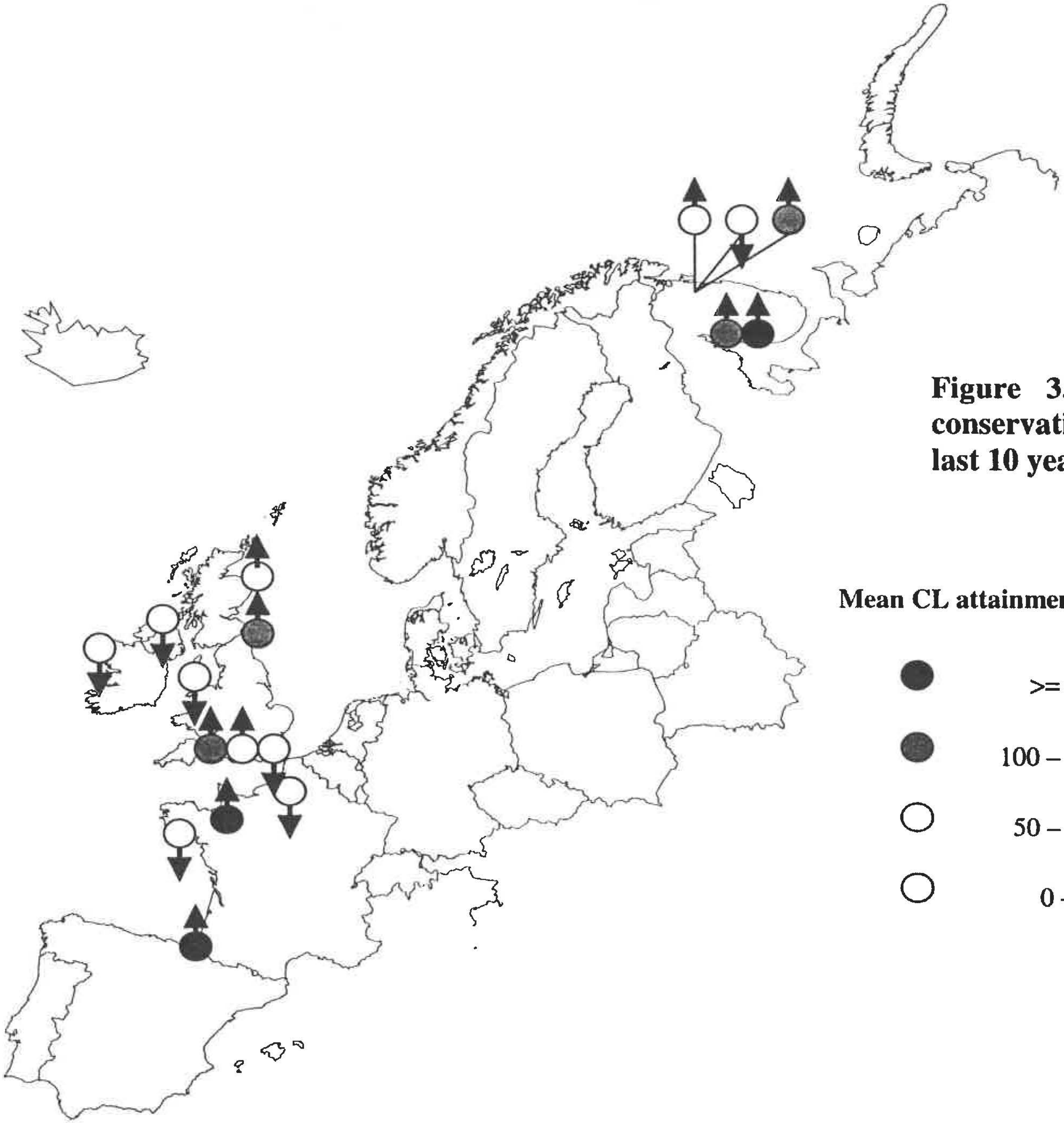


Figure 3.4.1.1 Rate of attainment of conservation limits : mean value over the last 10 years and 1998-1999 change

Mean CL attainment

>= 200 %

100 – 200 %

50 – 100 %

0 – 50 %

1998-1999 change

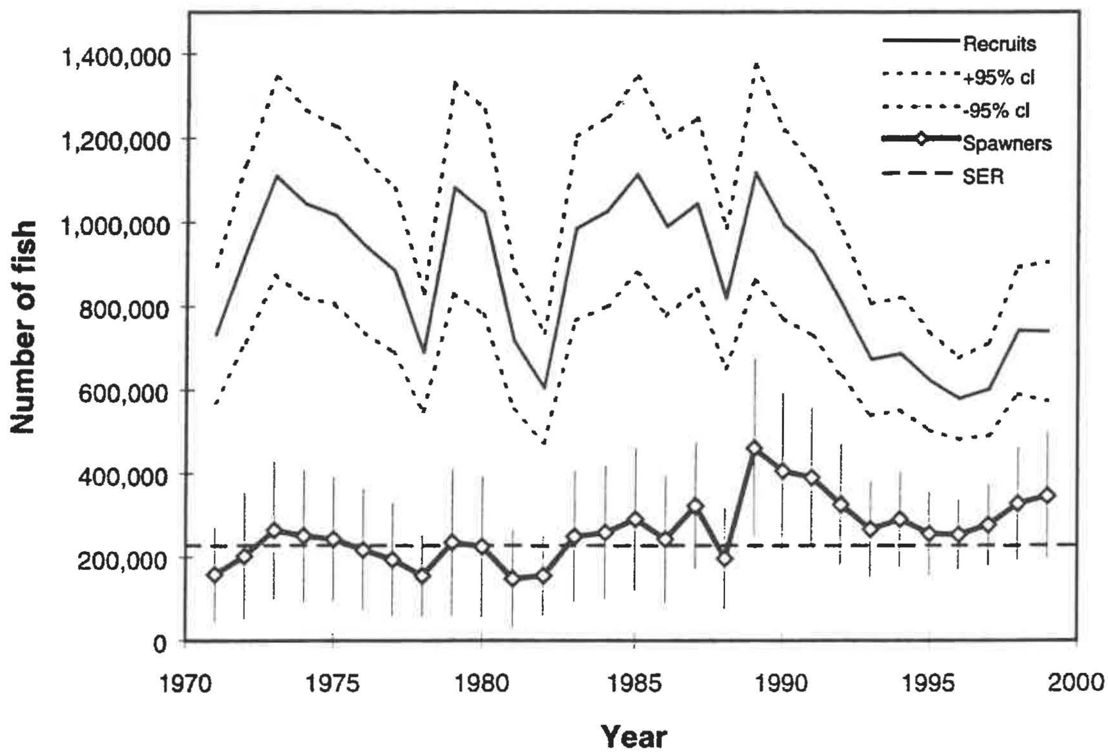
Increase

Decrease

Figure 2.3.1 Estimated PFA, spawning escapement and SER for maturing and non-maturing 1SW components of Northern European stocks, 1971-99.

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)

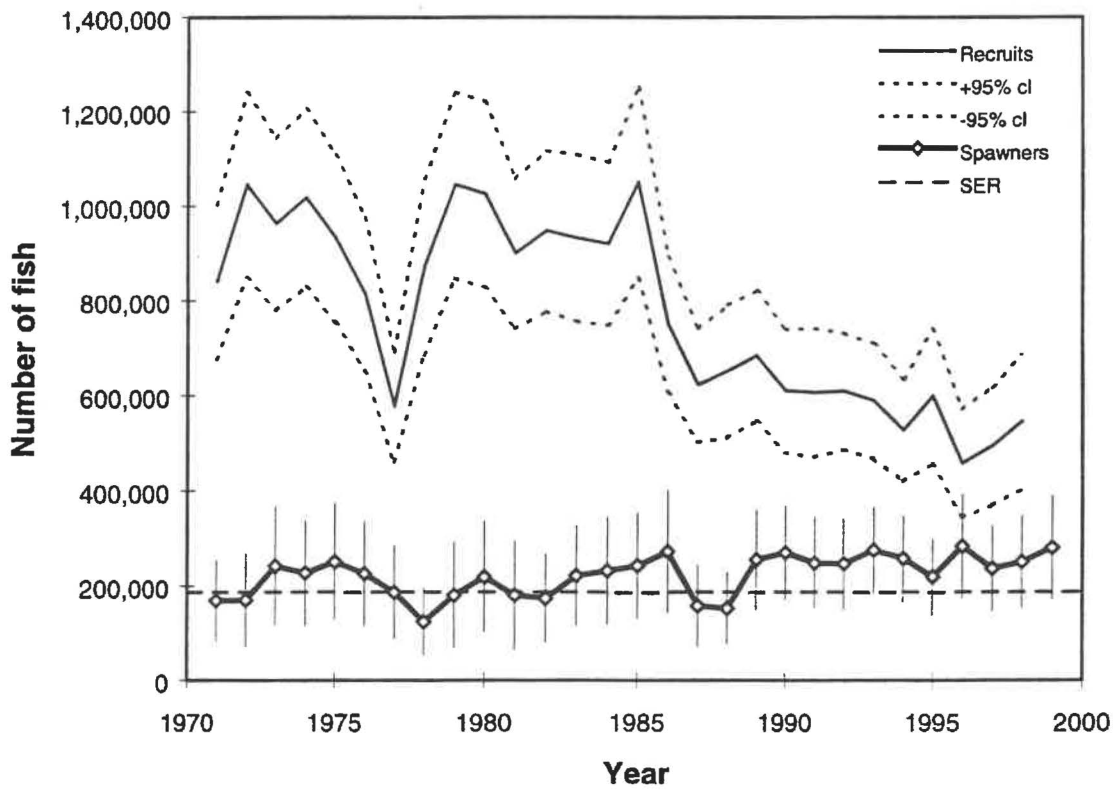
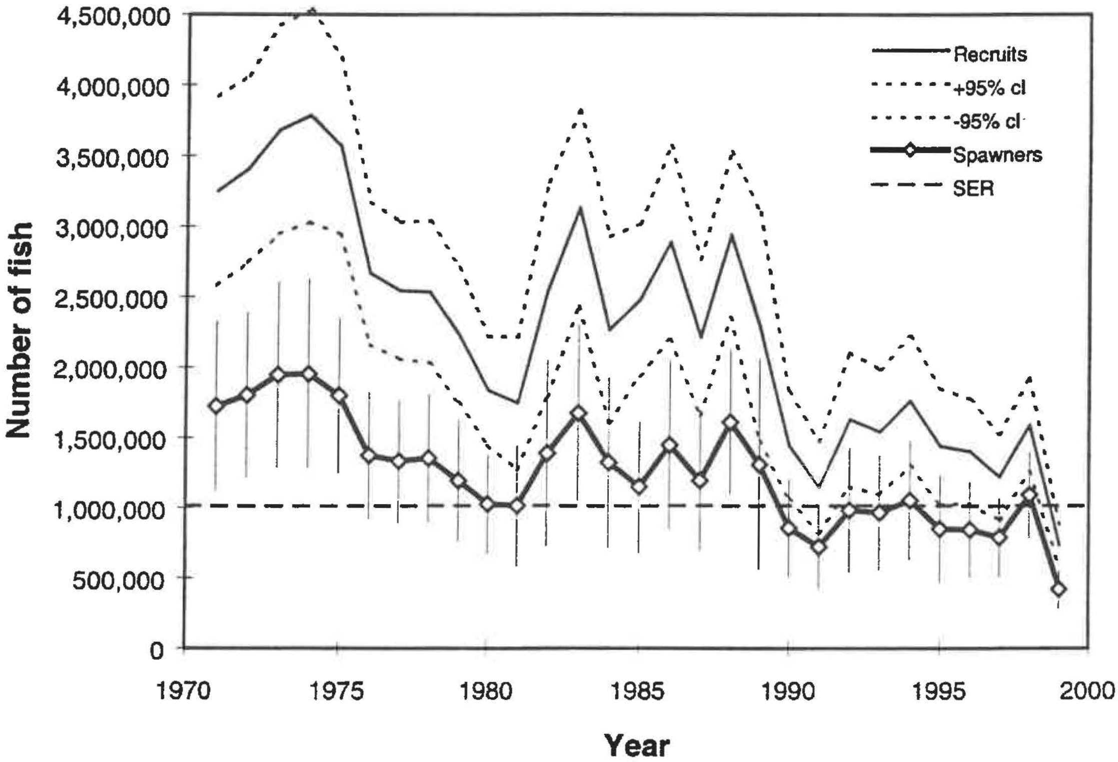


Figure 2.3.2 Estimated PFA, spawning escapement and SER for maturing and non-maturing 1SW component of Southern European stock groups, 1971-99

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)

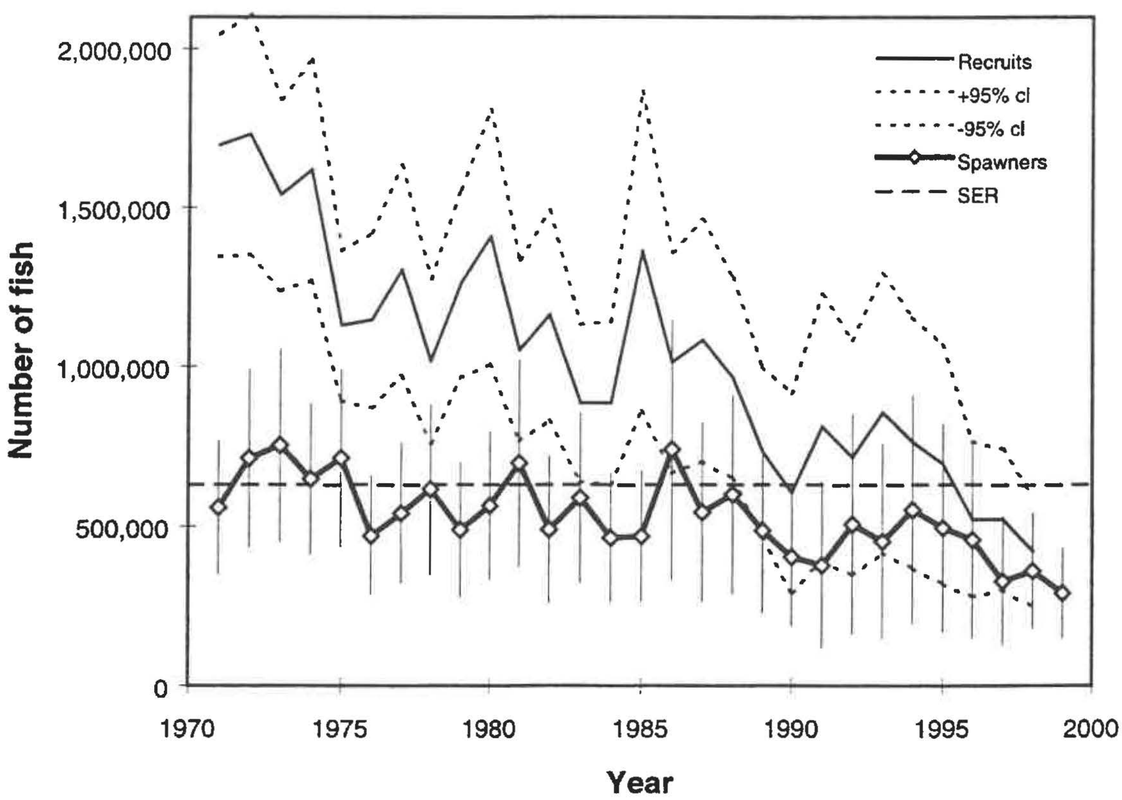
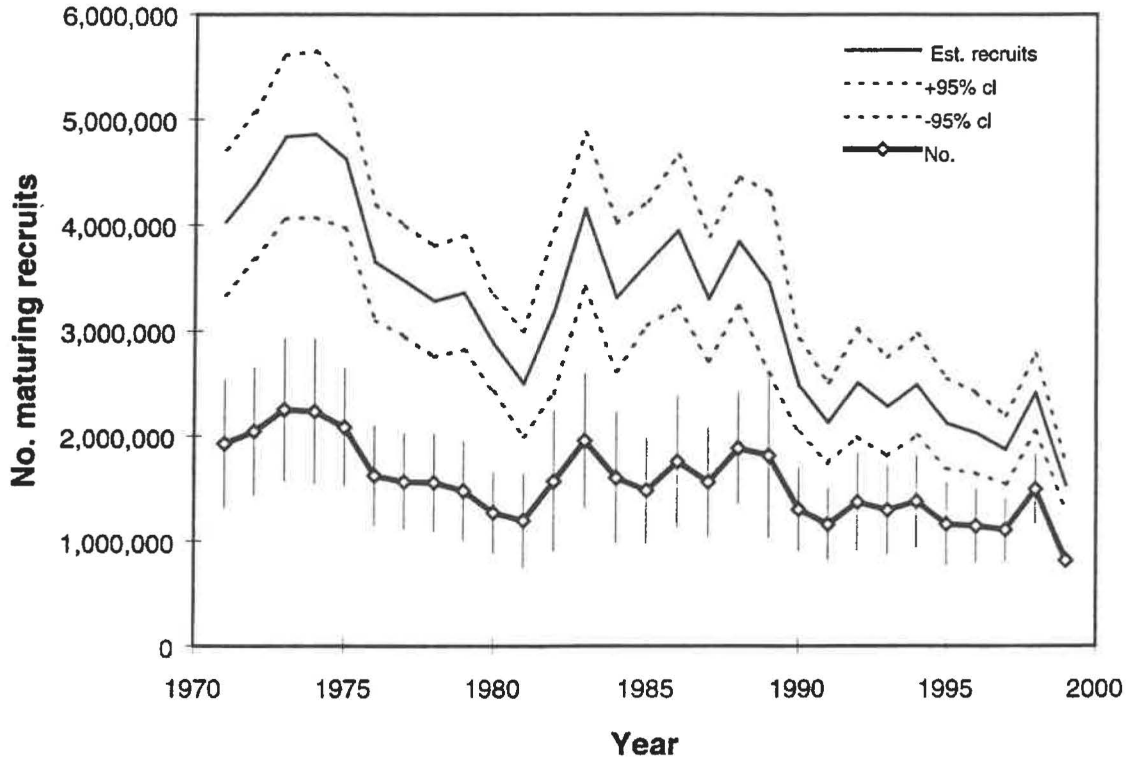


Figure 2.3.3 Estimated prefishery abundance of salmon stocks and spawning escapement in the NEAC Area, 1971-99

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)

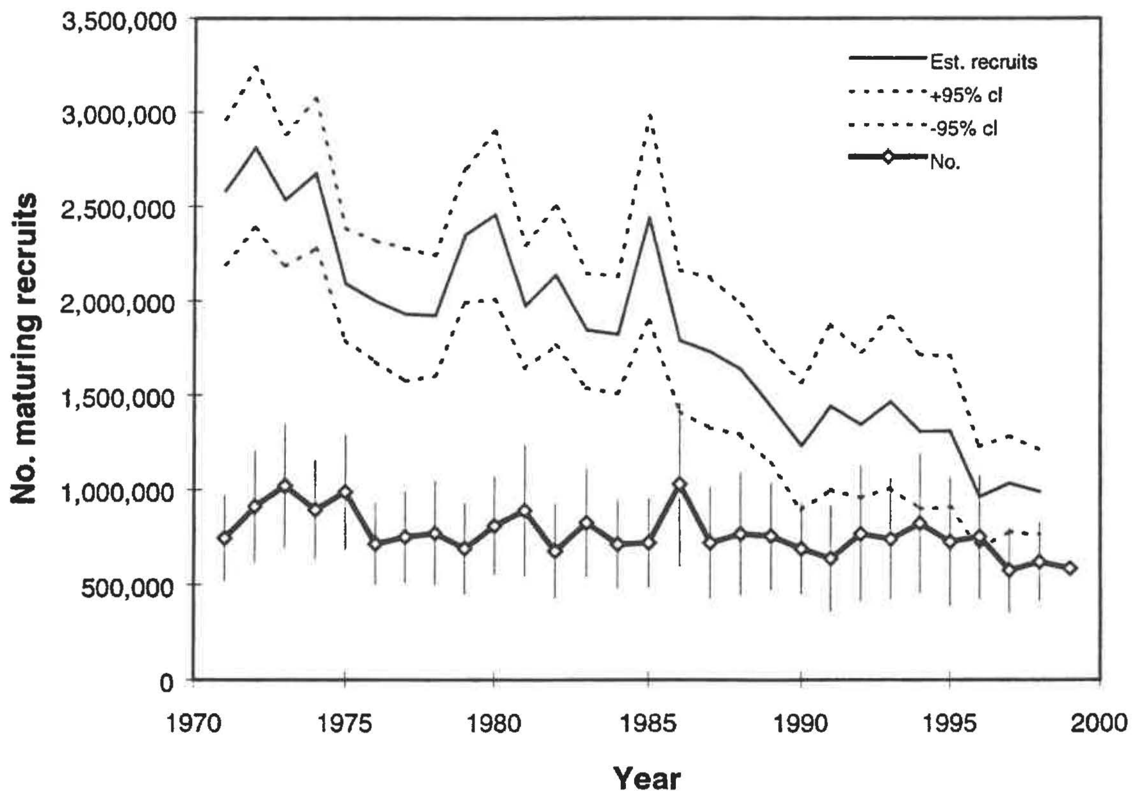


Figure 3.1.1.1. Map of Salmon Fishing Areas (SFAs) and Québec Management Zones (Qs) in Canada.

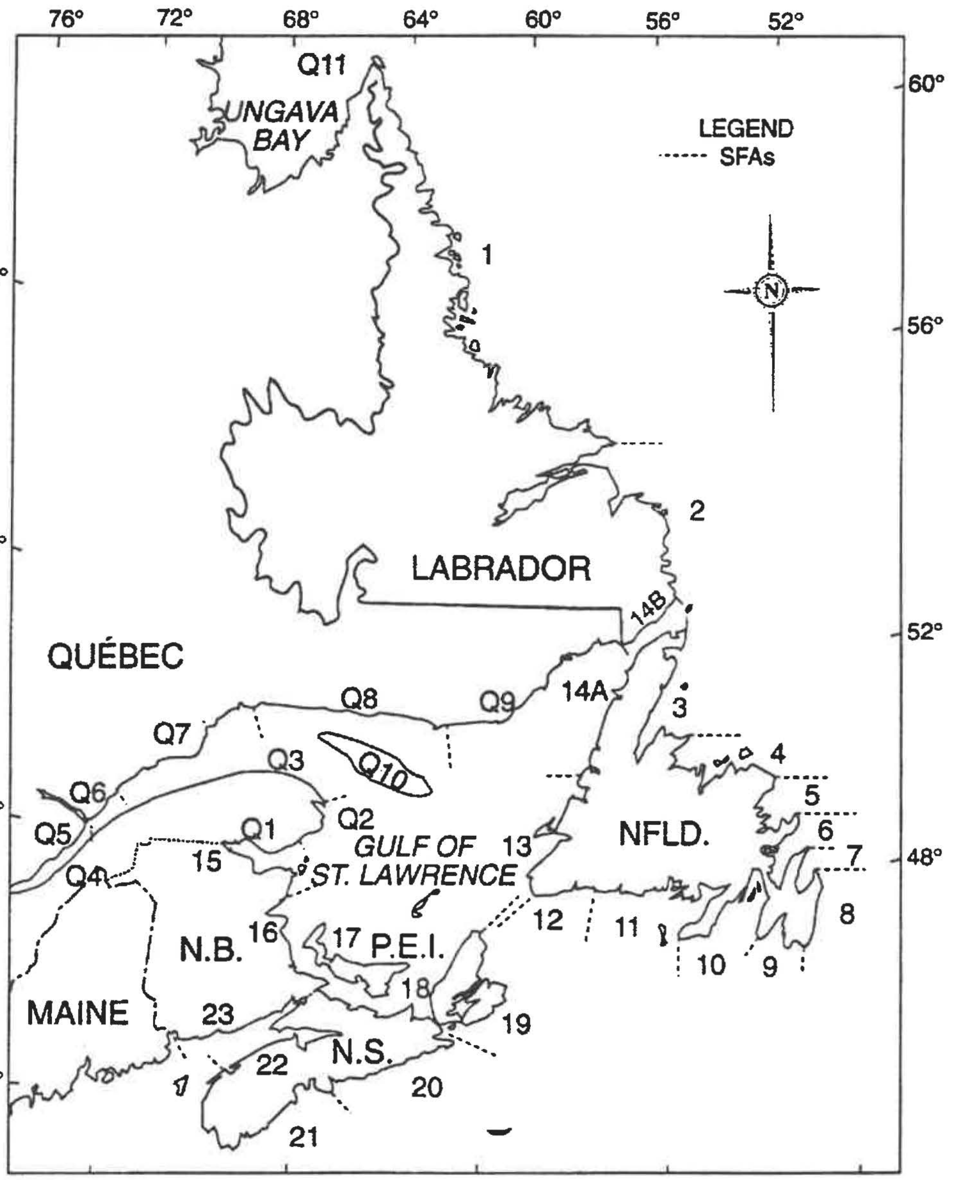


Figure 3.1.2.1 Estimated mid-points of 1SW returns (circles) to rivers of Nfld & Labrador and to SFAs of the other geographic areas, 1SW recruits of Nfld & Labrador origin before commercial fisheries in Nfld & Labrador (dashed lines), 1SW spawners (squares), 1971-99. Returns and spawners for Scotia-Fundy do not include those from SFA 22 and a portion of SFA 23. Labrador data for 1998-99 is unavailable.

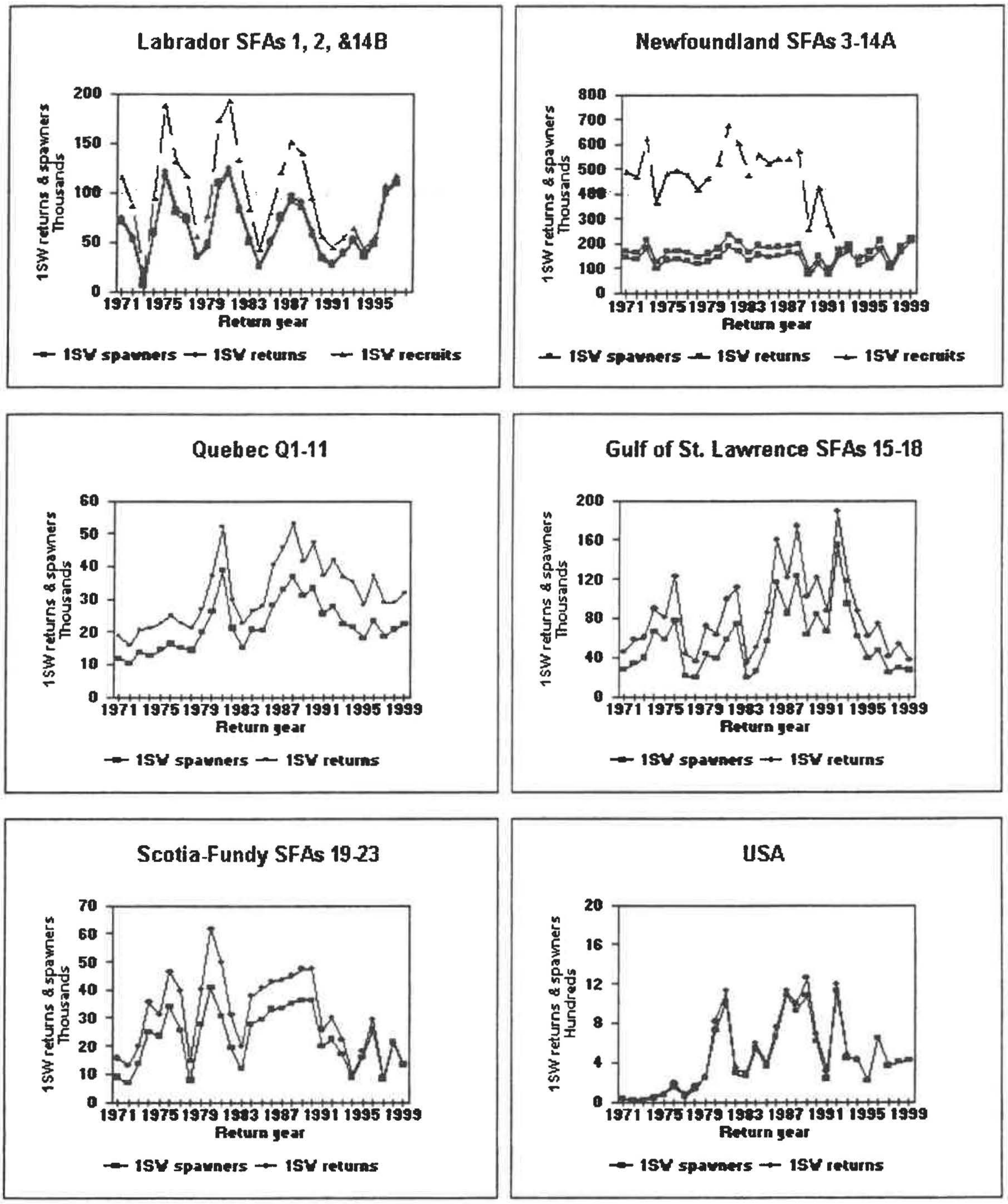


Figure 3.1.2.2 Comparison of estimated mid-points of 2SW returns (circles) to rivers of Nfld & Labrador and to SFAs of the other geographic areas, 2SW recruits of Nfld & Labrador origin before commercial fisheries in Nfld & Labrador (dashed lines), 2SW spawners (squares) and 2SW conservation requirements (triangles) for 1971-99 return years. Returns and spawners for Scotia-Fundy do not include those from SFA 22 and a portion of SFA 23. Estimates for 1998-99 for Labrador are unavailable.

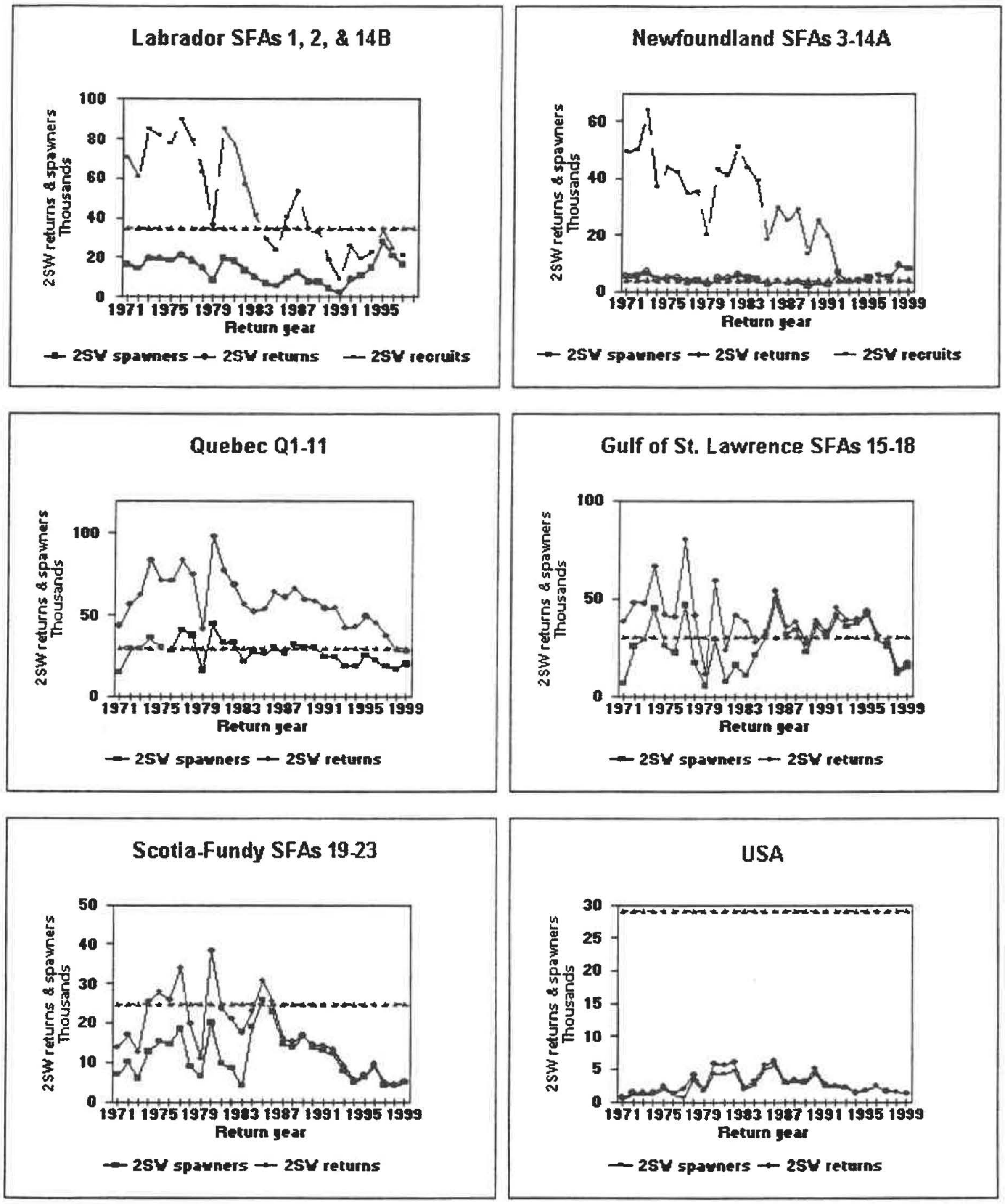
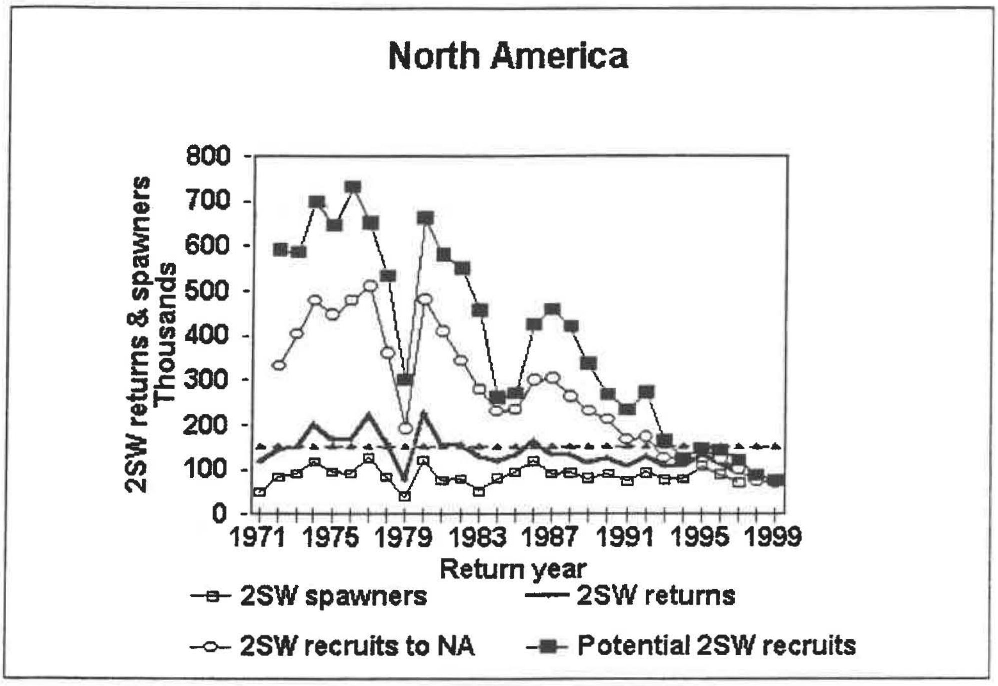


Figure 3.1.2.3 Top panel: comparison of estimated of potential 2SW production prior to all fisheries, 2SW recruits available to North America, 1971-99 and 2SW returns and spawners for 1971-97, as 1998-99 data for Labrador are unavailable. Triangles indicate the 2SW spawner threshold. Bottom panel: comparison of potential maturing 1SW recruits, 1971-99 and returns and 1SW spawners for 1971-97 return years as Labrador data for 1998-99 are unavailable.



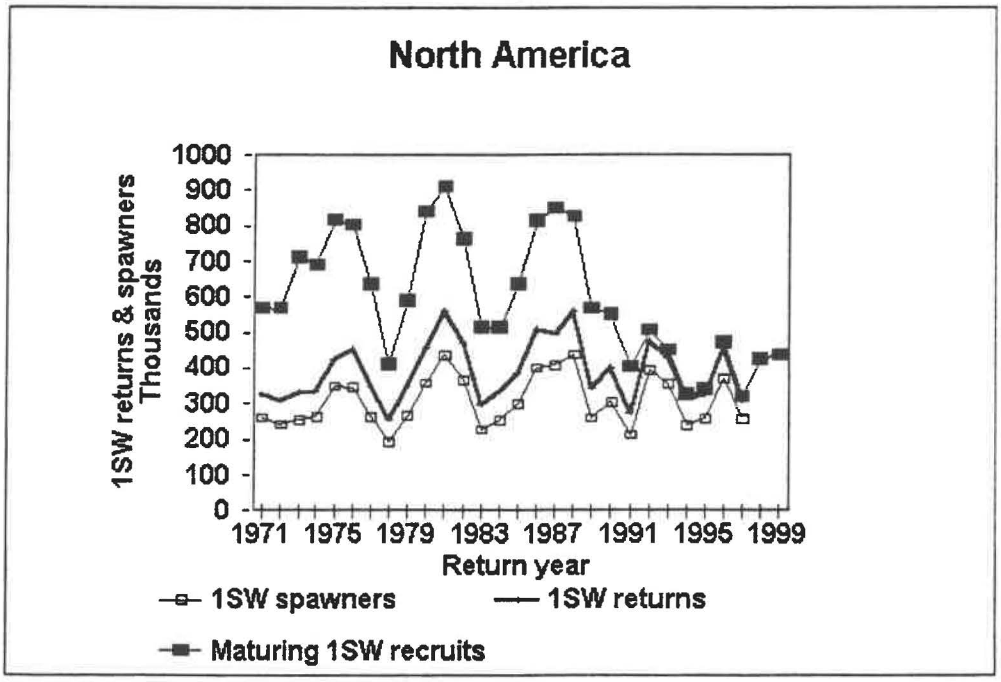


Figure 3.1.2.4 Pre-fishery abundance estimate of maturing and non-maturing salmon in North America (upper panel), and proportion of smolt class maturing after 1SW (lower panel).

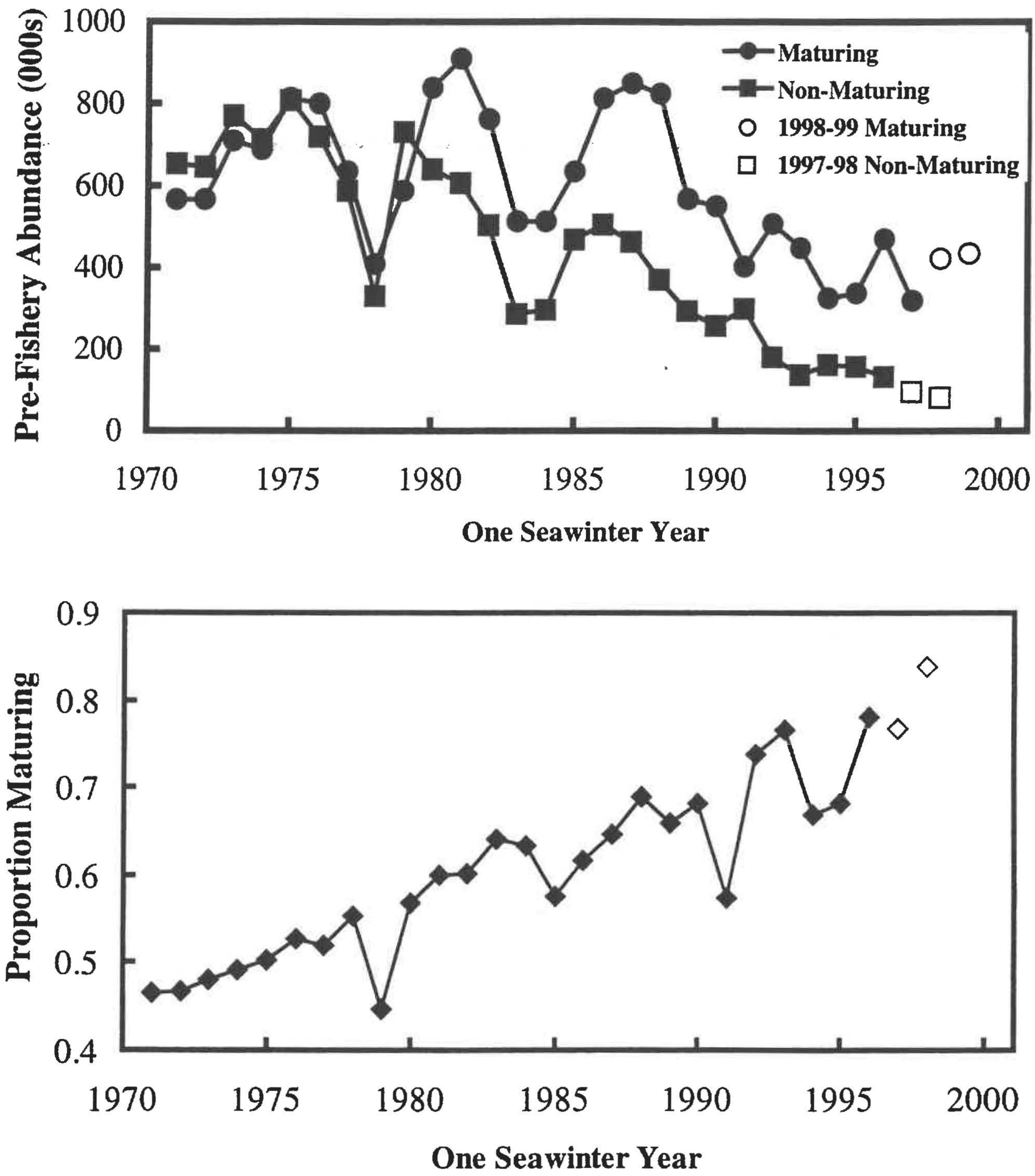


Figure 3.1.2.5 Total 1SW recruits (non-maturing and maturing) originating in North America.

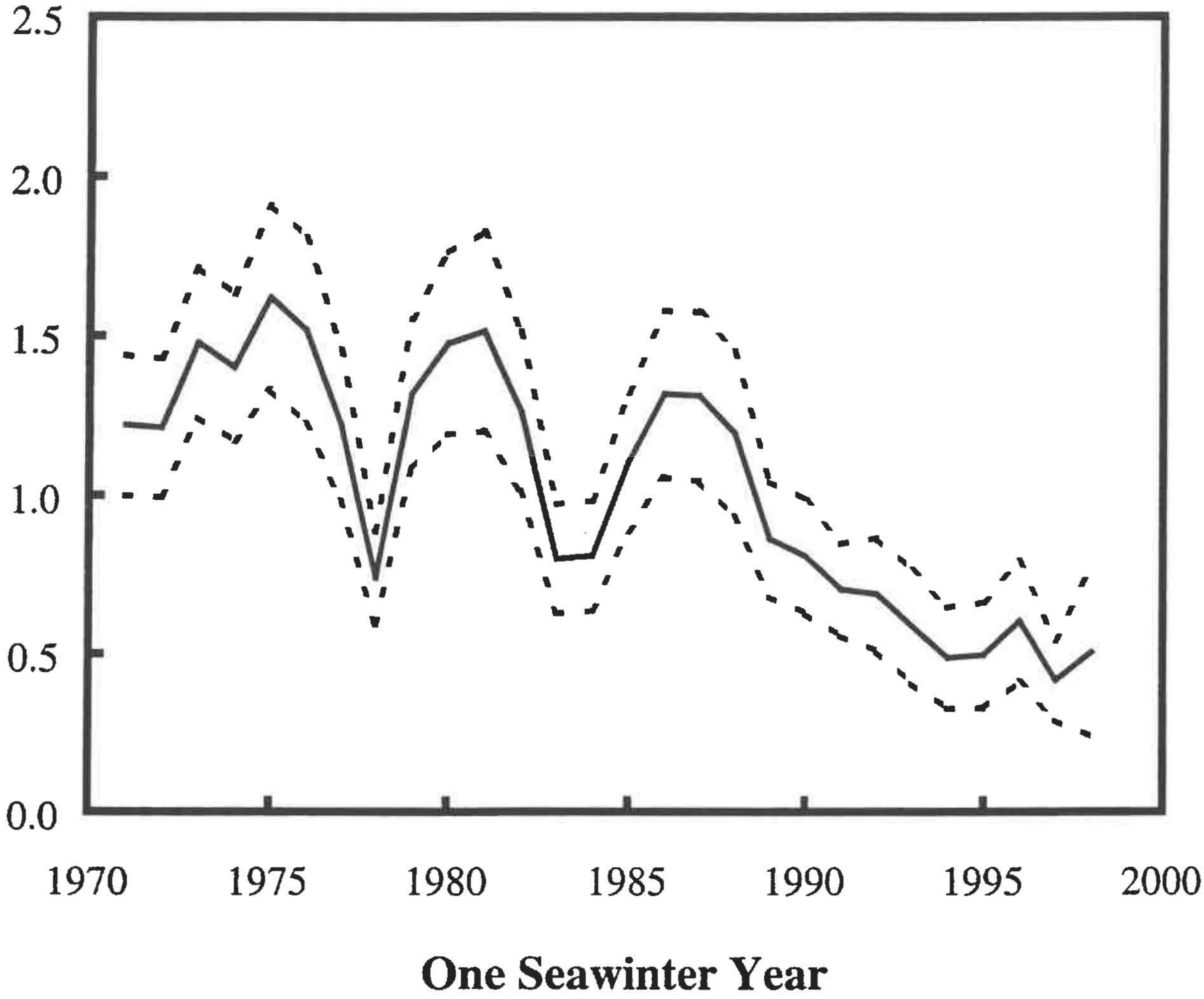
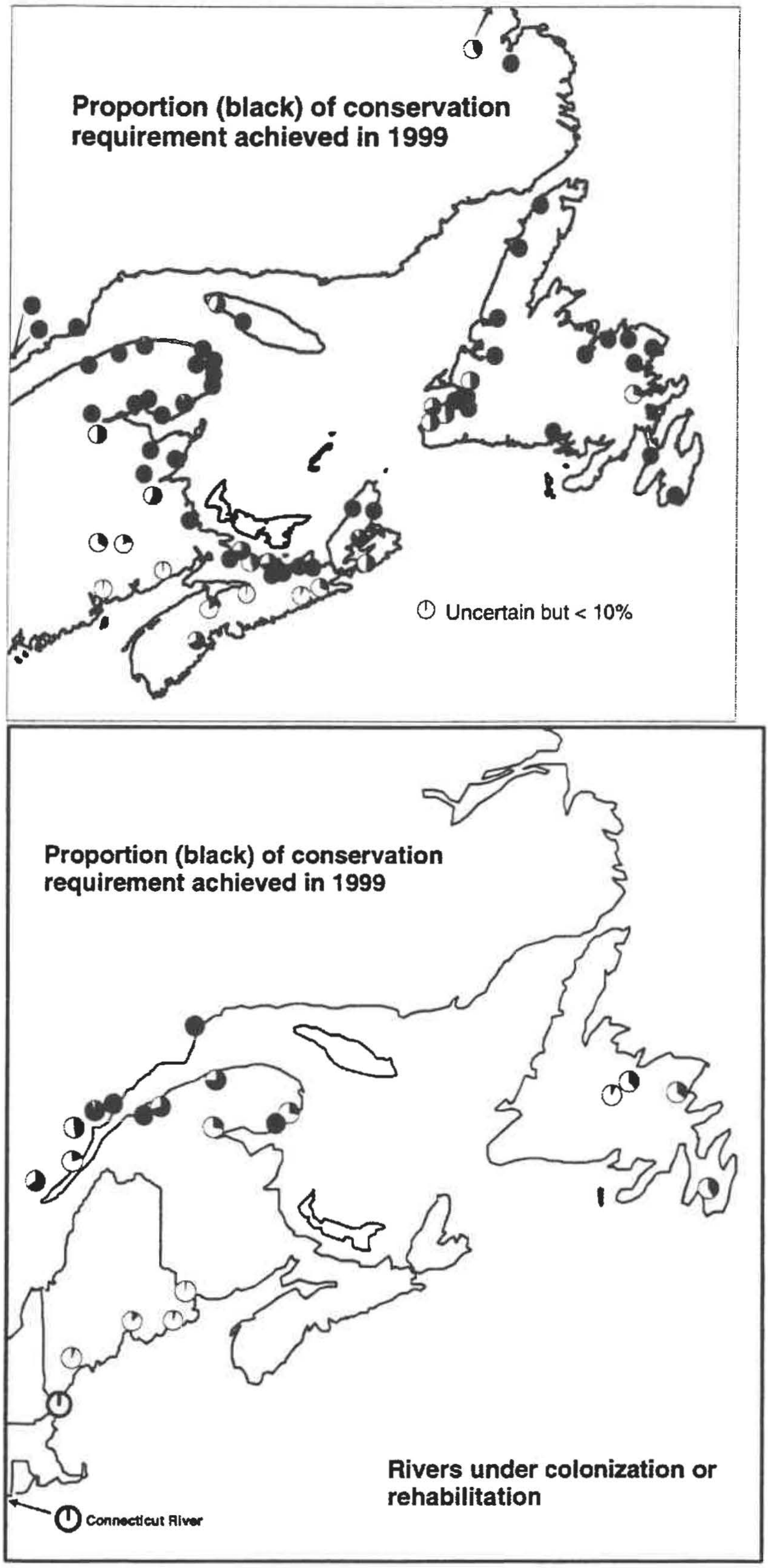


Figure 3.1.2.6 Egg depositions in 1999 relative to conservation requirements in 67 rivers (left panel) and for 17 rivers of eastern Canada and five rivers of U.S. under colonization or rehabilitation (right panel). The black slice represents the proportion of the conservation requirement achieved in 1999. A solid black circle indicates the egg deposition requirement was attained or exceeded.



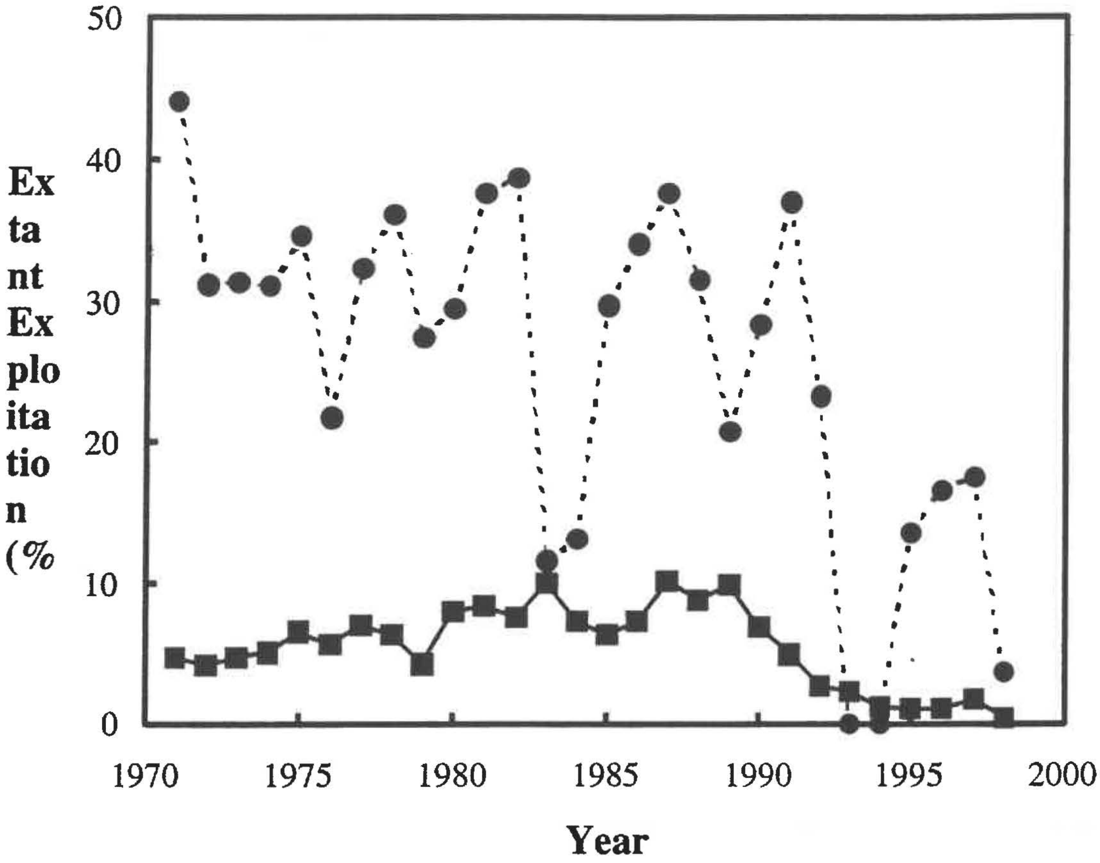


Figure 4.2.1 Extant exploitation of the non-maturing component of North American salmon as 1SW salmon in North America and Greenland from the run reconstruction statistics.

Figure 4.5.4.1 Precision index for estimate of the PFA for West Greenland catch model.

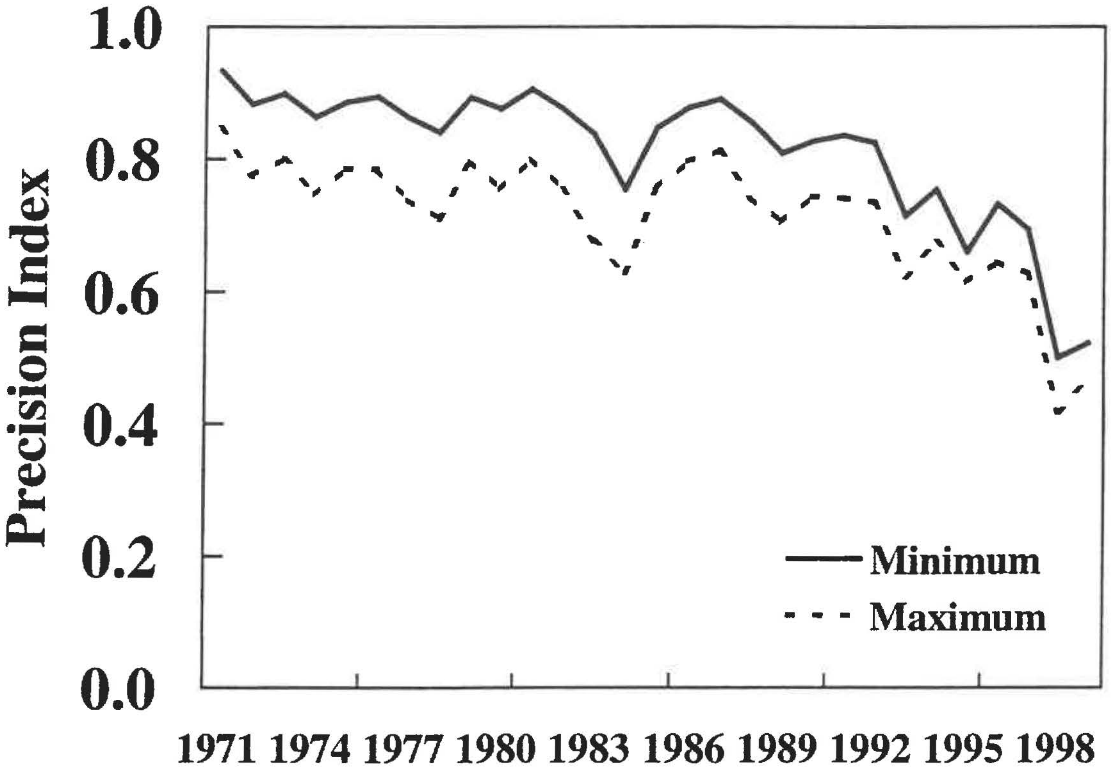


Figure 4.5.4.2. Posterior predictive distributions (5000 Monte Carlo simulations) of the 1999 PFA under varying levels of measurement errors in the PFA and lagged spawner (SNLQ) variables.

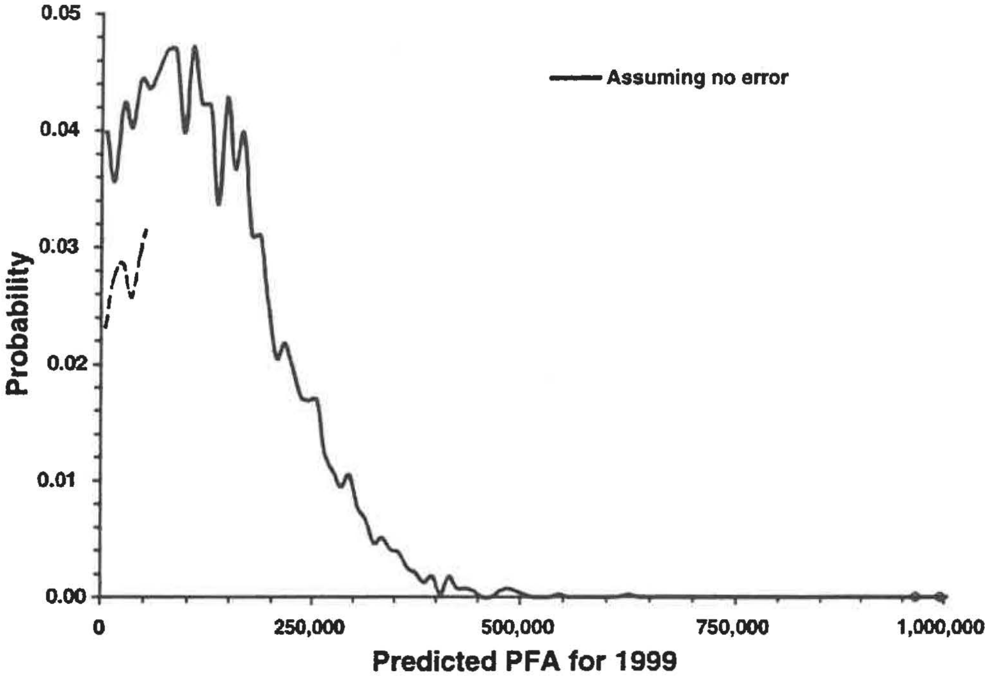


Figure 4.5.4.3. Approximate posterior predictive distribution (50000 Monte Carlo simulations) of the 1999 PFA using the annual error levels in the PFA and lagged spawner variables.

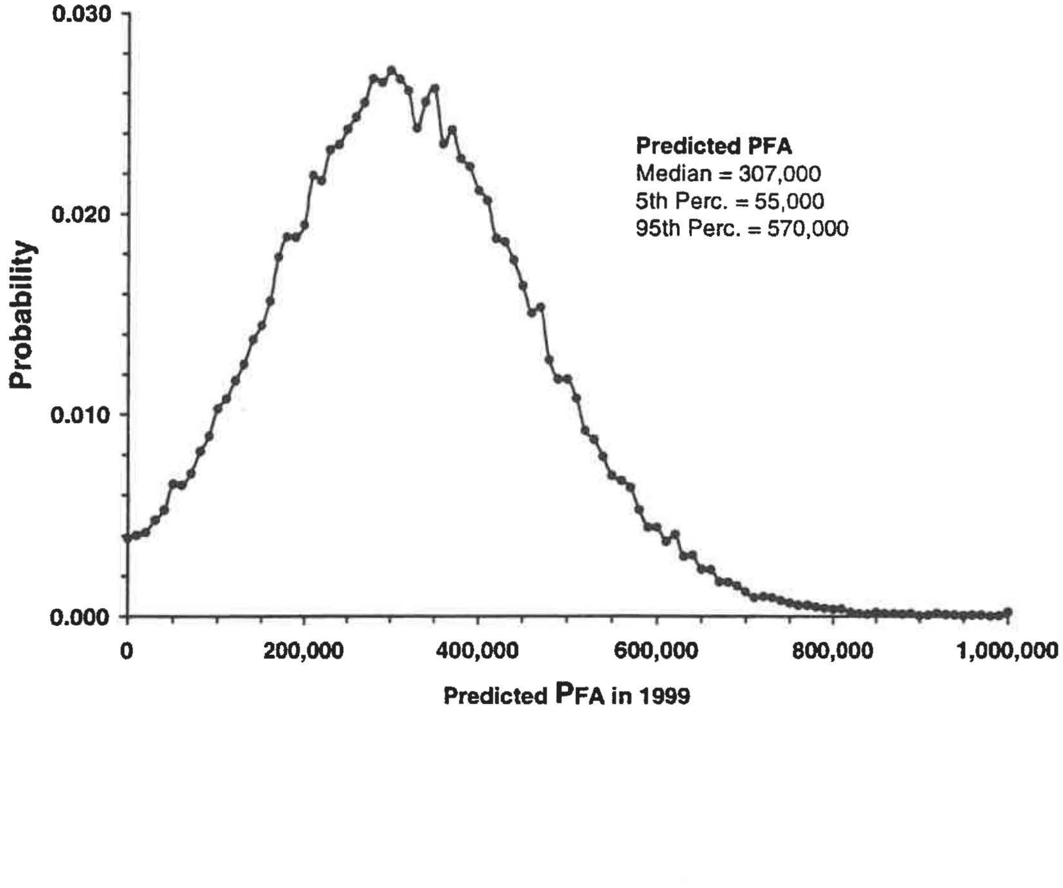
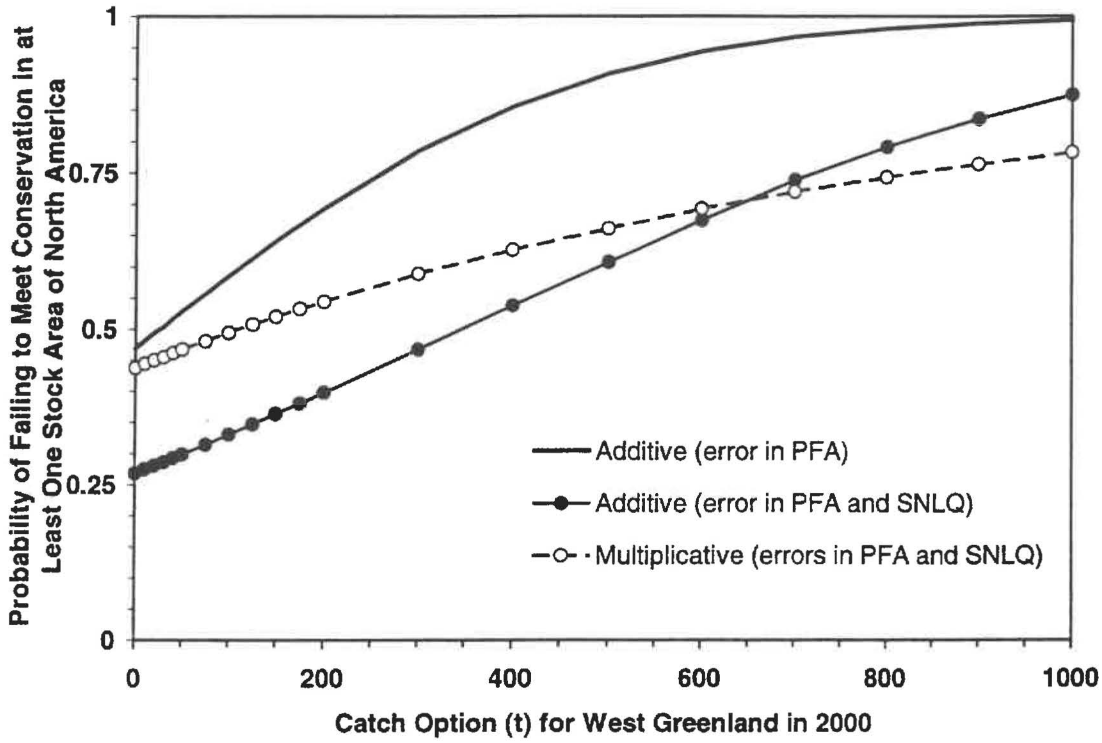


Figure 4.6.4.1 Risk analysis (probability of not meeting the conservation requirement in at least one of the six stock areas in North America) of catch options on the Pre-Fishery 1SW non-maturing salmon component in 2000. Risk is expressed relative to catch options at West Greenland relative to failing to meet 100% of the conservation requirement (upper panel) and the risk of severe underescapement (50% of conservation) (lower panel).



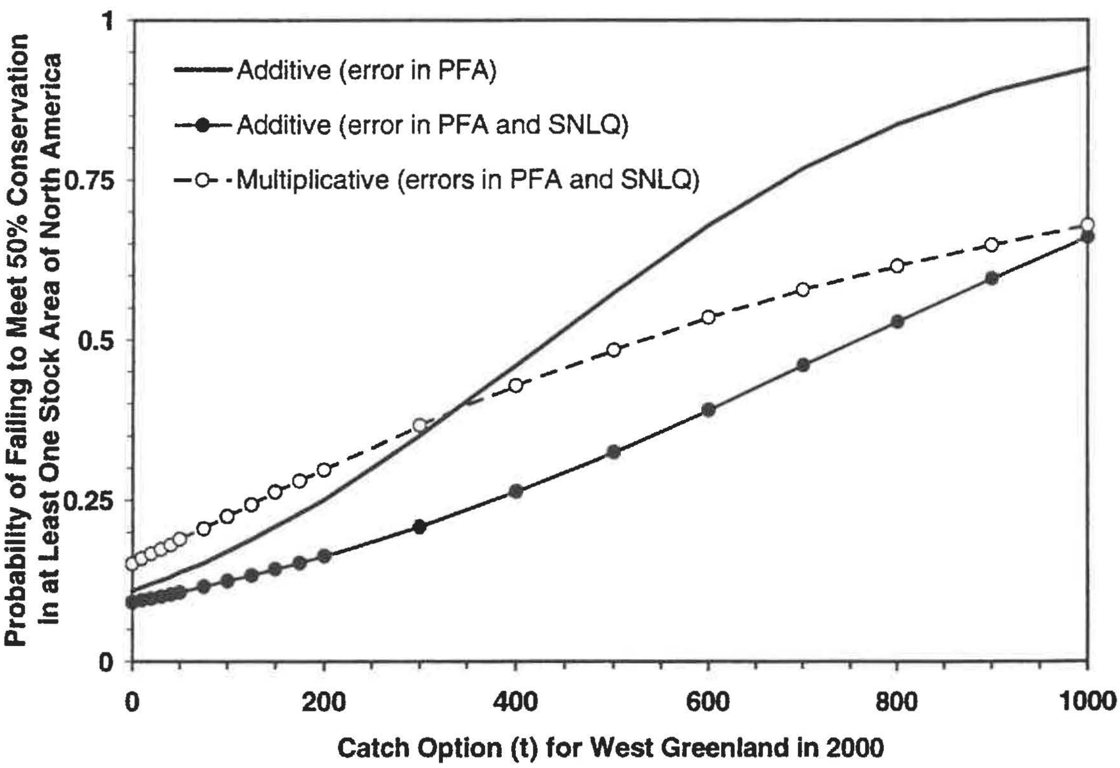


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Table 4.6.3.1 Quota options (mt) for 2000 at West Greenland based on H2-SNLQ regression forecasts of fishery abundance. Proportion at West Greenland refers to the fraction of harvestable surplus allocated to the West Greenland fishery. The probability level refers to the pre-fishery abundance levels derived from the probability density function.

Prob.	Proportion at West Greenland (Fna)										
level	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
25	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0
45	0	0	0	0	0	0	0	0	0	0	0
50	0	4	7	11	14	18	21	25	29	32	36
55	0	8	15	23	31	39	46	54	62	70	77
60	0	12	24	36	48	60	72	84	96	108	120
65	0	16	33	49	66	82	98	115	131	148	164
70	0	21	42	63	84	105	126	148	169	190	211
75	0	26	52	78	104	131	157	183	209	235	261

Sp. res =	170,286
Prop NA =	0.779
WT1SWNA =	2.666
WT1SWE =	2.832
ACF =	1.068