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Exploration of the Sea

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REPORT OF THE WORKING GROUP ON NORTH ATLANTIC SALMON

Copenhagen, 21-31 March 1988

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*General Secretary
ICES
Palægade 2-4
DK-1261 Copenhagen K
DENMARK

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1 INTRODUCTION

At its 1987 Statutory Meeting, ICES resolved that the Working Group should meet at ICES Headquarters from 21 - 31 March 1988 to consider questions posed to ICES by the North Atlantic Salmon Conservation Organization (NASCO) (Appendix 1).

In 1987, the Working Group expressed the view that time should be set aside at its next meeting to address the framework for provision of scientific advice for the management of Atlantic salmon. Such a framework was required because it had become increasingly difficult to provide complete answers to new and complex questions posed by NASCO and ICES. Accordingly, the Working Group was asked to discuss scientifically-based approaches for managing salmon in the context of existing fisheries.

To provide time to consider this issue, the number of questions asked was reduced and a study group was established to prepare data relevant to North American Commission questions.

Three study groups submitted reports to the Working Group: the Acid Rain Study Group, the Study Group on the Norwegian Sea and Faroes Salmon Fishery, and the Study Group on the North American Salmon Fishery. There were an additional thirty-four papers submitted (Appendix 2).

1.1 Participants

The following scientists participated:

E. T. Baum	USA
J. Browne (Chairman)	Ireland
V. Belobragin	USSR
W. W. Crozier	UK (N. Ireland)
K. Friedland	USA
L. P. Hansen	Norway
T. Hansen	Norway
A. Isaksson	Iceland
S. H. i Jåkupsstovu	Faroe Islands
J. Møller Jensen	Denmark
L. Karlsson	Sweden
H. Lassen	Denmark
T. L. Marshall	Canada
D. J. Meerburg	Canada
A. L. Meister	USA
E. A. Niemelä	Finland
T. R. Porter	Canada
E. C. E. Potter	UK (England and Wales)
P. J. Rago	USA
D. G. Reddin	Canada
W. M. Shearer	UK (Scotland)
M. Thibault	France
A. Zubchenko	USSR

2 CATCHES OF NORTH ATLANTIC SALMON

2.1 Nominal Catches of Salmon

Total nominal catches of salmon by country in all fisheries are given in Table 1, and nominal catches in homewater fisheries for 1961-1987 are given in Table 2. The updated 1986 catches (7,757 t) in homewaters were the highest since 1980. Figures for 1987 (6,511 t) are provisional, but it appears likely that the final data will show a decrease from 1986 except in Canada and Finland. Portugal reported a catch of 0.08 t which is not included in the tables.

Lack of information on fishing effort presents major difficulties in interpreting the catch data of any one year and also in comparing catches in different years.

The Working Group discussed unreported catches and considered them an important component in stock assessment. It agreed that methods to assess the unreported catch should be investigated. Towards this end, unreported catches are defined as follows:

> Harvests which are caught and retained, but do not enter into reported catch statistics; such harvests could be both legal and illegal, but would not include catch and release mortalities whether they arise from nets or angling gear. Such estimates would not include fish retained by public or private agencies for broodstock purposes.

Some countries could not provide data. However, the Working Group considered the unreported catch for all countries to be of the order of 3,000 t. This estimate is 500 t less than the corresponding value for 1986.

2.2 Catches in Numbers by Sea Age and Weight

Reported national salmon catches for several countries by sea age and weight are summarized in Table 3. As in Tables 1 and 2, catches in some countries include both wild and reared salmon and fish farm escapees. Figures for 1987 are provisional. The methods used by the different countries to break down their total catch by sea age are described in Anon. (1986b). However, in Anon. (1987a), it was indicated that, for Canada, numbers of 1SW and MSW salmon were calculated using an assumed mean weight of 2.0 kg for 1SW and 4.5 kg for MSW salmon; this applied to the years 1982-1984 only. Since 1984, the mean weights used have been specific to fishing area and gear, and catches by weight and number have been summed separately. In most countries, the decline in the reported 1987 homewater catches occurred in both the 1SW and MSW age groups.

3 SCIENTIFICALLY-BASED APPROACHES FOR MANAGING SALMON

3.1 Introduction

In 1986 and 1987, the Working Group on North Atlantic Salmon was asked to consider the concept of safe biological limits for the exploitation of Atlantic salmon. Various factors were discussed, and it was recommended that, given the complexity of the problem, a special effort was required to address the framework for the provision of scientific advice for the management of Atlantic salmon. In response, NASCO asked ICES to discuss scientifically-based approaches for managing salmon in the context of existing fisheries.

The Working Group considered that there were two aspects to this question.

It was necessary first to establish a practical management strategy and then to describe a possible scientific approach to providing supporting advice. The Working Group recognized three principal aims for managing Atlantic salmon: conservation of stocks; optimization of yields; and minimization of the variability of yield in each fishery.

> Conservation can best be achieved by controlling fishing mortality to ensure an adequate number of spawners in each river system to optimize production each year, and this must be the first priority of salmon management.
>
> It is likely to be difficult to optimize yields in mixed stock fisheries because individual stocks or stock complexes will have varying availability to the fisheries. The stocks or stock complexes having the largest proportion of their extant numbers available to the fishery will experience the highest exploitation rates and must, therefore, be the key to optimizing exploitation in the fishery. The varying relative productivity of stocks or stock complexes further complicates management of mixed stock fisheries.
>
> Wide annual variation in the yield in each fishery may have socio-economic implications that must be considered.

The Working Group considered that it was fundamental to rational management that scientists estimate a target number of spawners of each sea age or stock component which should be attained each year. This number can be converted into a target "spawning biomass" using appropriate mean weights.

In setting a target spawning biomass and managing the fisheries to achieve this target, scientists and fishery managers must be aware that even with the same egg deposition each year, there will be wide annual fluctuations in production of adult salmon due to varying levels of natural mortality in freshwater and in the sea. In fact, the annual production of adult recruits to the fisheries probably varies by at least ±30% from the average for a given spawning biomass. The management strategy must therefore:

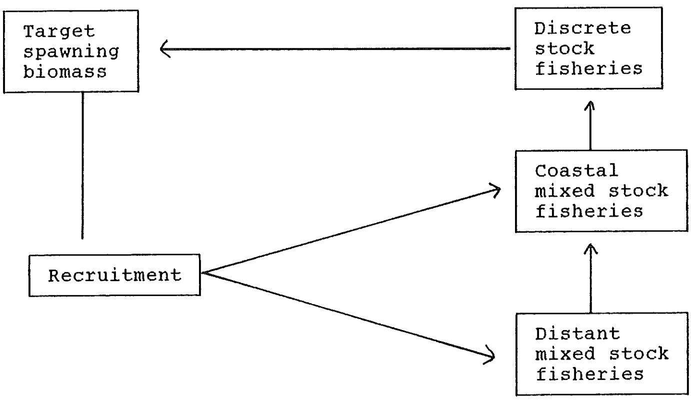
1) permit annual adjustment to harvest levels in all fisheries or;

2) fix the combined harvest of all fisheries at a sufficiently low level such that the target spawning biomass of each stock component is achieved within normal variations in production or;

3) fix the harvest in mixed stock fisheries at a sufficiently low level to allow final adjustments to the spawning escapement of each stock component in or close to the river of origin.

3.2 A Conceptual Framework

The Working Group prepared the following basic diagram to illustrate the type of relationships that could exist between the fisheries that must be managed in order to achieve target spawning biomass for each stock or stock complex. No attempt was made to show all variations in salmon migration patterns or all possible fisheries in this diagram. For example, some stocks may not be exploited in a discrete stock fishery, and others may have a portion of their population that is not present in any mixed stock fishery.



"Stock" is defined as a reproductively isolated spawning population. It may be the entire salmon population or a component of the population in a river system.

"Discrete stock fisheries" are fisheries which generally harvest single stocks. This type of fishery is usually found in a river system or estuary or in close proximity to the river and generally only harvests salmon returning to their native river to spawn.

"Coastal mixed stock fisheries" usually harvest salmon from more than one stock which are on their spawning migration to their river of origin. In some areas, however, they may take salmon which would have remained at sea for a further one or more years, and they may also take fish returning to rivers in other countries.

"Distant mixed stock fisheries" may also harvest both immature salmon which would have remained at sea for another one or two years and maturing salmon returning to homewaters in the same year.

"Exploitation", as used in this report, relates to the total extant stock. It is defined, as in Anon. (1985), as the number of fish caught in the fishery divided by the number of fish of the appropriate stock and smolt year classes extant at the time when 1/2 of the catch has been taken, plus the remaining half of the catch.

There are interactions between all fisheries. For example, a restriction on a mixed stock fishery could result in an increased harvest in subsequent fisheries unless they were also restricted. It should be noted that the composition of the stocks in the mixed stock fisheries may vary within and between years. In addition, the distribution of the salmon and their availability to the fisheries is influenced by conditions in the ocean.

Several models are available which, given sufficient data, can be used to estimate target spawning biomass or production and to assess the effects of varying fishing mortality in one fishery on the harvest in other fisheries and on spawning biomass (see Section 3.6).

3.3 Techniques to Attain Target Spawning Biomass

The ideal system for managing salmon would be to forecast the abundance of all stocks prior to the start of the fisheries each year and then to allocate catches to the fisheries on the basis of information on the distribution of the fish and target spawning escapement.

Limitations to this ideal system are numerous and obvious. The costs of monitoring the production of river systems are excessive, and the development of reliable stock and recruitment relationships would take many years. Interactions of climatic variation and the availability of salmon stocks to mixed fisheries have been investigated to a very limited extent.

The Working Group, therefore, concluded that the existing salmon fisheries could not presently be managed within an ideal framework. However, two approaches were discussed which could be used to achieve sufficient spawning escapement for some stock complexes. These approaches are discussed below.

3.3.1 Real-time management of fisheries

This method utilizes available information on stock abundance either before the fishery commences or while it is in progress.

This information is used to close or regulate mixed stock or discrete stock fisheries if the abundance of selected stocks or stock components is equal to or less than a predefined target.

An example of a real-time management system was introduced in the Faroese longline fishery. Areas with high proportions of undersized fish can be closed to fishing. Such real-time management has also been applied to other salmonid species. For example, in the Fraser River, British Columbia, assessments of the runs while they are in progress are used to adjust fishing mortality on pink, chum, and sockeye salmon. Another example occurs in North America, where closure systems are initiated on the basis of electrophoretic data to protect specific stocks from overfishing.

The method requires:

a) estimates of salmon abundance during the fisheries;

b) techniques to identify stocks;

c) models for estimating the impact of management measures on the predefined abundance targets;

d) enforcement mechanisms for implementation of management measures.

It is advisable that spawning escapement be monitored to determine the effectiveness of the management measures.

3.3.2 Management based on historical performance of the fisheries

Under this management regime, exploitation rates for all fisheries would be adjusted on the basis of historic data on the performance of the stocks in terms of spawning escapement and catches.

This management strategy is the one most commonly used at present. The major difficulty with it is that it only reacts to conservation and fishery problems after they occur and operates by trial and error. Results of attempts to reduce exploitation are not necessarily predictable and often affect non-target stocks. With data currently becoming available for some stocks and stock complexes, this management regime is becoming more successful and could be improved with appropriate research.

The method requires:

a) historical data on spawning escapements for a number of stocks;

b) data by stock or stock complex on the contribution to mixed stock fisheries.

3.4 Proposed Approach to Management

All of the management techniques discussed in Section 3.3 have limitations for managing salmon throughout the North Atlantic. The following suggested approach to management takes into account some aspects of these management techniques and the diverse scientific knowledge which is available on salmon stocks and their fisheries.

A primary goal of management is to ensure target spawning biomass. This can best be achieved by setting the harvests in mixed stock fisheries at a level which would ensure a greater number of salmon returning to the vicinity of the river of origin each year than is required for spawning. Adjustments would then be made to fisheries in or near the rivers to ensure that target spawning biomass is attained. Thus it is necessary to have an estimate of the lowest total production which would be expected given that the target spawning biomass has been achieved each year. By subtracting the target spawning biomass from the lowest estimate of production, a maximum harvest level can be established for mixed stock fisheries. However, if this maximum harvest is taken in the mixed stock fisheries during years when productivity is lowest, there would be insufficient salmon for a harvest in the discrete stock fisheries. This may have socio-economic implications for the management of these fisheries.

It is implicit in this management framework (which involves varying harvest in discrete stock fisheries to obtain target spawning biomass) that the discrete stock fisheries would have the greatest fluctuations in harvests. Small annual adjustments may be possible on mixed stock fisheries once some indicators of abundance, such as CPUE, have been established. Longer-term adjustments could be made based on the performance of the fisheries and success in achieving target spawning biomass.

It is not feasible to develop a management strategy or assess its effectiveness by determining the spawning biomass or the fishing mortality of all stocks. Annual assessments and calculations of these parameters should be made on "indicator stocks".

An "indicator stock" may be an individual stock or a group of stocks which can represent the stocks in a larger geographic area. Generally these stocks which have similar productivities can be called a stock complex. Within these stock complexes, salmon of similar sea ages at maturity are assumed to have similar migration and exploitation patterns. In some stock complexes, it may be sufficient to select as an indicator the stock which has the highest fishing mortality relative to its productivity. If the target spawning biomass is achieved on the "indicator stock", then it is assumed that the target spawning biomass will be reached by others in the stock complex.

For "indicator stocks", it will be necessary to have annual estimates of spawning escapement, fishing mortality in the various fisheries, and abundance of salmon returning to discrete stock fisheries.

3.5 Estimation of Target Spawning Biomass and Production

In most salmon rivers, it is not possible to obtain a reliable estimate of the target spawning biomass or production of recruits to the fisheries. Stock-recruitment relationships are available for only a small number of rivers. Therefore, indirect methods have to be used to estimate target spawning biomass and potential production. There are several approaches which can be used depending on the amount of knowledge already available on the stock and habitat. One approach would be to apply estimates of densities at various life stages, or adult production from stocks which have similar biological characteristics, i.e., use values from "indicator stocks". Another approach would be to use values from the literature.

Evaluation of the fisheries and performance of "indicator stocks" over time and additional scientific knowledge will assist in refining the estimates of target spawning biomass and production.

The Working Group reviewed a number of working papers which demonstrated how "indicator stocks" could be used to provide information on salmon production. In Northern Ireland, information was presented for the River Bush on: smolt production; adult salmon returns to the river; and exploitation on this stock in the various coastal mixed stock fisheries. Smolt and adult production was then estimated for all other rivers in Northern Ireland by assuming that the smolt production per unit drainage area is similar in all salmon-producing rivers.

Preliminary estimates of smolts and adult salmon recruits for Icelandic rivers were derived using 1) known exploitation rates on stocks in some rivers and applying these to stocks in all other rivers to calculate total returns of adult salmon to the rivers and 2) using known sea survival rates of tagged smolts to calculate the total number of smolts leaving the river. This approach was feasible in Iceland because fishing mortality at sea was assumed negligible.

A time series of data on the number of spawners, subsequent smolt production, fishing mortality, and adult returns is available for the North Esk, Scotland. Data on the life history of one year class were reviewed as an example of the first step in defining a stock-recruitment relationship for the North Esk salmon stock. Survival rates from eggs to smolts and fishing mortality were reviewed. The salmon populations in Scotland, however, have a diversity of biological characteristics, thus the salmon population in the North Esk is not considered representative of them all.

Similar approaches were used to determine fishing mortality for the River Imsa in Norway and Burrishoole River in Ireland (Section 7).

In North America, target spawning biomass has been calculated for several rivers using an egg deposition requirement of 2.4 eggs/m^2 and relevant biological characteristics of the stock. Predictions of returns of MSW salmon have been made from linear correlations between grilse and MSW salmon returns in the next year to the Miramichi, Restigouche, and Saint John rivers.

The Working Group also considered an approach to discriminate stock complexes in fisheries which harvest North American stocks. There is an increase in mean smolt age from south to north in rivers in North America. If sufficient data were available, it might be possible to identify stock complexes based on smolt ages. The harvest of salmon from these complexes could be examined by determining the ages of salmon in the fisheries.

3.6 Fisheries Model

The Working Group discussed the feasibility of modelling the marine life history of North Atlantic salmon. Models could be developed for salmon stocks with sufficient data. Eventually these individual models could be linked to develop a cohesive picture of interactions among fisheries and used to estimate the effects of management measures.

3.6.1 Choice of a model

The Working Group considered working papers on two models. It was suggested that an existing multi-species, multi-fishery yield prediction model or a model based on a spreadsheet approach could be used. While both approaches provided similar descriptions of the fisheries interactions, the spreadsheet provided a more understandable picture of the stock dynamics.

The spreadsheet system NOTIS-CALC, available at ICES Headquarters, was used to implement the model. Examples are shown in Tables 4 and 5 and represented graphically in Figures 1 and 2.

The model structure involves the following processes:

- post smolt mortality,
- migrations, including movements between fishing zones,
- exploitation in each fishing zone,
- natural mortality.

Relevant information for input to the model:

- results of tagging experiments,
- estimates of natural mortality,
- mean weight of fish in the fisheries,
- nominal catch in numbers by sea age,
- smolt production,
- exploitation rates,
- migration patterns and timing,
- mid-date of fisheries,
- non-reported catch,
- spawning escapement.

Not all of these parameters are essential for the running of the model, but information on each one will strengthen the model.

Standard measures of catch and abundance, e.g., traps, tag recaptures, etc. can be used to develop most, but not all, of the necessary parameters for the model. Therefore, each model will have an infinite number of parameter sets which will generate the observed data. Similarities among fisheries will allow the development of reasonable parameters where there are insufficient data. Furthermore, whatever parameter set is chosen for the simulation of effects of management measures, the parameter values will have to be mutually consistent. In the absence of estimates of post-smolt mortality, the model can begin with an estimate of recruitment of 1SW salmon. Tables 4 and 5 and Figures 1 and 2 show the layout for the model for two imaginary European rivers.

The model calculates the abundance and catch in each row (i.e., in each time step). All fish available in the previous time period are accounted for.

3.6.2 Fisheries models for selected stocks

The Working Group also examined two conceptual approaches to reducing exploitation on selected salmon stocks. The first approach, termed "real-time" management, relies on timely information on the fishery to define season and area closures, gear restrictions, or quotas. Information would be collected just prior to or early in the fishing season, rapidly analyzed, and followed by appropriate management measures. The key criterion for success of real-time management is that measures could be implemented well before transient target stocks leave the fishing area.

The second approach used linear programming to develop time and area closures that minimize interceptions in mixed stock fisheries, subject to constraints on yield reductions (Anon., 1988b). Available historical information on the unequal temporal and spatial distribution of two or more stock complexes could be used to demonstrate the maximum reduction in harvest that could be attained for a target stock. This reduction, however, is constrained by limitations on the acceptable levels of loss to the total fishery. By adjusting the number and types of constraints, the model can provide an objective standard against which more practical management measures can be evaluated.

3.7 Summary

The Working Group cautions that the models mentioned above are preliminary and are not intended to be used for management decisions in the immediate future. The models will be further developed as data sets become available. Nevertheless, they are the first steps in the description of salmon fisheries in the North Atlantic. The marine life history model is not predictive, but, given the appropriate parameter sets, it can give a descriptive view of the interactions of the various fisheries and spawning escapements.

To answer efficiently the questions being posed by ICES, the Working Group would welcome a response to the framework. The Working Group recommends that representatives of each country bring relevant data for the stocks or stock complexes to be used in the model to the next Working Group meeting.

4 QUESTIONS OF INTEREST TO THE WEST GREENLAND COMMISSION OF NASCO

4.1 The Fisheries in 1987

NASCO asked ICES to describe the events of the 1987 fisheries in the West Greenland Commission area with respect to gear, effort, exploitation rate, composition and origin of the catch, and assess the status of stocks. Descriptions of fisheries in home-waters are given in Section 7.

4.1.1 Description of the fishery at West Greenland

The fishery in 1987 was opened on 25 August and ended on 7 October. The total nominal catch was 966 t (Tables 6 and 7), 31 t more than the TAC of 935 t. The catch in 1986 was almost the same as in 1987, namely 960 t. The TAC agreed upon for 1987 was 850 t with an opening date of 1 August; this was adjusted to 935 t with an opening date of 25 August using the agreed formula (Anon., 1987a). The TAC was, as usual, divided into two components, viz. a "free quota" of 533 t in which all fishermen with a license could take part, and a "small-boat quota" of 356 t which was allocated to districts and only available for boats smaller than 30 feet. The rest of the TAC, 46 t, was reserved for a longline fishery and as a buffer for the total fishery.

The "free quota" was fished from 25 August to 2 September, and the catch, 614 t, exceeded this by 81 t. In total, 77% or 744 t were taken by boats smaller than 30 feet, and even during that period when all boats with licenses could take part in the fishery, the catches of the small boats accounted for 393 t or 64% of the catch. All the small-boat catches were taken in the inshore area or in the coastal area very close to the shore. Information from the logbooks indicate that a great part of the catches taken by boats bigger than 30 feet also came from the inshore area.

The geographical distribution of the fishery in 1987 (Table 7) differs from that in 1986, when the highest divisional catch was taken in NAFO Division 1F. In 1987, the greatest landings were recorded in NAFO Divisions 1C-1E.

The majority of the catch at West Greenland is taken with drift nets, which have a target mesh size of 140 mm stretched. The number of drift nets used by each type of boat varied considerably. On average, the small boats used 40 nets (SD = 23), each 25 m long, per fishing day, whereas the bigger boats used 99 nets (SD = 58) per day. The fishermen patrol the nets during the fishing period, remove the salmon caught, and in most cases the nets are cleared before the gear is hauled. This represents a significant change in the fishing operations compared with the procedures formerly used by the big drifters and should have reduced the non-catch fishing mortality.

Fixed gillnets are still used, but the number seems to be decreasing each year. Although it was anticipated that an experimental longline fishery would be operated in 1987, no information is available on any fishing having taken place.

During the first 7 days (25-31 August) and the first 14 days of the fishery (25 August - 7 September) (see text table below), the landings were 439 and 737 t, respectively, which is less than in 1986.

Year	Nominal catches in tonnes	
	First week	First two weeks
1976	147	360 (10-23 Aug)
1977	NA	500 (20 Aug - 2 Sep)
1978	NA	NA
1979	NA	509 (1-14 Aug)
1980	260	711 (1-14 Aug)
1981	465	735 (15-28 Aug)
1982	470	766 (25 Aug - 7 Sep)
1983	105	192 (10-23 Aug)
1984	17	58 (10-23 Aug)
1985	204	361 (1-13 Aug)
1986	509	848 (15-28 Aug)
1987	439	737 (25 Aug - 7 Sep)

Effort and catch information was provided by 60 boats out of a total of 350 to whom logbooks were distributed. This information together with the CPUE is given in Table 8. The figures from 1986 are updated and given in Table 9. In spite of the limited amount of information available, a comparison between the two years shows that the CPUE was higher in 1986 than in 1987.

4.1.2 Composition and origin of catch

The Working Group considered the composition and origin of salmon caught at West Greenland based on discriminant analysis of catch samples. In 1987, samples used to develop a data base for discriminating salmon at West Greenland came from salmon caught in homewaters and at Greenland between 1980 and 1986. These samples, (678 North American, 678 European) have been previously described by the Working Group in Anon. (1984, 1985, 1986b, and 1987a). These data were used to develop a discriminant function following normal procedures and based on scale characters to distinguish continent of origin. However, because of differences between circuli counts in the data base and in samples taken in 1987, the scale-character variable CS1W was excluded from the analysis and only CS1S was used. The results of classifying independent test samples indicated a misclassification rate of 22.6% and error rates of ±4.2%. The results of classifying samples caught at Greenland in 1987, identified to continent of origin by presence of a tag or particular genotype, indicated a misclassification rate of 18.6% and error rates of ±4.0%.

The results of classifying salmon in samples from commercial catches in 1987 indicated that the North American proportion by number was 59% (95% CL = 63,54) and the European proportion was 41% (95% CL = 46,37) (Table 10). The sampling was conducted during a period in which over 70% of the catch was taken.

An alternate estimate of the overall proportion of North American and European-origin salmon for the years 1982-1987 was derived by weighting division samples by catch in numbers. Pooled samples were applied to divisions with no samples. The table below gives the results:

Year	Proportion weighted by catch in number		Proportion all samples combined	
	NA	EU	NA	EU
1982	57	43	62	38
1983	40	60	40	60
1984	54	46	50	50
1985	47	53	50	50
1986	59	41	57	43
1987	59	41	59	41

In 1987, a proportion of 59% North American (NA) origin corresponds to a catch of 556 t or 179,918 salmon from North America and 411 t or 126,395 salmon from Europe (EU).

As in most previous years, comparisons showed no temporal trends in the proportions by continent of origin but significant differences between the proportions in some NAFO divisions. The North American proportion by NAFO division ranged from 47% in 1F to 68% in 1D.

ICES was requested by NASCO to provide estimates of the catches at West Greenland by country of origin. Recoveries from Greenland fisheries of Carlin-tagged fish released in Maine (Table 11) provided a basis for estimating the catches of Maine-origin fish. The model described in Section 2.3 of Anon. (1987a) was used to estimate the total harvest by statistical area for the period 1967-1986 (Table 12). The ratio parameter for each year was taken from Table 31. Non-catch fishing mortality (NC) for the Greenland fishery was assumed to be 0.2. It should be noted that, because of changes in the fishery, parameter values for the harvest model should be reviewed. The reporting rate for the recovered tags varied by year, as estimated in Section 3.7.1 of Anon. (1987a). The reporting rate for 1987 was assumed to be the same as 1986 (0.8).

Estimated total catch of Maine-origin salmon rose in 1986 to 2,096 from 1,515 in 1985. The total catch has ranged from 238 to 2,847 fish in 1967 and 1974, respectively. For the period 1970-1975, the average harvest was about 1,650 salmon. Following the imposition of a quota in 1976, the catch has averaged about 1,460 salmon. During this period, there was a general increase in the numbers of MSW salmon returning to Maine rivers. Much of this increase in run size can be attributed to increases in the numbers of smolts stocked.

Information on country of origin can also be derived from recoveries of coded-wire tags (CWT) at Greenland in 1987. Salmon landings at Greenland were again scanned in 1987 for adipose finclips and microtags using procedures similar to those in previous years (Anon., 1986a, 1987a). In 1987, a total of 25,047 salmon

(8.2% of the West Greenland catch) were examined for finclips and microtags by Canadian, USA, and Danish scientists. In the sample, 493 (2.0%) had adipose finclips, and microtags were recovered from 146 (29.6%) of the finclipped fish (Table 13). Microtags recovered in 1987 were from 5 countries and apportioned as follows: 17 (12%) from the UK (England and Wales), 2 (1%) from the UK (Scotland), 24 (16%) from Ireland, 82 (56%) from the USA, and 21 (14%) from Canada (Table 14).

The Working Group considered a method for estimating the number of fish harvested for stocks tagged with CWTs. The total tags in the fishery would be calculated as the product of the numbers of tags per fish scanned and the catches in numbers for each spatial area of the fishery by calendar weeks (weeks beginning on Monday). In the West Greenland fishery, the tags per fish for Division 1B would be applied to catches in Divisions 1A and 1B, the rate for Division 1D would be applied to Divisions 1C and 1D, and the rates for Divisions 1E and 1F would be applied to the catches in those divisions, respectively. The decision to utilize the rate for Division 1B in Divisions 1A and 1B was based upon the observed patterns of the fishery and the geographic location of sampling sites. The total number of tags would be raised to harvest by the ratio (RATIO) of tagged to untagged fish of the same cohort determined in homewaters the following year following the methods developed for external tags (Anon., 1986a).

The Working Group recommended a variance estimator be applied to the harvest estimates where possible. The total number of CWTs in the fishery from the marked stocks (A) is equal to the product of the total number of fish in the fishery (N) and the proportion of fish with tags (P) (Cochran, 1977):

$$A = NP$$

Then, A can be estimated using random stratified sampling:

$$\hat{A} = \Sigma N_s \cdot P_s$$

where P_s is the proportion of fish scanned with tags in area-week stratum s, and N_s is the number of fish caught in each stratum.

The estimate of the variance of A is given by Cochran (1977):

$$V(\hat{A}) = N^2 \cdot \Sigma \frac{W_s^2 \cdot P_s \cdot q_s}{n_s - 1} (1 - n_s/N_s)$$

where $N = \Sigma N_s$, $W_s = N_s/N$, n_s = the number of fish scanned in stratum s, $q_s = (1 - P_s)$, and $(1 - n_s/N_s)$ is the finite population correction factor. Harvest was estimated by the following:

$$H = \hat{A} \cdot (1/RATIO)$$

and the estimate of the variance of the harvest estimate is given by:

$$V(H) = V(\hat{A}) \cdot (1/RATIO)^2$$

In examples considered by the Working Group, this stratification scheme avoided overestimation caused by raising combined catches over time and yielded acceptable precision for harvest estimates at the tag scanning levels presently achieved in the field.

The Working Group reviewed a report providing information on levels of mitochondrial DNA (mtDNA) polymorphism among Atlantic salmon stocks and the value of mtDNA as a genetic marker for distinguishing North American from European salmon. Restriction site analysis (the cleavage of the mtDNA molecule by enzymes that recognize specific DNA base sequences) with twenty enzymes indicated that there were seven distinct mutation sites between the continental groups. Two distinct genotypes were observed amongst European-origin salmon suggesting that the methodology may have potentially greater resolution than to just continent of origin. Comparisons of continent of origin identifications made by mtDNA and electrophoretic techniques were in agreement. Thus, the Working Group recommended the comparison of this methodology with other techniques of stock identification.

Two preliminary stock identification studies utilizing image processing techniques were also reviewed by the Working Group. One study evaluated the usefulness of scale texture and circuli spacing patterns of scales to separate North American hatchery stocks by country of origin. Although the results of these preliminary analyses are encouraging, the Working Group agreed that the discriminant model may have been unnecessarily complex due to the inclusion of stocks with poor survival. A second study evaluated the usefulness of otolith shapes to identify continent of origin. Otolith samples from microtagged salmon recovered from the West Greenland fishery could be assigned to continent of origin with high efficiency, but there was concern over the poor representation of wild stocks in the model. Discrimination of Atlantic salmon to continent of origin based on otolith shape is potentially a useful calibration method for other discrimination techniques. However, this is potentially subject to inter-annual variability and warrants further investigation. Continent of origin discriminations based upon biochemical methods (Verspoor, 1986) can pose sampling and analysis problems due to cost and to the difficulties in obtaining certain tissue types and preserving them, whereas otoliths are relatively easy to obtain, do not require any special handling, and can be analyzed rapidly. Application of this method, however, will require more rigorous testing.

4.1.3 Biological characteristics

Biological characteristics were recorded from samples of commercial catches from NAFO Divisions 1B and 1D-1F in 1987 using the results of discriminant analysis to divide samples into North American and European components. The Working Group decided that a better estimate of catch composition could be made by raising samples to total numbers of salmon caught by NAFO division. This should be done for the entire time series if possible.

The compositions of fish length, weight, and ages between these two groups of fish were then compared. (Table 15). As previously observed, the North American 1SW salmon were significantly shorter and lighter than their European counterparts. The sea and smolt age compositions of samples are summarized in Tables 16a, 16b, and 17, respectively. The mean smolt age of 2.80 years observed in the samples from salmon of North American origin taken in 1987 is similar to that in 1986 of 2.86 years. Both values were higher than observed in 1983, 1984, and 1985 (i.e., 2.70, 2.61, and 2.74, respectively), but lower than the average mean smolt age (3.12 years) observed during the period 1968-1981. The mean smolt age of 2.02 years observed in the samples from salmon of European salmon taken in 1987 is slightly higher than observed in 1986 (1.98 years). There are no trends in the mean smolt ages of European-origin salmon between 1968 and 1986.

The sea age compositions in 1987 (Tables 16a and 16b) of 97.0%, 2.0%, and 1.0% of 1SW salmon, 2SW salmon, and previous spawners, respectively, differ from those found in 1983, 1984, and 1985. In those three years, the 2SW components were 8.1%, 11.6%, and 5.9%, respectively.

Based on a proportion of 59% North American in the 1987 West Greenland salmon catches, the catch at age by continental origin is as follows:

Sea age	NA	EU	Total
1	173,261	123,867	297,128
2	4,138	2,149	6,287
PS	2,519	379	2,898
Total	179,918	126,395	306,313

4.1.4 Stock abundance and exploitation

In 1987, the Working Group (Anon., 1987a) used a modified VPA approach, based on estimates of run size and harvest of Maine-origin salmon to develop preliminary estimates of the exploitation rate and population size of 1SW salmon at West Greenland. A limitation of the previous model was that it assumed that all fish returning to Maine rivers were available for exploitation in the Greenland summer fishery. The Working Group reviewed a paper in which the effects of this assumption were examined. For a given year, modelling analyses demonstrated that exploitation rates of Maine-origin salmon in Canada and Greenland were inversely related, as were estimates of exploitation rates and population size.

To examine the effect of inter-annual variation in migrations, the model was run with a variety of assumed values for the proportion of the stock exploited in Greenland only. Simulations suggested that exploitation rates in 1986 probably had increased and population size had decreased in West Greenland over 1985 values, but the magnitude could not be quantified. This inference from the model is not consistent with the apparent high abundance in the 1986 fishery as assessed by the catch rates in the first two weeks of the season as well as CPUE data. Low rates of catch of 2SW salmon in some Canadian and USA rivers, however, did support this prediction of the model.

The Working Group noted that an essential requirement for proper calibration of the model would be an estimate of the relative exploitation rates in Canadian waters. Temporal and spatial variations in the distribution of USA salmon relative to Canadian salmon could complicate this estimation. An independent estimate of the exploitation rate at West Greenland for recent years would also be useful.

Although exploitation estimates at Greenland based on CWT recoveries for Merrimack River salmon in 1986 were similar to rates derived for Maine stocks, the Working Group noted that model results could be strengthened by similar studies on larger North American stocks. The model provided useful insights into the relationships between run sizes to Maine rivers and exploitation in distant fisheries. The method also illustrated the independence of Canadian and Greenland harvest for a given year. The Working Group noted that more data and further analyses would be required before this information could be applied directly to management.

4.2 Accuracy of Age Determination of Hatchery-Origin Salmon at West Greenland

In 1986, the Working Group discussed a technique to derive an estimate of the harvest of USA fish at West Greenland (Anon., 1986b). The technique, called the "proportional harvest method", utilized observations of the number of North American salmon of river age 1 in the Greenland fishery and the relative proportions of 1-year-old smolts between USA and Canadian hatcheries. The Working Group noted that estimates from this method were about four times higher than estimates from a model based on Carlin-tag recoveries. As the proportional harvest method was very sensitive to the proportion of the harvest of North American fish estimated to be of river age 1, the Working Group concluded that classification error could significantly compromise the reliability of this method (Anon., 1987a).

Three possible sources of bias have been examined:

1) the accuracy of ageing of 1-year hatchery smolts;

2) the accuracy of the discriminant analysis between North American and European river age 1 salmon;

3) regenerated scales that could not be aged.

Using hatchery fish of known river age, it was noted that misclassification rates were low and incorrect ageing generally resulted in the overestimation of the true river age. For most samples, however, some European fish which were known to be 2-year smolts were incorrectly aged as river age 1 (17.5%). Weighting of all samples examined to the smolt age distribution of the West Greenland catch in 1987 shows a weighted error rate of about 1%.

Verifying the repeatability of ageing of scales involved re-interpreting a set of 202 scale samples; in 96.5% of the samples, the age determined was the same. Also, in reanalysis of the discriminating capability for North American and European smolts, the misclassification rate for 1-year smolts was 2.8% and the error rate was ± 2.8%. Thus the estimates of 1-year smolts of North American origin are not biased by the discriminant analysis. Evidence was also presented which indicated that the proportion of scales which could not be aged (due to regeneration) but which were still suitable for use in the discriminant function were not unduly biased toward river age 1 hatchery smolts.

Overall, the Working Group concluded that the reproducibilty of ageing was good and that the river age of salmon of North American origin could be determined without undue bias.

The Working Group again examined the proportional harvest model using updated and revised data. Model input data for Canadian smolts were modified to adjust for smolts less than 12 cm. Estimates, based on the model described in Anon. (1986b) were, on average, 4-5 times higher than those based on Carlin-tagged fish. The relative bias was less in recent years and was attributed to a decreased proportion of 2-year smolts released in the USA. Additional research on the relative error in the estimate of percent composition by river age and continent of origin was recommended.

4.3 Effectiveness of Management Measures in the Fishery at West Greenland

Prior to 1984, the quota for the West Greenland salmon fishery had been 1,190 t (or its equivalent adjusted by season opening date) for many years. Since 1984, the quota has been lower and, for 1986 and 1987, was set to be equivalent to 850 t in terms of number of fish if the season had opened on 1 August.

To assess the impact of the change in quota, the Working Group used data collected from the fishery since 1978, when the sampling program was implemented, and estimated the catch in numbers of North American and European salmon. To investigate the period prior to and subsequent to 1984, the Working Group decided not to use the years 1983 and 1984 as these were years for which the management measure (the quota) had no influence. The Working Group concluded that significant reductions have taken place in quota (lower by 26%) and total weight of harvest (lower by 21%) for the years 1985-1987 compared to 1978-1982 (Table 18). Numbers of fish in the catch were significantly lower by about 16%. However, due to changing proportions of North American and European fish, it could not be concluded that these harvests by continent of origin were significantly different from the earlier period, although the numbers are lower by 13% and 19% for North American and European salmon, respectively. Total harvest in Greenland averaged 308,000 during recent years, which is about 58,000 fish less than when the quota was 1,190 t.

5 QUESTIONS OF INTEREST TO THE NORTH-EAST ATLANTIC COMMISSION OF NASCO

5.1 The Fisheries in the 1986/1987 Season and in 1987

NASCO asked ICES to describe the events of the 1987 fisheries in the North-East Atlantic Commission area with respect to gear, effort, exploitation rate, composition and origin of the catch, and assess the status of stocks. Descriptions of fisheries in homewaters are given in Section 7.

5.1.1 Description of the fishery at Faroes

The nominal landings of salmon from the Faroese salmon fishery by calendar year and season are presented in Table 19. The total landings in 1987 amounted to 510 t, which was 20 t less than in 1986. This table represents a corrected version of previous tables. The nominal landings by seasons broken down into numbers and weights by sea age group are given in Table 3. Catch in number by statistical rectangle for the whole 1986/1987 season is presented in Figure 3.

The number of fish discarded was estimated to be 7.4% of the total caught. This estimate was made using sampling arrangements in which some vessels were asked to keep fish which would otherwise be discarded. This is an intermediate figure compared to previous years.

5.1.2 Fishing effort

The catch in number per unit effort (1,000 hooks) by statistical rectangle for the 1986/1987 season is presented in Figure 4. The CPUE by month and season is also presented in Table 20. From this, it appears that the average CPUE in the 1986/1987 season was the highest annual figure on record. In the 1985/1986 and 1986/1987 seasons, the highest catch rates were obtained in late spring. This contrasts with earlier seasons when the highest catch rates were recorded between November and January.

5.1.3 Origin of salmon in the Faroese fishery

The Working Group examined data on tag recoveries to determine the origin of salmon in the Faroese fishery. The only new release and recovery data for external tags presented were from Scotland. The number of recaptures in the Faroese fishery per 1,000 smolts tagged and released in the North Esk in 1981-1985 has declined from 2.5 to 0.3 (Table 21). Although the number of smolts tagged has declined, decreasing the precision of the results, these data may indicate a real decrease in the contribution which fish of North Esk origin have made to this fishery in recent years.

The numbers of microtags estimated to have been taken in the Faroese fishery in the 1986/1987 season are presented in Table 22. The recapture rates per 1,000 fish tagged in Ireland, Iceland, and England and Wales are lower than those presented previously.

There is no reason to change the view expressed previously by the Working Group (Anon., 1986b) that the number of recoveries of Norwegian Carlin tags relative to the number released indicates that Norway is by far the largest contributor to the Faroese fishery, especially taking into account the number of smolts produced by each country.

It was noted that tags from the USSR have been found in the Faroese fishery.

The Working Group noted that the proportion of untagged adipose finclipped fish caught in the Faroese fishery in the 1986/1987 season (1.0%) was about twice that in the 1984/1985 and 1985/1986 seasons. While it was not felt that this need significantly affect the reliability of microtag scanning programmes, it was recognized that it made scanning more difficult and precluded the possibility of estimating the catch rates for tagged fish from finclip data alone. Estimates of microtag loss rates have been made in various homewater fisheries and are generally less than 5%. It was, therefore, felt that the large number of finclipped fish occurring in the fishery could only be accounted for by experimental releases of untagged but finclipped juveniles, mainly in Norway but also in other European countries.

5.1.4 Abundance and exploitation

There are no measures of abundance of salmon in the Faroese EEZ other than the CPUE figures (Table 20). The Study Group on the Norwegian Sea and Faroes Salmon Fishery (Anon., 1988a), however, discussed the feasibility of assessing the abundance of salmon in the area using acoustic techniques, and an experimental study will take place in the forthcoming season (see Section 5.4).

Data from the River Imsa tagging experiments indicate that the exploitation of this stock in the Faroes area in the 1986/1987 season is similar to previous years (Tables 23 and 24). Estimates of the exploitation rate on the extant stock range from 0-4% on 1SW salmon and 13-63% on 2SW salmon.

Tag returns from the River Bush (Northern Ireland) tagging experiments indicate that the exploitation on this stock at Faroes is less than 1% of the extant stock. This is a similar figure to those previously obtained from tagging experiments on a stock from Ireland.

5.2 Effort Control in the Faroese Fishery

NASCO asked ICES to evaluate the effect in the Faroese fishery zone of effort control compared to the control of catches on the level of exploitation on salmon in the area.

Data were presented to the Working Group which showed that the numbers of hooks used by vessels in the fishery varied from less than 500 to about 3,500 per set. However, the average effort in the fishery has remained at 2,100-2,300 hooks per set for several years, and there is no evidence that experience has enabled fishermen to increase the numbers of hooks used. It was also noted that vessels between 100 and 200 GRT tended to achieve higher catch rates than smaller or larger vessels. This suggests that there is a practical limit to the number of hooks that can be used in a set, but indicates that there is room for some vessels to increase the average number of hooks used per day. Catch rates might also be maximized by issuing all licenses to vessels in the 100-200 GRT size range.

The Working Group recognized that in managing salmon stocks there was an advantage in stabilizing the fishing mortality in each fishery. It was agreed that a catch limitation (quota) should provide a constant fishing mortality if recruitment remained constant, while effort control might stabilize the fishing mortality as long as the proportion of the extant stock available to the fishery remained constant. The Working Group recognized that both recruitment and the geographic distribution of salmon in the sea varied from year to year. Sufficient data were not available, however, to compare the extent of these variations and it was, therefore, not possible to evaluate the relative effects of effort and quota control on fishing mortality in the Faroese fishery zone.

5.3 Contribution of Hatchery-Reared Salmon and Fish Farm Escapees to the Salmon Fishery

Based on scale samples from the Faroese fishery in the 1986/1987 season, 2.6-3.6% of the fish were classified as reared. This is within the range of 0-13% estimated from various samples presented in 1987.

Apart from this, no new data were presented to the Working Group. However, results from Norwegian experiments detailing the fate of fish farming escapees will be available in the near future.

5.4 Acoustic Survey at Faroes

The Working Group discussed the recommendation of the Study Group on the Norwegian Sea and Faroes Salmon Fishery (Anon., 1988a) that a study should be carried out to test the feasibility of using acoustic techniques to estimate the numbers of salmon in the Faroese fishery zone. Two methods were identified for obtaining stock size estimates: one using sonar and one using echosounders.

The equipment required to test both methods is available on the Faroese research vessel "Magnus Heinason", and the Faroese have indicated that this vessel would be available for the project in early February or April 1989. In addition, the Marine Fisheries Research Laboratories in Aberdeen (Scotland) and Bergen (Norway) have agreed to supply acoustics experts to take part in the experiments and assist with the data analysis.

The Working Group endorsed the recommendations of the Study Group that the feasibility study should go ahead early in 1989.

5.5 Effectiveness of Management Measurements in the Faroese Fishery

At the Fourth Annual Meeting of NASCO in June 1987, it was agreed that the Faroese catch should be controlled in accordance with an effort limitation programme for a trial period of three years (1987-1989). The total nominal catch should not exceed 1,790 t, and in any given year, the annual catch should not be 5% more than the annual average (626.5 t).

The following regulatory measures were also agreed:

1) Areas with salmon below 60 cm in length will be closed for salmon fishing at short notice, following the general rules for closing areas with undersized fish already in force in the Faroese fisheries zone.

2) The number of boats licensed for salmon shall not exceed 26.

3) The salmon fishing season will be limited to 15 January - 30 April and 1 November - 15 December.

4) Subject to the maximum annual catch, the total allowable number of fishing days for the salmon fishery in the Faroe Islands zone shall be set at 1,600 each year.

These agreements were reached after the majority of the 1987 catch had been taken. Catch rates in November and December 1987 were low and so the total catch for the year (510 t) was less than the agreed maximum. It was not found necessary to close areas in which undersized fish were taken because the fishermen themselves avoided these areas. A total of 20 licenses was issued for the 1987/1988 season and the fishery was opened on 1 November 1987 and closed for the period 16 December 1987 - 14 January 1988 as agreed.

Data on number of days fished are not available for the calendar year 1987, but in the 1986/1987 season, 868 sets were fished, which is well below the annual limit of 1,600 fishing days.

As the first year of effort control was in 1987, it is not possible for the Working Group to assess the effect of this measure on either the Faroese or homewater fisheries.

6 QUESTIONS OF INTEREST TO THE NORTH AMERICAN COMMISSION of NASCO

6.1 The Fisheries in 1987

NASCO asked ICES to describe the events of the 1987 fisheries in the North American Commission area with respect to gear, effort, exploitation rate, composition and origin of the catch, and assess the status of the stocks. The fisheries for Canada and USA are described in Sections 7.1 and 7.11, respectively.

6.2 Effectiveness of Management Measures

6.2.1 USA

Maine is the only state that allows sport harvest of Atlantic salmon. In 1987, a mandatory registration system for all salmon >64 cm in total length caught by anglers was instituted. This measure was expected to affect the reporting rate for salmon taken in the Maine sport fishery, but sufficient data were not available to determine whether the reporting rate increased in 1987. The management measures initiated in 1985 (Anon., 1987a) are still in effect and have resulted in a 50% reduction in the exploitation rate of MSW salmon in the Penobscot River. The exploitation rate for the period 1982-1985 averaged 24% and for 1985-1987 it was 11%.

6.2.2 Canada

The management measures imposed in Canada in 1984 and 1985 were described in Anon. (1986a, 1987a). It was estimated that the complete closure of some fisheries resulted in a 22% reduction in landings of MSW salmon and a 3% reduction in landings of 1SW fish. Based on the final 1986 harvest figures, this would have resulted in a decreased harvest and increased spawning escapement of 220 t of MSW and 24 t of 1SW salmon. Using preliminary 1987 figures, these measures resulted in a decrease in harvest of 258 t of MSW and 25 t of 1SW salmon.

The average reduction in salmon catch in the Newfoundland-Labrador commercial fishing areas due to a delayed opening of the season was estimated to be 84 t of MSW salmon and 7 t of 1SW salmon (Anon., 1987a). This is the average catch in 1981-1983 prior to 5 June in affected statistical areas, and these values are 11 and 1%, respectively, of the average total commercial landings in those areas in 1981-1983. For 1986, using final catch statistics of 622 t MSW and 608 t 1SW, it is estimated that 77 t of MSW salmon and 6 t of 1SW salmon would have been affected by the delayed opening of the commercial fishery. Similarly, using preliminary catch statistics for 1987 (748 t MSW and 694 t 1SW), 92 t of MSW and 7 t of 1SW salmon would have been affected. Some of these salmon would be subjected to fishing mortality when the season opened; however, this is not quantifiable.

As noted in Anon. (1987a), the average landings of salmon after 15 October (1981-1983 and 1985) were 7 t. These fish were either immature 1SW or MSW salmon. Some of these salmon might have been available to the interception fisheries in the following year; however, the majority would probably return to rivers in the USA and Canada.

The impact that management measures have had on returns of MSW salmon to river systems and spawning escapements was further investigated by evaluating data available for the Miramichi, Restigouche, Saint John, and LaHave rivers (Table 25). In 1987, estimated returns to the Miramichi, Restigouche, and Saint John rivers were substantially less than predicted (in some cases below the 95% CL). The reduction is in contrast to the situation for 1985 and 1986 when estimated returns to the Miramichi and

Restigouche rivers were greater than predicted and estimated returns to the Saint John River were only slightly below predicted . Low returns relative to predictions are also inconsistent with the management measures intended to reduce fishing mortality in distant Canadian and West Greenland fisheries on MSW salmon originating in these rivers.

The spawning escapements and ratios of spawners to returns for MSW salmon increased in all four rivers in 1984-1987 compared to those observed previously (Table 25). These increases can be attributed to measures to reduce fishing mortality in both the commercial and recreational fisheries within and at the mouths of the respective rivers. Changes in harvest pattern in Newfoundland fisheries may also have been a contributing factor.

Table 26 compares the percentage of total catches in Newfoundland-Labrador commercial fisheries taken in statistical areas targeted to reduce interceptions by delayed season opening and closure of J_2 under the 1984 Management Plan with non-target areas for years prior to and during the Plan. Catches in target areas since 1984 were generally lower than for the average of years prior to 1984, with 1987 being lowest. Catches prior to and during the Plan were similar for non-target areas. This suggests that management measures had a similar impact in 1987 on the distribution of catches in the areas of interceptory fisheries as previously observed.

The mean ratio of MSW salmon to 1SW salmon in the Canadian harvests of the same smolt class for the period 1983-1986 (1.23 ± 0.07) was significantly lower ($P < 0.01$) than the mean ratio for the years 1970-1982 (2.05 ± 0.54) presented in Table 27. This indicates that Canada is catching fewer MSW salmon than before 1984, relative to 1SW catches of the same smolt class.

The Working Group concluded that the reductions in landings of MSW salmon and increased spawning escapements in 1984-1987 are consistent with the intent of the management measures taken in Canada for those years.

In the Canadian fisheries, the only new conservation measure in 1987 was in the Newfoundland-Labrador commercial fishery where legislation requiring market tagging came into effect. A description of the commercial fisheries was provided in Anon. (1986a).

6.2.3 Effect of Canadian management measures on USA stocks

No new measures were enacted in 1987 which would be expected to reduce the harvest of USA-origin salmon in the Canadian commercial fishery. The Working Group noted last year (Anon., 1987a) that area closures and season reductions for 1984 and 1985 should have resulted in an 11% reduction in the harvest of Maine-origin salmon. The harvest of Maine-origin 1SW salmon in the Newfoundland-Labrador commercial salmon fisheries before standard week 23 (4-10 June) and subsequent to standard week 41 (8-14 October) for the period 1967-1986 are provided in Table 28. Some slight reduction occurred in the licensed fishing effort in Newfoundland-Labrador since 1986 (Table 29), but the impact on harvest is not quantifiable. New information was presented on fishing effort and catch in three communities of Area B, but this could not be related to fishing mortality or the impact of a reduction in licensed effort since 1981. No information was presented to quantify the impact of the mandatory tagging of legally harvested salmon in the commercial fishery, but it was again noted that the intent of such a regulation is to reduce illegal harvest.

To assess the impact of the 1986 fall closure in Newfoundland, which was previously estimated to account for an average of 29% of the Maine-origin 1SW fish in 1967-1985, the Working Group reviewed sea age composition of MSW salmon sampled in the Penobscot River, Maine in 1987 relative to the average for the years 1981-1986. The number of alternate year spawners and 3SW fish in 1987, i.e., fish which may be considered to be both available and vulnerable to distant commercial fisheries in 1986, were 2.5 times more than the average for 1981-1986. Although based on only a single observation (1987), results are consistent with the intent of the management measure which closed the Newfoundland fall fishery. The Working Group noted, however, that sea age data for Penobscot and other MSW stocks should be collected for a number of years before drawing conclusions about the impact of the fall closure.

To assess the combined effect of all measures taken by Canada for 1984-1986, one can compare only the harvest of 1SW salmon of Maine origin in the Newfoundland-Labrador commercial fishery to the Maine run size of 2SW fish in the following year (i.e., fish of the same smolt class). For the years 1967-1983, the ratio of Newfoundland harvest to homewater run size averaged 0.53 ± 0.36; the value for 1984-1986 was 0.35 ± 0.11 (Table 30). The 1986 ratio is less than that of any year since 1981, although the mean of the three recent years (1984-1986) is not significantly different from the mean of 1967-1983 ($t = 0.830$; $p = 0.418$) because of the high variability in the ratio in the early years. Both harvest levels in 1986 and run size of the same smolt class decreased compared to 1984 and 1985. The reduced harvest in Newfoundland is consistent with the expected impact of the closure of the fall fishery by Canada in 1986.

The Working Group noted that a more complete answer would require more detailed analysis of the historic catches of MSW salmon in Canadian waters and a review of information to provide harvest estimates of 1SW and MSW Maine-origin salmon in the provinces of New Brunswick, Nova Scotia, and Quebec. It is recommended that tag recovery information from salmon recovered in these areas be examined next year to provide estimates of the impact of management measures.

6.3 Numbers of Salmon of USA Origin in Canadian Fisheries

6.3.1 Historical catches in Newfoundland-Labrador commercial fisheries of 1SW salmon which originated in USA

The Working Group considered a revision of the estimated harvest of Maine-origin 1SW salmon in Newfoundland and Labrador. The revised estimates of tagged and untagged 2SW salmon returning to Maine rivers, and the ratio values of the harvest model are presented in Table 31. The harvest model parameters were the same as those utilized by the Working Group in 1987 (Anon., 1987a). The revised harvest estimates are presented by year by standard week (Table 32) and by year (Table 33). A comparison of the previous and new estimates is presented in Table 34. Though some years show substantial changes, for example, a 20% change occurred in the 1973 estimate, the overall change across all years is only 0.3%.

The estimated harvest of Maine-origin salmon in Newfoundland and Labrador during 1986 was substantially lower than the estimates for recent years (Table 30). There was evidence of a change in the proportional distribution of the harvest of Maine-origin salmon in 1986 (Table 33). The Working Group felt the higher proportion of harvest in Area O and a lower proportion in Area B as compared to previous years was consistent with the expected result because of the closure of the fall fishery.

The Working Group estimated the harvest of 1SW Connecticut River origin salmon in Newfoundland (Area A, 1 tag) and Labrador (4 tags) to be 254 in 1986 compared to 649 in 1985. There were 340 untagged and 8 tagged 2SW salmon counted in the Connecticut River in 1987.

6.3.2 Historical tag recoveries of 1SW and MSW salmon of USA origin in provinces of Quebec, Nova Scotia, and New Brunswick and MSW salmon in Newfoundland-Labrador

Additional information on the annual capture of 1SW and MSW Maine-origin salmon in the commercial fisheries of Quebec, New Brunswick, and Nova Scotia was provided for the period 1963-1987 (Tables 35 and 36). The Working Group noted that this new information was of benefit; however, these data should be further summarized by standard week and statistical area for each individual year. Similarly, new information was provided summarizing the annual capture of tagged MSW salmon of Maine origin in Newfoundland-Labrador fisheries (Table 37). Since 59% of these recaptures were combined for Statistical Areas E-N, the Working Group felt that a more complete annual breakdown by individual statistical area and standard week should be provided. Additionally, a further separation of post-kelt and MSW salmon returns is desirable, since it appears that a high proportion of those recaptures listed in Table 37 were post-kelts. It was recommended that tag recovery information from salmon recovered in these areas be re-examined in the future in order to provide improved estimates of the impact of management measures taken by Canada in an effort to reduce the harvest of USA-origin salmon.

6.3.3 Average percentage by number of USA fish in the total harvest of the Newfoundland-Labrador commercial fishery

The Working Group examined the mean of the percentage (and its variance) of Maine-origin fish in the total harvest of the Newfoundland-Labrador commercial fishery each year from 1974-1986, exclusive of 1979 (Table 38). The mean percentages were broken down by standardized week and fishing area and included only standardized weeks from weeks 23-41. The equations to calculate mean percentage and variance (Cochran, 1977) are:

(1) percentage of Maine-origin fish in the harvest by standard week and by statistical area is:

$$p_i = a_i \div m_i \times 100$$

where p = percentage

a = catch in numbers of Maine-origin fish by statistical areas

m = catch in numbers of all sea ages by statistical area

i = years from 1-12.

(2) the mean percentage (P) of Maine-origin fish in the Newfoundland-Labrador harvest by standard week and by statistical area over i years 1-12, n = 12 is:

$$P = \frac{1}{n} \Sigma p_i$$

(3) the estimated variance of P is:

$$V(P) = \frac{\Sigma(p_i - P)^2}{n - 1}$$

From 1974-1986, the mean percentage by standard week of Maine-origin salmon in the total catch of the Newfoundland-Labrador commercial fishery ranged from 0.05-2.55% with a mean of 0.34% (Table 38). The following table summarizes the mean percentage of Maine-origin salmon in each statistical area.

Stat. Area	A	B	C	D	E-N	O
Mean percentage	0.38	0.28	0.29	0.31	0.07	0.27
Range	0-2.42	0-6.25	0-67.51	0-0.92	0-0.24	0-2.88

In the weeks when the mean percentage of Maine-origin salmon in the total catch is less than 0.005, the mean percentage is rounded to 0 (Table 38). In weeks where there were only landings of Maine-origin fish in one of the 12 years (1974-1986), the mean percentage and the standard errors are the same. The Working Group also noted that the weeks in which there were high mean percentages of Maine-origin salmon harvested, the landings in the statistical areas for those weeks were small.

6.4 Review of Report of Acid Rain Study Group

The Working Group considered the questions submitted by NASCO to ICES and the detailed response provided in the Report of the Acid

Rain Study Group (Anon., 1988c). The questions asked in 1986 and again in 1987 were:

1) identify freshwater habitats which support or have supported Atlantic salmon populations and classify these habitats in relation to their vulnerability to loss of productivity of Atlantic salmon due to acidification;

2) describe the trends in acidification of habitat identified in question 1, and in the fish populations supported by those habitats;

3) describe the influence of acidification of freshwater habitat on growth and survival of Atlantic salmon fry and parr and the implications for smolt and adult production;

4) describe the effectiveness of mitigation measures such as liming and the extent to which these measures are in current use.

6.4.1 Freshwater habitats of Atlantic salmon populations and their vulnerability to acidification

Approximately 1,000 km^2 of riverine Atlantic salmon habitat is accessible to anadromous Atlantic salmon in areas of North America. A minimum estimate of areas vulnerable to acidification was provided for those areas where mean volume-weighted annual alkalinity is known to be less than 50 μeq/l. A habitat was determined to be lost to salmon productivity when it had a mean annual volume-weighted pH of less than 5.0 and no longer had juvenile salmon present as detected by electrofishing. The Working Group noted that, with inclusion of salmon habitat from an additional 28 rivers in the provinces of Newfoundland-Labrador and Quebec, the area of vulnerable habitat doubled to about 100 km^2 (Table 39). Exclusion of salmon habitat area from catchments ≤18 km^2 and revised estimates of other river systems reduced the area lost to Atlantic salmon production from 10 km^2 to 6 km^2.

Review of pH and alkalinity data confirmed that for North American habitat, alkalinity values should be used to classify areas according to vulnerability to acidification. However, the minimum standard for vulnerability (Anon., 1987b; mean volume-weighted annual alkalinity <50 μeq/l) is revised to meet one of the following criteria: a) a mean value of 75 μeq/l or less (derived from at least 8 measurements that include seasonal changes and a realistic range of water flows) or b) when sampling has been or must be limited, a value of 150 μeq/l or less derived from consistent measurements of low summer flows, preferably repeated over a 5-year period as an acceptable approximation of a) above. These values should be measured by Gran titration to the "inflection point".

New information indicating that salmon rivers of Eastern North America are characterized by high levels of dissolved organic carbon and are generally highly coloured. As a consequence, virtually all of the aluminum present is in the non-toxic, organically-bound form. Hence, aluminum toxicity in Eastern North

American waters had been judged negligible, with hydrogen ion stress the major cause of mortality.

6.4.2 Trends in acidification of habitat and in the fish populations

The Working Group noted that no new information on trends of acidification or historical angling records was reported, thus the Acid Rain Study Group's conclusions from 1987 were unchanged (Anon., 1987b). Additionally, the Study Group was unable to address the specific concern over seasonal trends in acidification raised by the Working Group in 1987 (Anon., 1987a). No information was available to determine if there was acidification in salmon producing areas outside the Southern Uplands of Nova Scotia. A discussion on this subject in relation to growth and survival is covered in Section 6.4.3.

The Working Group considered a revision of Atlantic salmon production loss in the Southern Upland of Nova Scotia published by Watt (1986). The revision reflected a reevaluation of habitat area in the Southern Upland, removal of a habitat-per-unit-drainage correction factor and a scaling of production potential [following the advice of the Working Group (Anon., 1987a)] for different pH rivers based on historical angling trends. The revised estimated loss of Atlantic salmon annual production due to acidification since 1950 has been about 5,600 fish/year. Additionally, the Working Group noted the Study Group's concern over the robustness of this estimate due to unexplained sensitivity of the estimate of production per unit habitat.

Following the advice of the Working Group (Anon., 1987a), an alternative method of estimating Atlantic salmon production loss was attempted by the Study Group. The alternative method was based on 1) an estimation of rearing habitat quantified by gradient and production areas based on 1955 pH values calculated by use of a quadratic equation from current pH values, and 2) a presmolt production versus pH relationship. The product indicated a substantial decline in Atlantic salmon production. This second alternative, however, was judged to be insufficiently developed at this time to calculate actual production losses.

The Working Group was concerned that the Study Group had been unable to arrive at a method of determining production based on smolts per unit area which was suitable for their evaluation of trends in fish populations associated with acidification.

6.4.3 Influence of acidification on growth and survival of Atlantic salmon

In addition to addressing the question asked by NASCO, the Working Group considered the influence of acidification on the egg and alevin stages and on adult salmon during their residence in freshwater.

The Working Group concluded that low pH can lead to mortality in several stages of the salmon's life cycle. Alevins are particularly vulnerable at hatching and transition to first feeding, while the water-hardened egg is relatively resistant to low pH. Mortality can also occur in parr and smolts, particularly if the pH is rapidly reduced as may occur during snow melt in some areas.

In assessing the effect on smolt production, the Working Group noted that low pH seems not to affect growth rates. However, due to mortalities, juvenile production will tend to fall below the lower limit for maintenance of the population if minimum pH levels of 4.7 are reached, and stay below carrying capacity at more moderate pH levels up to about 5.6. As an example, in a comparison of an acidified (pH 5.0) and a non-acidified (pH 6.1) river in close proximity in Nova Scotia, smolt production was approximately 1/6 in the acidified river even though egg densities which produced these smolts were assessed to be similar. It is also apparent that low pH levels will drastically limit reproductive success to the point where a stock may disappear before food supplies are themselves impoverished.

6.4.4 The effectiveness of mitigation measures

The Working Group recognized that the only satisfactory permanent solution to the problem of acidification of Atlantic salmon rivers would be the elimination of the source of acidity. Feasible short-term mitigation measures are liming, stocking, and the preservation of genetically diverse stocks. Liming of Atlantic salmon rivers has been used successfully in Europe and North America as a mitigation method to reduce juvenile salmon mortality and increase production. Hatchery-reared stocks, although used, are best adapted to situations where production declines are not yet severe. Mitigation approaches involving preservation of genomes and the selection of acid-resistant stocks requires further research and development prior to practical implementation.

6.4.5 Recommendations

The Working Group endorsed the recommendations presented by the Study Group (Appendix 4) and commended the Group for its progress on a very difficult task.

7 HOMEWATER FISHERIES

NASCO asked ICES to describe the events of the 1987 fisheries with respect to homewaters. These questions are addressed for the different countries in the subsections below.

With respect to the origin of fish caught in different fisheries in 1987, the Working Group compiled a table showing the areas in which salmon tagged in different countries had been recaptured (Table 40). For stocks from Denmark, Iceland, Faroes, and Greenland, there was no physical evidence for interception in 1987. No data were available for Spain and Portugal.

The Working Group noted that in several countries there appeared to be no plans to evaluate the possible effects of new or proposed management measures. It was considered to be very important to assess the probable effects of proposed measures and to review the effectiveness of measures introduced.

In order to assist the Working Group in answering the questions asked by NASCO a list of the data required from each country was prepared and is given in Appendix 5.

7.1 Canada

7.1.1 The fishery in 1987

Total salmon landings for Canada (1960-1987) are given in Tables 1-2. The recreational fisheries harvested 9.8%, commercial fisheries 88.9%, and native food fisheries harvested 1.3% of the total landings by weight. The Working Group noted that Canadian landings of 815 t of grilse (423,698 fish) and 916 t of salmon (193,168 fish) increased 3% and 18%, respectively, over 1986 landings by weight. The 1987 landings by weight are 33% above the previous 5-year mean for grilse and 16% for salmon. Of the total Canadian landings by weight, 9.3% were in Quebec, 86.1% in Newfoundland-Labrador, 3.3% in the Maritimes, and a further 1.3% in native fisheries.

The commercial landings for Newfoundland-Labrador in 1987 are presented in Table 41, and from 1971-1987 in Table 42. In Newfoundland-Labrador, there were about 3,400 fishermen licensed to fish about 13,600 gear units (1 unit = 50 fathoms of gillnet) for salmon in 1987. Historical information on number of licensed fishermen and licensed gear units is shown in Table 29. The Working Group noted that there was a 17% increase in landings in the Newfoundland-Labrador commercial fisheries from 1986 to 1987. The increase in catch was mainly due to increased landings in Areas O and A which may have been attributable to increased abundance of northern stocks. The proportional increase in landings in Area A may have been due to environmental conditions.

The Working Group reviewed the sampling program for recoveries of coded wire tags in 1987 from the Newfoundland-Labrador commercial fisheries. Landings were examined in the ports of Twillingate, Harbour Deep, and the Cottrell's Cove area, Newfoundland, and Makkovik and Square Islands, Labrador. Two of the ports, Harbour Deep and the Cottrell's Cove area, were additions to the 1986 sampling program. Sampling dates in Twillingate and Square Islands were selected to coincide with peak historical catches; sampling dates in Makkovik, Harbour Deep, and Cottrell's Cove were selected to maximize the likelihood of encountering USA-origin fish.

A total of 7,792 salmon (32% Labrador, 68% Newfoundland) were sampled. Of these, 76 fish (1% of sample) had adipose clips and 16 contained coded wire tags (CWT). Ten of the CWTs originated from USA hatcheries, with 9 of the 10 originating from Penobscot River smolt releases in 1986. One CWT from a Connecticut River smolt release was found in Makkovik, Labrador. Distribution of tag recoveries by country and location was as follows:

Sampling location	Country of origin	
	USA	Canada
Twillingate	-	3
Square Island	1	-
Makkovik	4	1
Harbour Deep	5	2
Cottrell's Cove	-	-
Total	10	6

It would be inappropriate to infer differential exploitation on the USA and Canadian tagged salmon due to differences in timing, location of sampling, and the number of fish scanned for tags.

Recoveries of Carlin tags in 1987 from USA smolts released in 1986 were also examined by the Working Group. To date, reported tags by area have been as follows:

Area:	A	B	C	D	O	Other	Unknown
Penobscot River Tags:	12	4	5	2	14	4	1

Tags reported in 1987 from the Penobscot River smolts were double those of 1986, but only 54% of the average number between 1974 and 1986. In addition, one Carlin tag (Penobscot) was reported from the Quebec North Shore region of the Gulf of St. Lawrence in 1987. No Carlin tags from Connecticut River smolt releases were reported in 1987. Estimates of harvest of USA-origin salmon using Carlin tags will not be available until after 1988 returns to homewaters.

7.1.2 Status of stocks

There has been no target spawning biomass calculated for most Canadian salmon stocks. However, for some rivers, a minimum egg deposition target of 2.4 eggs/m^2 of juvenile rearing habitat, exclusive of lacustrine habitat, has been established. Exceptions to this are the Conne and other rivers of insular Newfoundland, for which spawning requirements cannot be estimated on the basis of stream rearing habitat because the young salmon also utilize lakes. For these systems, target egg depositions are set at the number of eggs that would be needed to maintain the total returns as assumed rates of egg-to-adult survival.

Numbers of spawners required to achieve target egg deposition for the Miramichi, Restigouche, and Saint John rivers are based on the eggs from MSW spawners. For the Conne river, only the contribution by 1SW fish is included in the estimate of egg requirements, whereas the contribution of eggs from both MSW and 1SW fish is considered in the target egg deposition determined for the Margaree and LaHave rivers.

Actual egg depositions were calculated utilizing sex ratios from sampled fish, fecundities, and estimates of spawning escapements determined from total river returns minus removals. Estimates of total river returns were based on mark-recapture experiments in the Miramichi and Conne rivers, fishway counts on the Saint John River, angler harvest and exploitation rates on the Margaree and LaHave rivers, and angler harvest and mean spawner to angled fish ratio on the Restigouche River. Actual egg depositions include eggs deposited by both 1SW and MSW salmon. Target egg deposition and spawning requirements together with spawning escapement and egg depositions for 1987 were available for six rivers in Canada:

	Target			Spawning escapement		
		Fish			Fish	
River	Eggs (10^6)	MSW	1SW	Eggs (10^6)	MSW	1SW
Restigouche	71.4	12,200	2,600	42.5	7,138	3,548
Miramichi	132.0	23,600	22,600	155.7	11,319	75,266
Saint John	67.7	10,100	7,600	40.7	5,718	13,166
Margaree	6.7	1,036	579	14.0	2,154	697
LaHave	4.9	467	2,218	14.2	1,475	6,832
Conne	7.8	-	4,000	15.7	463	7,344

Estimates of actual egg depositions in 1987 exceeded target egg requirements in four (Miramichi, Margaree, LaHave, and Conne) of the six systems. In the Miramichi River, the deficit of eggs from MSW spawners was compensated for by the contribution made by the large escapement of 1SW fish (i.e., >3 times the target spawning escapement of 1SW salmon). Only 60% of the egg deposition targets for the Saint John and Restigouche rivers were achieved. The extent that egg deposition targets in the five previous years for the Restigouche, Miramichi, Saint John, and LaHave rivers were achieved is given in Table 25.

Returns of 2SW salmon in 1987 to the Restigouche, Miramichi, and Saint John rivers were considerably lower than forecasts based on 1986 returns of grilse (Table 25). Similarly, returns of 2SW salmon to the Penobscot River, Maine in 1987 were lower than expected (see Section 7.11). The Working Group was concerned over the increase in the grilse component of homewater returns in Canada and the USA in recent years and felt a change in age at maturity would affect interpretation of the harvest of 1SW salmon and return to homewaters of 2SW salmon. The data to completely evaluate the effect of age at maturity were not available to the Working Group.

7.1.3 Fishing effort

The Working Group in 1987 (Anon., 1987a) identified a continuing need for additional study of the relationship between licensed fishing effort and fishing mortality in Canadian fisheries. A study was undertaken in three communities of the commercial salmon fishery in Notre Dame Bay of Newfoundland between 1984 and 1987. Using logbooks, fishermen recorded actual gear used and catch over fishing seasons. There was variability among communities and years as to the week when peak effort expenditure occurred; it was found that 37-75% of the gear allowed (potential effort) was actually used. The overall amount of potential effort used varied from 16-43% over the entire fishing season.

The Working Group noted that these studies confirmed the difficulty of using licensed gear per fisherman as an index of actual fishing effort. It was also agreed that these studies could not be extrapolated to other areas of Newfoundland-Labrador because of differences in environmental conditions and of the fishermen's choice of target species at any specific period.

7.2 Finland

7.2.1 The fishery in 1987

Catches of salmon in Finland were 30% higher in 1987 than in 1986 (Table 1), although a delay in the run of MSW salmon at the end of May and beginning of June resulted in a decrease in the drift net catch.

7.2.2 Status of stocks

In the Rivers Tana and Neiden, the size of the spawning stocks is controlled by regulation of the fishery. Fish stocking is prohibited. Since 1979, the density of juvenile salmon has increased in the River Tana but decreased in its tributaries. Grilse in the tributaries are overexploited by sea trout gillnet, which have a mesh size of 80-90 mm stretched.

During the 1980s, annual catches have been lower than in the 1970s.

7.2.3 Effectiveness of management measures

There will be new fishing regulations operating in the River Tana from 1989. Sea trout gillnets will be prohibited totally. During the grilse migration (15 June - 31 July), it will not be permitted to use special gillnets for other fish species. The use of new methods and materials will be prohibited in the weir and gillnet fisheries, and distances between fishing stations will be increased. On the Finnish-Norwegian border, drift and seine net fishermen will be confined to their national waters.

Although stocks were thought to be low in 1979, an increase in the weekly fishery closed period resulted in improved spawning as assessed by juvenile surveys in 1980.

7.3 France

7.3.1 The fishery in 1987

There are commercial fisheries in some estuaries and also in freshwater in the Loire River. Angling also takes place in all salmon rivers. The fishing season starts between 26 January and 14 March on different parts of the Loire and on 7 March elsewhere; it ends at the end of July for rivers in the south and in mid-July elsewhere. In 1987, the nominal catch of 28 t was higher than for several years, but reflects mainly the importance of the catch in the estuary of the Adour (18 t) of which 85% were grilse. MSW fish constituted 71-100% of the angling catch in different rivers, while the majority of the fish caught in estuaries were grilse.

7.3.2 Abundance and exploitation

Minimum stock size estimates from traps on the Bresle, Nivelle, and Elorn rivers in 1987 were 122, 178, and 1,429 fish, respectively, and most of these were grilse. Rod exploitation rates on these rivers are estimated to be less than 2% on the Bresle and Nivelle and 8% on the Elorn; on the Elorn, the exploitation rate on MSW salmon is 34% and on grilse 4%.

7.3.3 Status of stocks

Stocks have been maintained since the beginning of the 1980s on the Bresle and Nivelle rivers and since 1987 on the Elorn. Annual juvenile stock surveys are carried out on some rivers.

7.3.4 Effectiveness of management measures

In 1986, the following new measures were introduced in the freshwater zones:

1) a carcass tagging scheme was introduced;

2) the rod and line season was lengthened on rivers in the north and west with fly fishing only from mid-June to mid-July;

3) a single license fee was payable for sea trout and Atlantic salmon.

Measures introduced in 1987 were:

1) an annual quota system in the freshwater zones; anglers permitted to take 4 fish and commercial fishermen between 15 and 50;

2) separate license fees are payable for salmon and sea trout. A tag is required for each salmon caught in freshwater costing 150 francs for anglers and 50 francs for commercial fishermen.

Scientists were not involved in the introduction of these measures, and it has not been possible to assess the effectiveness of the action taken.

7.4 Iceland

7.4.1 The fishery in 1987

Preliminary statistics indicate that the total catch in 1987 was 220 t, approximately 62,000 salmon, of which 48,000 were from rod and riverine net fisheries and 14,000 from salmon ranching.

The runs of 2SW salmon were reasonably good, but these salmon migrated into the streams unusually early and over a short period, especially in western Iceland. The grilse runs, on the other hand, were relatively poor and average weights were low. This was apparent both in rivers and ranching stations.

7.4.2 Abundance and exploitation rates

Salmon were less abundant in 1987 than in 1986, especially the grilse component. Due to the unusual timing of the 2SW salmon runs, it is probable that the exploitation rates on these fish in the riverine net fisheries were lower than in a normal year. The summer of 1987, as in 1986, was unusually dry in southwestern Iceland, and it is felt that in conjunction with the low abundance, this may have resulted in an increase in the exploitation rate (>50%). The exploitation rates in the sport fisheries have been shown to vary from 30-80% depending on stock abundance and stream size.

7.4.3 Status of stocks

There is no reason to believe that the Icelandic salmon stocks are being overexploited. There is a ban on salmon fishing within the 200-mile EEZ limits, and freshwater exploitation is rigorously regulated. There is, however, considerable variation in salmon abundance between years, which in many cases can be related to variation in marine survival. A link with sea conditions has been difficult to establish in southern Iceland, but a very good correlation has been found in northern and eastern Iceland (Scarnecchia, 1984). Returns to ranching stations, primarily in the southwestern part of the country, have been useful in determining whether reduced abundance of wild salmon is caused by reduced freshwater production or low sea survival.

7.4.4 Effectiveness of management measures

The Icelandic management regulations were described in Anon. (1987a). These measures have been in force for 30 years and have proved beneficial for the salmon stocks. There is, however, growing concern regarding the interaction of wild, ranched, and farmed populations. Increased sea cage rearing of salmon as well as salmon ranching may pose a threat to wild stocks if allowed to expand without proper control. It is expected that half of the salmon caught in Iceland in 1988 will be from ranching, and ranched salmon will dominate the catch in the ensuing years. Control measures are being discussed to regulate the distance of sea cages and ranching operations from major salmon rivers.

7.5 Ireland

7.5.1 The fishery in 1987

The catch in 1987 was 1,112 t of grilse and 127 t of salmon giving a total of 1,239 t. This is lower than in 1986 (Table 2) and also lower than the average for the last five years.

7.5.2 Abundance and exploitation rates

Available data suggest that the abundance of salmon was lower in 1987 than in 1986, which was a particularly good year. There were good returns of grilse (8.8%) in the Burrishoole System in 1987. Although this return rate was higher than usual, it arose from a particularly small smolt run and total numbers returning were low. This high return rate was not reflected in the rest of the country where tagging suggests that survival at sea was relatively poor.

Exploitation rates by drift nets at sea were established for two reared stocks in 1987. These ranged from 69-80% for fish released as 1+ and 2+ smolts from the Burrishoole system. For smolts of the Erne River, the exploitation rate was estimated to be between 45-54%. The upper values for two river stocks are determined by using subjective estimates of non-catch fishing mortality. The percentage return from both 1-year-old and 2-year-old smolts in the Burrishoole was approximately 2%, whereas in the Erne, which had a lower exploitation rate, the percentage return was 4%.

Tags of Irish origin appeared in the Faroese fishery, the Greenland fishery, and off the English coast (Table 40).

7.5.3 Effectiveness of management measures

To achieve effective management of the Irish salmon fishery, the Salmon Review Group (Anon., 1988d) has made the following recommendations:

a) A system of dead tagging and quotas for all commercial and sport fisheries should be introduced by 1989.

b) A logbook system for commercial fishermen should be introduced by 1989.

c) A closed season for salmon drift netting should be extended to 30 April or even later when the runs of fish are known to occur later (e.g., Eastern Region).

d) The annual closed season for estuarine fisheries should end sometime earlier and begin sometime later than the closed season for drift net fishing.

e) The weekend closed period for drift netting should remain at 48 hours, but should be reviewed periodically with a view to extending it if necessary.

f) The length of boat used in salmon fishing should not exceed 12 meters.

g) There should be a prohibition of drift netting for salmon outside 9 nautical miles from baseline in 1989, outside 6 nautical miles by 1990, and subsequently outside 3 nautical miles.

h) The present dealer license scheme should be extended to their agents. A licensing scheme for hotels and restaurants is also to be introduced.

i) All boats including commercial fishing and leisure craft should be registered and marked clearly and uniquely.

j) The ban on monofilament should be revoked provided the tags and quota system are in place and are seen to be operating. (It is assumed the tags and quota system, if properly enforced, will reduce the catch of salmon to an acceptable level.)

k) Length and depth of drift nets should be regulated regionally allowing a length of 2,000 metres and a depth of 45 meshes.

The Working Group noted that no plans were in place to monitor the proposed measures. However, it was suggested that the effectiveness of many of the measures could be estimated.

7.6 Norway

7.6.1 The fishery in 1987

In 1987, the gear types used in marine fisheries in Norway were drift nets, bag nets, bend nets, stake nets and lift nets. In some areas, there was also a recreational fishery with rods. With very few exceptions, rods were the only legal fishing gear in Norwegian salmon rivers. Compared with 1986, the total reported salmon catch declined in 1987 (Tables 1 and 2).

7.6.2 Abundance and exploitation rates

Based on Carlin tag returns from the Rive Imsa, exploitation rates were calculated at Faroes and in Norwegian homewaters. Updated figures for wild and hatchery-reared fish are given in Tables 23 and 24. Exploitation rates were estimated as described in Anon. (1985).

Homewater exploitation is very high, both for 1SW and 2SW salmon. The exploitation rate for 2SW fish in the Faroese fishery is lower than in homewaters. However, the catch in numbers of 2SW fish in the Faroese fishery can be as high as in homewaters because more fish are available.

7.6.3 Status of stocks

In Norway, there are between 400 and 500 salmon rivers. In many of these, the salmon stocks are thought to be healthy, but several stocks have problems. Some of them suffer from overexploitation, but the greatest threat to Norwegian salmon stocks at present is the parasitic fluke *Gyrodactylus salaris*. This parasite has been recorded in 30 salmon rivers, and it has been estimated that 300 t of salmon were lost to Norwegian homewater stocks in 1985 (Johnsen and Jensen, 1986). In southernmost Norway, some salmon stocks have been lost due to acidification, and others are threatened.

An increased proportion of reared salmon has been observed in the Norwegian homewater fishery and among the spawning populations in many rivers. Data presented to the Working Group suggested that 7-12% of the salmon caught in three commercial fisheries on the Norwegian coast were of reared origin (ranched fish and escapees from fish farms). Although there is no direct evidence of adverse effects on natural stocks, many salmon biologists are concerned about this.

7.6.4 Effectiveness of management measures

To reduce the total fishing pressure on Norwegian salmon stocks, new regulations will be introduced in the Norwegian homewater fishery (Anon., 1987a). The ban on monofilament in bend nets should reduce their efficiency. The ban on drift nets should reduce the catch of Swedish-, Finnish-, and USSR-origin salmon in the interceptory fishery on mixed stocks in Norwegian waters. However, the number of these salmon caught by this fishery is unknown. Because a license scheme for fixed nets is not yet in place, it is not possible to predict the overall effectiveness of these management measures.

7.7 Sweden

7.7.1 The fishery in 1987

The catches of North Atlantic salmon in 1987 were somewhat lower than in 1986. The main reason was probably high river flows causing the salmon to move upstream earlier than normal. As a result, the catches in fixed gears along the west coast decreased, while the sport fishery in the rivers was very successful and took around 35% of the total catch.

7.7.2 Status of stocks

Major parts of southwestern Sweden are heavily influenced by acid precipitation. Salmonid populations in many of the rivers have been seriously affected. Since the beginning of the 1980s, liming programmes have been set up to cover most of the affected salmon rivers. As a result, salmonid populations have recovered considerably in recent years. This recovery has been intensely studied in Høgvadsån, a tributary of the River Åtran. The liming started there in 1978 and will continue at least until 1991. A smolt trap combined with a trap for adult fish is situated near the outlet into the Åtran, and electrofishing is also carried out each year. The trap only catches a small part of the smolt run during periods of high flow, but the number of migrating smolts sampled has increased from about 100 in 1978 to between 2,600 and 4,000 in recent years. At the same time, the number of spawners counted has increased dramatically from 20 in 1979 to around 1,600 in 1986 and 1987.

7.7.3 Effectiveness of management measures

In 1986, new regulations were introduced for the salmonid fishery along the Swedish west coast. Drift netting is now forbidden and set gillnets may only be used between 20 June and 20 July. Around 20% of the coastal catch is made in set gillnets which are mainly used by sport and part-time commercial fishermen within a few kilometers of the shore. Use of these nets is not licensed, and there are no restrictions on how many gillnets an individual fisherman may operate. The normal mesh size is 120 mm stretched. Around 75% of the coastal catch is from pound nets situated in private waters near the shore. Licensed professional fishermen operate around 90% of the pound nets, while the remainder are being operated by part-time fishermen at inferior sites further from the rivers. There are zones around river mouths where fishing is probibited. These zones are variable in width but normally cover a distance of 500-1,000 m on each side of the river mouth. Rod and line is the only legal method for fishing salmon in rivers.

7.8 UK (England and Wales)

7.8.1 The fishery in 1987

Final catch data for 1987 for England and Wales will not be compiled until June, but the provisional figures suggest that catches were over 30% lower than in 1986 and about 20% below the average for the last 10 years (Table 1). Commercial catches were particularly poor in the northern regions, although rod fisheries in these areas were similar to, and on the River Tyne much better than, 1986. In the south and west, however, commercial landings were similar to 1986, while rod catches were very poor.

Tags from England and Wales were recovered in fisheries in Scotland, Ireland, Northern Ireland, Faroes, and West Greenland in 1987 (Table 40).

7.8.2 Status of stocks

There are no rivers in England and Wales for which reliable annual estimates of salmon smolt production or adult returns are available. The status of national stocks can, therefore, only be assessed on the basis of catch statistics and a limited amount of juvenile stock monitoring. These data suggest that there are some stocks showing signs of improving markedly in recent years, but a few that have declined seriously. For the majority, however, there is insufficient evidence to say whether they have changed significantly.

7.8.3 Effectiveness of management measures

Management provisions operating in the salmon fisheries in England and Wales, including some new measures introduced in the Salmon Act 1986, were outlined in Anon. (1987a). Reports suggest that increased controls on the use of fixed gillnets in coastal waters may have improved runs of salmon into rivers in some areas. No data are available on the effectiveness of other measures taken to deter illegal salmon fishing. It is expected that the Salmon Dealer Licensing scheme will be introduced by the end of 1988. Changes to regulations and additional restrictions introduced in the northeast coast fishery will be assessed in a review to be prepared in 1989.

7.9 UK (Northern Ireland)

7.9.1 The fishery in 1987

Available information indicates that homewater catches in Northern Ireland were poorer than in 1986. The nominal catch (mainly grilse) at 48 t represented a reduction to around 44% of the previous year (Table 1). Most coastal netting stations are in the form of fixed bag nets, for which 28 licenses were issued in 1987. One license was issued for a commercial freshwater trapping station on the River Bann. In 1987, a total of 231 other commercial licenses were issued, the majority in the Foyle area, where 112 drift nets, 104 draft nets, and a stake net were licensed. Commercial fishing in the Foyle area ceased on 6 August 1987, compared to 15 September in the rest of the Northern Ireland fishery.

7.9.2 Abundance and exploitation rates

Data on homewater exploitation rates are available from recoveries of microtagged wild and hatchery-reared smolts released from the River Bush. Tags of River Bush origin appeared in the Faroese, Greenland, Irish, and English fisheries. In 1987, the Irish coastal fishery was sampled for microtags, together with returns to the adult trap on the River Bush. After correction for non-reported catch, it was possible to produce estimates for homewater exploitation. Resultant exploitation rates for grilse varied from 77-94% for hatchery-reared salmon and was estimated at 68% for wild salmon. A homewater exploitation rate of 46% for 2SW salmon was estimated from returns of the 1985 microtagged hatchery-reared smolt release from the River Bush.

7.9.3 Status of stocks

Data on adult runs in the River Bush are available from 1973 to the present, but cannot be regarded as indicative of the status of Northern Ireland salmon stocks generally, as adult escapement was artificially regulated during the early years of the River Bush project. Return rates of wild grilse to the River Bush in 1987 were good (9.4%), exceeding average grilse return rates (8.5%) for the river between 1974 and 1986.

7.9.4 Effectiveness of management measures

In Northern Ireland, management measures comprise licensing of coastal and estuarine netting stations, together with restrictions on material and mesh sizes used in nets. Weekly and seasonal closed periods are defined, with the seasonal closure of the Foyle commercial fishery being varied in response to adult escapement as measured by electronic counters. No changes in regulations were implemented in Northern Ireland in 1987, and none are proposed for 1988. The effectiveness of existing management measures has not been assessed.

7.10 UK (Scotland)

7.10.1 The fishery in 1987

The provisional 1987 nominal catch will be towards the lower end of the range for 1960-1986 (Tables 1 and 2). Angling accounted for approximately 10% and 50% of grilse and salmon catches, respectively. Catches of grilse and MSW fish have both declined, but variations in the fishing effort present major difficulties in interpreting the catches for any one year and also in comparing data for different years. It is not known whether trends observed in the catches are correlated with the availability of fish or with the fishing effort. Since 1986 many fishing stations have been closed, but the reduction in the catch may not be directly proportional because these stations tend to have the lowest catches.

7.10.2 Abundance and exploitation rates

The exploitation rates by the net and coble fishery on the returning North Esk 1SW and MSW stocks in 1987 were 0.29 and 0.38, respectively. The corresponding values in 1981-1986 ranged between 0.15-0.40 and 0.29-0.59, respectively.

Tags from Scotland were recovered from England, West Greenland, Faroes, Ireland, Northern Ireland, and Norway (Table 40).

7.10.3 Status of stocks

The only data available on the status of stocks in Scotland comes from the North Esk. In 1981-1987 (the only years for which data are available), the number of potential spawners each year ranged between 9,072 in 1981 and 6,326 in 1986. Although smolt production fluctuated widely between years, the underlying trend is remarkably stable since records began in 1964.

After rigorous testing on the North Esk at Logie, an updated automatic fish counter, jointly developed by the Department of Agriculture and Fisheries for Scotland and Aquatic Ltd., has been shown to count upstream migrating salmon ≥50 cm in length (the minimum length required) with a high degree of accuracy. Within the next few years, it is anticipated that this type of counter will be situated in a number of rivers to allow, for example, stock size to be determined.

7.10.4 Effectiveness of management measures

The main management provisions in the Salmon Act 1986 were described in Anon. (1987a). There is a proposal to increase the weekly closed time from 42 to 60 hours in 1988. An order has been made extending the annual period during which fishing for salmon in the River Tweed using natural prawn and shrimp is banned. The Atlantic Salmon Conservation Trust has bought netting rights both on the coast and in rivers to allow them to close the netting stations. A number of netting stations in the Moray Firth have already been closed in addition to the net fisheries in the River Dee and in the adjacent fishery district. By the same means, the number of netting stations operating in the River Tweed has also been markedly reduced. Unfortunately, it will not be possible to determine the effects of these measures in the absence of effort data. In addition, it is anticipated that a Salmon Dealer Licensing scheme will come into operation towards the end of 1988.

7.11 USA

The regulations described in Anon. (1987a) continued in effect for USA rivers. The only change was the introduction of a mandatory registration programme for all MSW salmon taken in Maine sport fisheries. The reported harvest for USA rivers in 1987 was:

River	1SW	2SW	3SW	PS	Total
Penobscot	20	125	8	5	158
Narraguagus	-	35	-	2	37
Machias	-	4	-	-	4
E. Machias	-	13	1	-	14
Sheepscot	3	12	-	-	15
Dennys	-	1	-	-	1
Ducktrap	-	-	-	-	-
All others	6	21	-	-	27
Total	29 (11.3%)	211 (82.4%)	9 (3.5%)	7 (2.7%)	256

The low harvest of MSW salmon from the Penobscot River was a result of a smaller run and because there was a seasonal limit of 1 large salmon (>64 cm total length) per angler. Additionally, there was a general decrease in the harvest from all Maine rivers, especially in the numbers of 2SW fish. There was no clear evidence that low water levels affected USA homewater harvests in 1987; harvests appeared to be related to low stock abundance in homewaters.

The exploitation rate on 2SW salmon from the Penobscot River in 1987 was 9.4%, which was similar to the 10.6% and 12.6% exploitation rates for 1985 and 1986, respectively.

The Working Group reviewed an analysis which utilized redd counts to estimate spawning escapement and exploitation rate in 6 small Maine rivers and concluded that the low angling catches recorded for some rivers in 1987 were not a good indicator of total run size. The Working Group noted that the use of redd counts might provide an independent estimate of run size and exploitation rate in these rivers if problems identified in the methodology can be resolved. These problems are outlined in Anon. (1988b).

For USA stocks, target spawning escapement and actual spawning escapement for female MSW salmon for the period 1985-1987 were as follows:

River	Target escapement	Actual spawning escapement		
		1985	1986	1987
Penobscot	3,000	1,400	1,750	858
Merrimack	1,537	105	53	62
Connecticut	4,076	152	170	193

The spawning escapement of female MSW salmon to the Penobscot River in 1987 decreased by 46% compared to the average of the previous two years, although there were modest increases in escapement to the Merrimack and Connecticut rivers.

Returns of 2SW salmon in 1987 to the Penobscot River were lower than expected.

7.12 USSR

In 1987, the salmon fisheries in the USSR opened at the beginning of June and closed on 3 December. Trap net fisheries are operated at the mouths of the rivers Pechora, North Dvina, Onega, Mezen, Umba, Varzuga, Ponoy, Jokanga, Tuloma, Kola, and others in the Archangelsk, Kavelia, and Murmansk areas. Seine nets are also used in the River Mezen, and traps are operated in the sea along the coast.

The total catch in 1987 was 559 t, of which 110 t was taken in the sea. This catch was 49 t lower than in 1986, which was a relatively good year. About 60% of the catch was 1SW, 20% 2SW, and 20% 3SW salmon. The average weight of fish caught varied between fisheries from 2.3-7.4 kg. Temperature changes in the Norwegian Sea resulted in a 1-month delay in the return of salmon to freshwater in 1987 and thus an increase in the proportion of 3SW fish caught. Salmon stocks in the USSR are believed to fluctuate on an 11-year cycle; catches peaked in 1985 and are expected to decline for the next few years.

All commercial fisheries are state owned, and sport fisheries are limited to three small rivers and require licenses.

8 GENERAL TASKS

8.1 Compilation of Tag Data

NASCO has requested information from ICES concerning tagging carried out on Atlantic salmon. C.Res.1987/3:2 stated:

1) in connection with a request from NASCO, data on Atlantic salmon tag releases in 1987 will be submitted by member countries to the Working Group on North Atlantic Salmon, using the format of the ANACAT microtag, finclip, and external tag reports;

2) these data will be compiled by the Working Group and supplied to NASCO in association with the report of ACFM.

The NASCO request arose from Working Group discussions (Anon., 1987b) which identified problems with the tagging data sheets provided by the Anadromous and Catadromous Fish Committee (ANACAT) of ICES. NASCO, therefore, proposed [CNL(87)22] that it should establish a comprehensive repository for information on tagging of Atlantic salmon to be updated annually. This proposed data base would be accessible to the Working Group, ANACAT, or the ICES Secretariat, but material would not be available outside NASCO or ICES without prior joint agreement. The current arrangements for analyzing tag returns would not be affected.

8.1.1 Compilation of tag release data for 1987

The Working Group considered several aspects of the NASCO request including 1) the level of detail to be provided, 2) possible duplication of information already held at several national repositories, and 3) whether the compiled data should be held at ICES and copied to NASCO in summary form only. It was agreed that the full 1987 tagging data set would be prepared as a separate report (Anon., 1988e) and a copy forwarded to NASCO. The Working Group noted, however, that there did not seem to be a need for NASCO to develop a tagging data base.

In excess of 1.1 million microtags and 0.4 million external tags were applied to Atlantic salmon in 1987 (Table 43). In addition, 1.3 million salmon were finclipped. Thus, more than 2.9 million fish were marked.

The Working Group noted that some tagging agencies might not be represented in the national contributions and, therefore, tags may be recovered that could not be traced through a central repository. It was decided that each national contribution should include a statement indicating whether or not the data provided are believed to represent all the tags or finclips applied.

8.1.2 Microtags for 1988

The Working Group Chairman had requested provision of data detailing microtag codes likely to be used for 1988 salmon releases. Members were unable to provide all these data in advance of tagging being completed. It should, however, be possible to assign a country of origin from agency codes even though full batch code data will not be available until 1989. Members agreed to send tagging data to the clearing house for the Northeast Atlantic (Ireland) as soon as possible during the current year of release.

8.1.3 Microtag detection

The Working Group reviewed two papers that presented data on problems of detecting coded wire tags in salmon. In one paper, adipose finclipped salmon that potentially could have had coded wire tags were tested by a procedure that attempted to magnetize a tag assuming that it was not properly magnetized when originally inserted. Magnetization failure was thought not to be a problem because out of 214 adipose finclipped salmon examined, only one additional tag was detected. However, the Working Group noted that, to be absolutely certain that a tag was not present, the fish would have to be x-rayed. The other paper examined the difference in the proportion of microtagged and finclipped salmon released from and returning to the River Bush, Northern Ireland. The significant difference in proportion of untagged fish at release and return (X^2 = 21.9, $P < 0.001$) suggests that non-detection of tags in returning adults may be a factor in this instance. There is no explanation to account for this difference, but data from some other countries suggest that tag loss or non-detection of tags are not general problems. The Working Group recommended that tag loss be estimated at time of release and return.

9 RESEARCH REQUIREMENTS AND DATA DEFICIENCIES

The Working Group has outlined a framework for scientifically-based approaches for managing salmon in Section 3. Inherent in that approach are many of the research needs identified in Anon. (1987a). Many of the research needs listed there have now been fulfilled, or research on them has been initiated. It was, therefore, decided to draw up a new list of research priorities which would reflect the proposed approach to scientific management.

The main research requirements are projects which will provide the data necessary for the models proposed in Section 3. The requirements are of two types:

a) Immediate requirements where research is urgently needed and where in many cases the projects are under way but require greater effort:

Index rivers

Index rivers (Anon., 1985) are the basis for the proposed models and any expansion into modelling stock complexes, national stocks, and finally global stocks. The main elements or parameters include information on adult escapement and smolt migration.

Spawning stock biomass

Information on this subject is of primary importance as it gives a measure of the status of stocks as well as providing basic information for the models.

Stock composition of fisheries

The origin of stocks, migration routes, and migration times and their effects on harvest in adjacent fisheries are at present investigated mainly by tagging and methods of discrimination based on scales. The Working Group is aware of advances in the field of stock discrimination and is anxious that research effort should be put into this area. These techniques include restriction site analysis of mitochondial DNA electrophoretic techniques, immune response reactions, and image processing.

Exploitation rates

Exploitation rates are required for each fishery in the proposed models.

b) Long-term research requirements which will be more difficult to attain or which will require long-time series of data. Some of these are ongoing and include:

all the sampling programmes currently in place in the high sea fisheries;

the discard collection programme at Faroes and biological data collection and monitoring for tags at Faroes and Greenland;

research programmes to study post-smolt mortality.

c) Other data deficiencies. In addition to the recommendations in Anon. (1988a and 1988b), two items were identified which required attention:

The accuracy of estimates of catches of North American hatchery-origin salmon by smolt age at West Greenland should be examined and attention should be paid to the variability of estimates of low frequency river ageclasses.

Scale samples taken in the Newfoundland-Labrador commercial fisheries should be examined to determine the river age composition of the catch. Available data should be examined to determine the re-presentativeness of existing samples and to determine sampling requirements to obtain estimates for the entire provincial fishery.

Recommendation

All member countries of the North Atlantic Salmon Working Group should, where possible, research the topics outlined in the section on Research Requirements (Section 9) so that they can contribute towards the production of the proposed salmon model.

10 OTHER BUSINESS

The attention of the Working Group was drawn to an eye condition of salmon which has been reported from Scotland. Cataracts were first noted in the eyes of salmon caught in a commercial bag net fishery on the west coast of Scotland in June 1984, and have since been noted each year. In 1987, fish showing this symptom were noted in samples from around the entire Scottish coast and in angling catches. It was observed in the eyes of both wild and farmed fish and can occur in one or both eyes. The percentage of the catch showing this symptom varied widely both between weeks and fishing stations. In general, it was about 10% of the total annual catch. Scottish observers on board Faroese longliners in 1984 and 1985 observed a similar condition in a proportion of the salmon catches.

The cataracts consisted of a deep-seated, irregular opacity in the eye. No corneal opacity was present. An examination of the lens in frozen material showed that the outer epithelium was intact, but the outer layers of lens fibres appeared to have broken down leaving a fluid-filled gap. The inner part of the lens showed an ingoing split in the concentric layers, with lens fibres splaying out from this split. These splayed-out lens fibres caused the opacity. The cataracts do not resemble those caused by dietary deficiencies, which are always in both eyes.

Table 1 Nominal catch of SALMON by country (in tonnes round fresh weight) 1961-1987.

Year	France	Engl.+ Wales	Scotland	Ireland[2]	Northern Ireland[2,3]	Norway[4]	Sweden (west coast)	Finland	USSR	Iceland	Canada[5]	USA	Faroes[6]	Green- land[7]	Total[8]
1961	75	232	1,196	707	132	1,533	27	-	790	127	1,583	<2	-	127	6,530
1962	75	318	1,740	1,459	356	1,935	45	-	710	125	1,719	<2	-	244	8,727
1963	75	325	1,698	1,458	306	1,786	23	-	480	145	1,861	<2	-	466	8.614
1964	75	307	1,914	1,617	377	2,147	36	-	590	135	2,069	<2	-	1,539	10,807
1965	75	320	1,563	1,457	281	2,000	40	-	590	133	2,116	<2	-	861	9,437
1966	75	387	1,624	1,238	287	1,791	36	-	570	106	2,369	<2	-	1,370	9,845
1967	75	420	2,133	1,463	449	1,980	25	-	883	146	2,863	<2	-	1,601	12,018
1968	75	282	1,563	1,413	312	1,514	20	-	827	162	2,111	<2	5	1,127	9,411
1969	75	377	1,947	1,730	267	1,383	22	-	360	133	2,202	<2	7	2,210	10,213
1970	75	527	1,329	1,787	297	1,171	20	-	448	195	2,323	<2	12	2,146	10,331
1971	75	426	1,419	1,639	234	1,207	18	-	417	204	1,992	<2	-	2,689	9,320
1972	34	442	1,693	1,804	210	1,568	18	32	462	250	1,759	<2	9	2,113	10,395
1973	12	450	1,964	1,930	182	1,726	23	50	772	256	2,434	2.7	28	2,341	12,171
1974	13	383	1,631	2,128	184	1,633	32	76	709	225	2,539	0.9	20	1,917	11,491
1975	25	447	1,561	2,216	164	1,537	26	76	811	266	2,485	1.7	28	2,030	11,624
1976	9	208	1,010	1,561	113	1,530	20	66	NA	225	2,506	0.8	40	1,175	8,464
1977	19	345	1,131	1,372	110	1,488	10	59	NA	230	2,545	2.4	40	1,420	8,221
1978	20	349	1,323	1,230	148	1,050	10	37	NA	291	1,545	4.1	37	984	2,020
1979	10	261	1,075	1,097	99	1,831	12	26	430	225	1,287	2.5	106	1,395	2,857
1980	30	360	1,134	947	122	1,830	17	34	631	249	2,680	5.5	553	1,194	9,787
1981	20	493	1,233	685	101	1,656	26	44	450	163	2,437	6.0	1,025	1,264	9,603
1982	20	286	1,092	993	132	1,348	25	54	311	147	1,798	6.4	865	1,077	8,154
1983	16	432	1,221	1,656	187	1,550	28	57	436	198	1,424	1.3	678	310	8,191
1984	25	345	1,013	829	78	1,623	40	44	593	159	1,112	2.2	628	297	6,788
1985	22	361	913	1,595	98	1,561	45	49	652	217	1,133	2.1	566	864	8,078
1986	28	430	1,271	1,730	109	1,598	54	38	608	330	1,559	1.9	530	960	9,247
1987[1]	27	291	910	1,239	48	1,389	47	49	559	220	1,731	1.1	510	966	7,987[9]

[1] Provisional figures.
[2] Catch on River Foyle allocated 50% Ireland and 50% Northern Ireland.
[3] Not including angling catch (mainly grilse).
[4] Before 1966, sea trout and sea char included (5% total).
[5] Includes estimates of some local sales and by-catch.
[6] In some years, part of the catch taken outside EEZ of Faroes.
[7] Including 7 t caught on longline by one of two Greenland vessels in the Labrador Sea.
[8] USA catch taken as 1 t from 1961-1971.
[9] 0.08 t reported by Portugal not included.

Table 2 Nominal catch of SALMON in home waters by country (in tonnes round fresh weight) 1961-1987.

Year	France	Engl.+ Wales	Scotland[2]			Ireland[3]			N. Ireland[3,4]	Norway[5]			Sweden (west coast)	Finland	USSR	Iceland	Canada[6]			USA	Total[7] all countr.
	T	T	S	G	T	S	G	T	T	S	G	T	T	T	T	T	S	G	T	T	T
1961	75	232	772	424	1,196	-	-	707	132	-	-	1,533	27	-	790	127	-	-	1,583	<2	6,403
1962	75	318	808	932	1,740	-	-	1,459	356	-	-	1,935	45	-	710	125	-	-	1,719	<2	8,483
1963	75	325	1,168	530	1,698	-	-	1,458	306	-	-	1,786	23	-	480	145	-	-	1,861	<2	8,148
1964	75	307	913	1,001	1,914	-	-	1,617	377	-	-	2,147	36	-	590	135	-	-	2,069	<2	9,268
1965	75	320	835	728	1,563	-	-	1,457	281	-	-	2,000	40	-	590	133	-	-	2,116	<2	8,576
1966	75	387	788	836	1,624	-	-	1,238	287	-	-	1,791	36	-	570	106	-	-	2,369	<2	8,475
1967	75	420	857	1,276	2,133	-	-	1,463	449	-	-	1,980	25	-	883	146	-	-	2,863	<2	10,417
1968	75	282	783	780	1,563	-	-	1,413	312	-	-	1,514	20	-	827	162	-	-	2,111	<2	8,279
1969	75	377	539	1,408	1,947	-	-	1,730	267	801	582	1,383	22	-	360	133	-	-	2,202	<2	8,496
1970	75	527	503	826	1,329	-	-	1,787	297	815	356	1,171	20	-	448	195	1,562	761	2,323	<2	8,173
1971	75	426	496	923	1,419	-	-	1,639	234	771	436	1,207	18	-	417	204	1,482	510	1,992	<2	7,631
1972	34	442	588	1,105	1,693	200	1,604	1,804	210	1,064	514	1,568	18	32	462	250	1,201	558	1,759	<2	8,273
1973	12	450	661	1,303	1,964	244	1,686	1,930	182	1,220	506	1,726	23	50	772	256	1,651	783	2,434	2.7	9,802
1974	13	383	578	1,063	1,631	170	1,958	2,128	184	1,149	484	1,633	32	76	709	225	1,589	950	2,539	0.9	9,554
1975	25	447	669	892	1,561	274	1,942	2,216	164	1,038	499	1,537	26	76	811	266	1,573	912	2,485	1.7	9,616
1976	9	208	328	682	1,010	109	1,452	1,561	113	1,063	467	1,530	20	66	NA	225	1,721	785	2,506	0.8	7,249
1977	19	345	369	762	1,131	145	1,227	1,372	110	1,018	470	1,488	10	59	NA	230	1,883	662	2,545	2.4	7,311
1978	20	349	781	542	1,323	147	1,082	1,230	148	668	382	1,050	10	37	NA	291	1,225	320	1,545	4.1	6,007
1979	10	261	598	478	1,075	105	922	1,097	99	1,150	681	1,831	12	26	430	225	705	582	1,287	2.5	6,356
1980	30	360	851	283	1,134	202	745	947	122	1,352	478	1,830	17	34	631	249	1,763	917	2,680	5.5	8,040
1981	20	493	843	389	1,233	164	521	685	101	1,189	467	1,656	26	44	450	163	1,619	818	2,437	6.0	7,314
1982	20	286	596	496	1,092	63	930	993	132	985	363	1,348	25	54	311	147	1,082	716	1,798	6.4	6,212
1983	16	429	672	549	1,221	150	1,506	1,656	187	957	593	1,550	28	57	436	198	911	513	1,424	1.3	7,203
1984	25	345	504	509	1,013	101	728	829	78	995	628	1,623	40	44	593	159	645	467	1,112	2.2	5,863
1985	22	361	514	399	913	100	1,495	1,595	98	923	638	1,561	45	49	652	217	540	593	1,133	2.1	6,648
1986	28	430	745	526	1,271	136	1,594	1,730	109	1,042	556	1,598	54	38	608	330	779	780	1,569	1.9	7,757
1987[1]	27	291	498	412	910	127	1,112	1,239	48	894	495	1,389	47	49	559	220	916	815	1,731	1.1	6,511[8]

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

[1] Provisional figures.
[2] Salmon and grilse figures for 1962-1977 corrected for grilse error.
[3] Catch on River Foyle allocated 50% Ireland and 50% N. Ireland.
[4] Not including angling catch (mainly grilse).
[5] Before 1966, sea trout and sea char included (5% total).
[6] Includes estimates of some local sales and by-catch, some fish in "G" column are non-maturing.
[7] USA catch taken as 1 t from 1960-1971.
[8] 0.08 t reported by Portugal not included.

Table 3 Reported catch of SALMON in numbers and weight in tonnes (round fresh weight).

Country	Year	1SW		2SW		3SW		4SW		5SW		MSW[1]		PS		Total	
		No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt
France	1985	1,074	-	-	-	-	-	-	-	-	-	3,278	-	-	-	4,352	22
	1986	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6,801	28
	1987	6,013	18	-	-	-	-	-	-	-	-	1,806	9	-	-	7,819	27
Scotland	1982	208,061	416	-	-	-	-	-	-	-	-	128,242	596	-	-	336,303	1,092
	1983	209,617	549	-	-	-	-	-	-	-	-	145,961	672	-	-	320,578	1,221
	1984	213,079	509	-	-	-	-	-	-	-	-	107,213	504	-	-	230,292	1,013
	1985	158,012	399	-	-	-	-	-	-	-	-	114,648	514	-	-	272,660	913
	1986	202,861	526	-	-	-	-	-	-	-	-	148,398	745	-	-	351,259	1,271
	1987	162,117	412	-	-	-	-	-	-	-	-	102,917	498	-	-	265,034	910
Ireland	1980	248,333	745	-	-	-	-	-	-	-	-	39,608	202	-	-	287,941	947
	1981	173,667	521	-	-	-	-	-	-	-	-	32,159	164	-	-	205,826	685
	1982	310,000	930	-	-	-	-	-	-	-	-	12,353	63	-	-	322,353	993
	1983	502,000	1,506	-	-	-	-	-	-	-	-	29,411	150	-	-	531,411	1,656
	1984	242,666	728	-	-	-	-	-	-	-	-	19,804	101	-	-	262,470	829
	1985	498,333	1,495	-	-	-	-	-	-	-	-	19,608	100	-	-	517,941	1,595
	1986	498,125	1,594	-	-	-	-	-	-	-	-	28,335	136	-	-	526,450	1,730
	1987	358,842	1,112	-	-	-	-	-	-	-	-	-	-	-	-	384,626	1,739
Norway	1981	221,566	467	-	-	-	-	-	-	-	-	213,943	1,189	-	-	435,509	1,656
	1982	163,120	363	-	-	-	-	-	-	-	-	174,229	985	-	-	337,349	1,348
	1983	278,061	593	-	-	-	-	-	-	-	-	171,361	957	-	-	449,442	1,550
	1984	294,365	628	-	-	-	-	-	-	-	-	176,716	995	-	-	471,081	1,623
	1985	299,037	638	-	-	-	-	-	-	-	-	162,403	923	-	-	461,440	1,561
	1986	264,849	556	-	-	-	-	-	-	-	-	191,524	1,042	-	-	456,373	1,598
	1987	237,626	495	-	-	-	-	-	-	-	-	153,554	894	-	-	391,180	1,389
Iceland	1982	23,026	58	-	-	-	-	-	-	-	-	18,119	89	-	-	41,145	147
	1983	33,769	85	-	-	-	-	-	-	-	-	24,454	113	-	-	58,223	198
	1984	18,901	47	-	-	-	-	-	-	-	-	22,188	112	-	-	41,089	159
	1985	50,000	125	-	-	-	-	-	-	-	-	16,300	94	-	-	66,300	217
	1986	52,500	130	-	-	-	-	-	-	-	-	39,500	200	-	-	92,000	330
	1987	30,000	72	-	-	-	-	-	-	-	-	32,000	148	-	-	62,000	220

(cont'd)

Table 3 (cont'd

Country	Year	1SW		2SW		3SW		4SW		5SW		MSW[1]		PS		Total	
		No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt
Canada	1982	358,000	716	-	-	-	-	-	-	-	-	240,000	1,082	-	-	598,000	1,798
	1983	265,000	513	-	-	-	-	-	-	-	-	201,000	911	-	-	466,000	1,424
	1984	234,000	467	-	-	-	-	-	-	-	-	143,000	645	-	-	377,000	1,112
	1985	333,084	593	-	-	-	-	-	-	-	-	122,621	540	-	-	455,705	1,133
	1986	417,269	780	-	-	-	-	-	-	-	-	162,305	779	-	-	579,574	1,559
	1987	423,698	815	-	-	-	-	-	-	-	-	193,168	916	-	-	616,866	1,731
USA	1982	33	-	1,206	-	5	-	-	-	-	-	-	-	21	-	1,265	6.4
	1983	26	-	314	1.2	2	-	-	-	-	-	-	-	6	-	348	1.3
	1984	50	-	545	2.1	2	-	-	-	-	-	-	-	12	-	609	2.2
	1985	23	-	528	2.0	2	-	-	-	-	-	-	-	13	-	557	2.1
	1986	76	-	482	1.8	2	-	-	-	-	-	-	-	3	-	541	1.9
	1987	29	-	211	1.1	9	-	-	-	-	-	-	-	7	-	256	1.1
Faroe Islands	1982/1983	9,086	-	101,227	-	21,663	-	448	-	29	-	-	-	-	-	132,453	625
	1983/1984	4,791	-	107,199	-	12,469	-	49	-	-	-	-	-	-	-	124,508	651
	1984/1985	324	-	123,510	-	9,690	-	-	-	-	-	-	-	1,653	-	135,776	598
	1985/1986	1,672	-	141,740	-	4,779	-	76	-	-	-	-	-	6,287	-	154,554	545
	1986/1987	76	-	133,078	-	7,070	-	80	-	-	-	-	-	-	-	140,304	520
West Greenland	1982	315,532	-	17,810	-	-	-	-	-	-	-	-	-	2,688	-	336,030	1,077
	1983	90,500	-	8,100	-	-	-	-	-	-	-	-	-	1,400	-	100,000	310
	1984	78,942	-	10,442	-	-	-	-	-	-	-	-	-	630	-	90,014	297
	1985	292,181	-	18,378	-	-	-	-	-	-	-	-	-	934	-	311,493	864
	1986	307,800	-	9,700	-	-	-	-	-	-	-	-	-	2,600	-	320,100	960
	1987	297,128	-	6,287	-	-	-	-	-	-	-	-	-	2,898	-	306,313	966
Sweden (West coast)	1985	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14,467	45
	1986	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17,350	54
	1987	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12,916	47
England & Wales	1985	-	-	-	-	-	-	-	-	-	-	-	-	-	-	95,531	361
	1986	-	-	-	-	-	-	-	-	-	-	-	-	-	-	110,794	430
	1987	-	-	-	-	-	-	-	-	-	-	-	-	-	-	78,500	291

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

<u>Table 4</u> Example output and cell form… from the model for a river in Europe (River 1).

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1:	NORTH ATLANTIC SALMON MIGRATION AND EXPLOITATION														
2:															
3:				RIVER	ICES 1	EUROPA									
4:	MONTH	AGE	RIVERS	CATCH	HOME	CATCH	NORW.	CATCH	WEST	CATCH	TOTAL	TOTAL	EXPLOIT		
5:					WATER		SEA		GREENL		STOCK	CATCH	RATE(%)		
6:	JUNE	6	2920.00								2920.00	0.00	0.00		
7:	MARCH	15					408.80	12.26			408.80	12.26	0.42		
8:	JULY	19			152.36	114.27	190.46				342.82	114.27	3.91		
9:	AUGUST	20			37.71				37.71	5.66	75.42	5.66	0.19		
10:	SEPT	21	37.33						31.73		69.07	0.00	0.00		
11:	MARCH	27					211.25	27.46			211.25	27.46	0.94		
12:	JULY	31			176.54	105.92					176.54	105.92	3.63		
13:	SEPT	33	69.21		0.00						69.21	0.00	0.00		
14:															
15:															
16:															
17:	S -	0.99			EXPL 1 =	0.75	EXPL 1	0.0300	EXPL	0.1500					
18:	S-SURV	0.14			EXPL 2	0.60	EXPL 2	0.1300							
19:	NS TO HW	0.40	GRILSE	1.00											
20:	NS TO WG	0.10	SALMON	1.00											
21:	--														

```
C10  :C9*#EXP(B17,B10-B9)*D19
C13  :(E12-F12)*#EXP(B17,B13-B12)*D20
E8   :(G7-H7)*#EXP(B17,B8-B7)*B19
E9   :(E8-F8)*#EXP(B17,B9-B8)
E12  :(G11-H11)*#EXP(B17,B12-B11)
E13  :(E12-F12)*#EXP(B17,B13-B12)*(1-D20)
F8   :E8*F17
F12  :E12*F18
G7   :C6*B18
G8   :(G7-H7)*(1-B19-B20)*#EXP(B17,B8-B7)
G11  :G8*#EXP(B17,B11-B8)+I9*#EXP(B17,B11-B10)
H7   :G7*H17
H11  :G11*H18
I9   :(G7-H7)*#EXP(B17,B9-B7)*B20
I10  :(I9-J9)*#EXP(B17,B10-B9)
J9   :I9*J17
K6   :C6+E6+G6+I6
K7   :C7+E7+G7+I7
K8   :C8+E8+G8+I8
K9   :C9+E9+G9+I9
K10  :C10+E10+G10+I10
K11  :C11+E11+G11+I11
K12  :C12+E12+G12+I12
K13  :C13+E13+G13+I13
L6   :D6+F6+H6+J6
L7   :D7+F7+H7+J7
L8   :D8+F8+H8+J8
L9   :D9+F9+H9+J9
L10  :D10+F10+H10+J10
L11  :D11+F11+H11+J11
L12  :D12+F12+H12+J12
L13  :D13+F13+H13+J13
M6   :L6/$K6*100
M7   :L7/$K6*100
M8   :L8/$K6*100
M9   :L9/$K6*100
M10  :L10/$K6*100
M11  :L11/$K6*100
M12  :L12/$K6*100
M13  :L13/$K6*100
```

Table 5 Example output and cell formulae from the spread sheet model for a river in Europe (River 2).

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1:															
2:	NORTH ATLANTIC SALMON		MIGRATION AND EXPLOITATION												
3:															
4:				RIVER	ICES 2	EUROPE									
5:															
6:	MONTH	AGE	RIVERS	CATCH	HOME	CATCH	NORW.	CATCH	WEST	CATCH	IRMINGER	CATCH	TOTAL	TOTAL	ACCUM.
7:					WATER		SEA		GREENL				STOCK	CATCH	CATCH
8:	JUNE	8	4000										4000		0
9:	MARCH	15					1000						1000	0	0
10:	JULY	19			672	504							961	504	504
11:	AUGUST	20			166				95	10			452	10	514
12:	SEPT	21	165						85				282	0	514
13:	MARCH	27					257	103					257	103	617
14:	JULY	31			148	133							148	133	750
15:	SEPT	33	15										15	0	750
16:															
17:															
18:															
19:	S =	0.9900			EXPL 1 =	0.7500			EXPL 1	0.1000					
20:	SM SURV	0.2500			EXPL 2	0.9000	EXPL 2	0.4000							
21:	NS TO HW	0.7000													

```
C12  :E11*#EXP(B19,B12-B11)
C15  :(E14-F14)*#EXP(B19,B15-B14)
E10  :B21*G9*#EXP(B19,B10-B9)
E11  :(E10-F10)*#EXP(B19,B11-B10)
E14  :(G13-H13)*#EXP(B19,B14-B13)
F10  :E10*F19
F14  :E14*F20
G9   :C8*B20
G13  :G9*(1-B21-B22)*#EXP(B19,B13-B9)+I12*#EXP(B19,B13-B12)
H13  :G13*H20
I11  :G9*(1-B21-.2)*#EXP(B19,B11-B9)
I12  :(I11-J11)*#EXP(B19,B12-B11)
J11  :I11*J19
M8   :C8
M9   :C8*B20
M10  :G9*#EXP(B19,B10-B9)
M11  :(M10-F10)*#EXP(B19,B11-B10)
M12  :M11*#EXP(B19,B12-B11)-C12
M13  :C13+E13+G13+I13+K13
M14  :C14+E14+G14+I14+K14
M15  :C15+E15+G15+I15+K15

N9   :D9+F9+H9+J9+L9
N10  :D10+F10+H10+J10+L10
N11  :D11+F11+H11+J11+L11
N12  :D12+F12+H12+J12+L12
N13  :D13+F13+H13+J13+L13
N14  :D14+F14+H14+J14+L14
N15  :D15+F15+H15+J15+L15
O8   :N8/$M8*100
O9   :N9/$M8*100
O10  :N10
O11  :N10+N11
O12  :N10+N11+N12
O13  :N10+N11+N12+N13
O14  :N10+N11+N12+N13+N14
O15  :N10+N11+N12+N13+N14+N15
```

Table 6 Nominal catches at West Greenland, 1960-1987 (in tonnes, round fish weight).

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

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

Factor used for converting landed catch to round fresh weight in fishery by Greenland vessels = 1.11. Factor for Norwegian, Danish, and Faroese drift net vessels = 1.10.

Table 7 Distribution of nominal catches (tonnes) taken by Greenland vessels in 1975-1987 by NAFO divisions according to place where landed.

Div.	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987[1]
1A	124	171	201	81	120	52	105	111	14	33	85	46	48
1B	168	299	393	349	343	275	403	330	77	116	124	73	114
1C	175	262	336	245	524	404	348	239	93	64	198	128	229
1D	204	218	207	186	213	231	203	136	41	4	207	203	205
1E	315	182	237	113	164	158	153	167	55	43	147	233	261
1F	185	43	46	10	31	74	32	76	30	32	103	277	109
1NK	-	-	-	-	-	-	20	18	-	5	-	-	-
Total	1,171	1,175	1,420	984	1,395	1,194	1,264	1,077	310	297	864	960	966
East Greenl.	+	+	6	8	+	+	+	+	+	+	7	19	+
Total	1,171	1,175	1,426	992	1,395	1,194	1,264	1,077	310	297	871	979	966

[1] Provisional figures.

Table 8 Distribution by NAFO division and time of effort, catch, and catch per unit effort in the Greenlandic drift net fishery for ATLANTIC SALMON, 1987. The data comprise the fishery by 60 vessels. (C = number of salmon caught, f = number of nets used, and C/f = number of salmon caught per 100 nets).

NAFO division		Week							Total
		35	36	37	38	39	40	41	
1A	C	845	305	24	-	-	116	24	1,314
	f	1,416	480	80	-	-	338	192	2,506
	C/f	60	64	30	-	-	34	13	52
1B	C	1,397	409	593	150	-	-	-	2,549
	f	1,012	364	500	150	-	-	-	2,026
	C/f	138	112	119	100	-	-	-	126
1C	C	11,872	7,001	1,282	60	1,765	1,022	-	23,002
	f	4,471	3,832	1,085	30	1,057	651	-	11,126
	C/f	266	183	118	200	167	157	-	207
1D	C	1,466	1,010	600	366	154	137	-	3,733
	f	675	548	274	272	228	170	-	2,167
	C/f	217	184	219	135	68	81	-	172
1E	C	3,301	858	-	-	-	-	-	4,159
	f	1,276	861	-	-	-	-	-	2,137
	C/f	259	100	-	-	-	-	-	195
	C	3,024	788	106	1	-	-	-	3,919
1F	f	2,241	1,200	139	15	-	-	-	3,595
	C/f	135	66	76	7	-	-	-	109
1A-F	C	21,905	10,371	2,605	577	1,919	1,275	24	38,676
	f	11,091	7,285	2,078	467	1,285	1,159	192	23,557
	C/f	198	142	125	124	149	110	13	164

Table 9 Distribution by NAFO division and time of effort, catch, and catch per unit effort in the Greenlandic drift net fishery for ATLANTIC SALMON, 1986. The data comprise the fishery by 17 vessels. (C = number of salmon caught, f = number of nets used, and C/f = number of salmon caught per 100 nets).

NAFO division		Week 33 Aug 15-17	Week 34 Aug 18-24	Week 35 Aug 25-31	Total Aug 15-31
1C	C	864	833	726	2,423
	f	364	750	609	1,723
	C/f	237	111	119	141
1D	C	3,155	4,280	508	7,943
	f	945	2,183	240	3,368
	C/f	334	197	212	236
1E	C	6,059	2,613	1,021	9,693
	f	1,722	1,198	416	3,336
	C/f	352	218	245	291
1F	C	746	612	48	1,406
	f	279	409	91	779
	C/f	267	150	53	180
1C-F	C	10,824	8,338	2,303	21,465
	f	3,310	4,540	1,356	9,206
	C/f	327	184	170	233

Table 10 Percentage (by number) of North American and European SALMON in research vessel catches at West Greenland 1969-1982 and from commercial samples 1978-1987.

Source	Year	Sample size: Length	Sample size: Scales	Continent of origin (%): NA	(95% CL)	EU	(95% CL)
Research	1969	212	212	51	(57,44)	49	(56,43)
	1970	127	127	35	(43,26)	65	(74,57)
	1971	247	247	34	(40,28)	66	(72,50)
	1972	3,488	3,488	36	(37,34)	64	(66,63)
	1973	102	102	49	(59,39)	51	(61,41)
	1974	834	834	43	(46,39)	57	(61,54)
	1975	528	528	44	(48,40)	56	(60,52)
	1976	420	420	43	(48,38)	57	(62,52)
	1977	-	-	-	(-)	-	(-)
	1978	606	606	38	(41,34)	62	(66,59)
	1978[1]	49	49	55	(69,41)	45	(59,31)
	1979[2]	328	328	47	(52,41)	53	(59,48)
	1980	617	617	58	(62,54)	42	(46,38)
	1981	-	-	-	(-)	-	(-)
	1982	443	443	47	(52,43)	53	(58,48)
Commercial	1978	392	392	52	(57,47)	48	(53,43)
	1979	1,653	1,653	50	(52,48)	50	(52,48)
	1980	978	978	48	(51,45)	52	(55,49)
	1981	4,570	1,930	59	(61,58)	41	(42,39)
	1982	1,949	414	62	(64,60)	38	(40,36)
	1983	4,896	1,815	40	(41,38)	60	(62,59)
	1984	7,282	2,720	50	(53,47)	50	(53,47)
	1985	13,272	2,917	50	(53,46)	50	(54,47)
	1986	20,394	3,509	57	(66,48)	43	(52,34)
	1987	13,425	2,960	59	(63,54)	41	(46,37)

[1] During fishery.

[2] Research samples after fishery closed.

Table 11 Tag returns from 1-SW SALMON of Maine origin in West Greenland by year and NAFO division.

Year	1A	1B	1C	1D	1E	1F	UNK	TOT
1967	1	10	10	8	3	2	3	37
1969	0	1	3	0	1	0	1	6
1970	10	14	6	7	12	2	7	58
1971	29	34	50	57	58	60	94	382
1972	5	4	35	6	15	5	12	82
1973	5	28	25	16	13	12	32	131
1974	8	75	95	79	32	20	48	357
1975	10	22	16	5	1	3	70	127
1976	13	11	9	3	0	0	3	39
1977	0	1	6	0	1	2	1	11
1978	0	5	2	0	0	0	2	9
1980	0	37	20	9	0	0	6	72
1981	0	17	5	0	0	0	18	40
1982	1	42	1	1	0	2	2	49
1983	0	1	6	0	0	0	0	7
1984	1	9	9	0	1	3	0	23
1985	4	25	7	8	0	5	9	58
1986	1	10	15	17	11	18	0	72
1987	2	29	51	43	26	7	0	158
UNK	0	7	6	6	2	0	3	24
Total	90	382	377	265	176	141	311	1742

Table 12 Estimates number of 1-SW SALMON of Maine origin harvested in West Greenland by year and NAFO division.

Year	1A	1B	1C	1D	1E	1F	UNK	TOT
1967	6	64	64	51	19	13	19	238
1969	0	97	290	0	97	0	97	580
1970	155	216	93	108	185	31	108	896
1971	199	234	344	392	399	412	646	2626
1972	55	44	386	66	166	55	132	905
1973	50	282	251	161	131	121	322	1318
1974	64	598	758	630	255	159	383	2847
1975	108	237	173	54	11	32	755	1370
1976	561	475	389	130	0	0	130	1684
1977	0	87	523	0	87	174	87	959
1978	0	653	261	0	0	0	261	1175
1980	0	1220	659	297	0	0	198	2374
1981	0	852	251	0	0	0	902	2005
1982	28	1178	28	28	0	56	56	1374
1983	0	75	450	0	0	0	0	525
1984	38	345	345	0	38	115	0	883
1985	104	653	183	209	0	131	235	1515
1986	29	291	437	495	320	524	0	2096
Total	1399	7602	5885	2621	1708	1824	4332	25370

Table 13 The periods of sampling at sites in West Greenland in 1987 with the number of of salmon examined and the number of adipose finclipped (AFC) and micro-tagged fish observed. The percentages of the fish examined that were adipose finclipped and microtagged are given in parentheses.

Place	NAFO div.	Sampling period From	Sampling period To	Number salmon examined	Number adipose finclips (%)	Number microtags (%)	% of AFC fish with microtags	Number untagged AFC fish (%)
Sisimut	1B	26 Aug	9 Sep	6,073	138 (2.27)	46 (0.76)	33.3	92 (1.51)
Nuuk	1D	27 Aug	4 Sep	9,263	203 (2.19)	61 (0.66)	30.0	142 (1.53)
Paamiut	1E	27 Aug	1 Sep	6,139	79 (1.39)	18 (0.29)	22.8	61 (0.99)
Narssaq	1F	27 Aug	7 Sep	3,572	73 (2.04)	21 (0.59)	28.8	52 (1.46)
Total				25,047	493 (1.97)	146 (0.58)	29.6	347 (1.39)

Table 14 Origin of microtags recovered at sites in West Greenland in 1987. Recovery rates per 1,000 fish examined given in parentheses.

Place	NAFO div.	UK		Ireland	USA	Canada	Total
		Engl. & Wales	Scotland				
Sisimut	1B	7 (1.153)	- (-)	6 (0.988)	26 (4.281)	7 (1.153)	46 (7.575)
Nuuk	1D	8 (0.864)	1 (0.108)	9 (0.972)	35 (3.778)	8 (0.864)	61 (6.585)
Paamiut	1E	- (-)	1 (0.163)	6 (0.977)	7 (1.140)	4 (0.652)	18 (2.932)
Narssaq	1F	2 (0.560)	- (-)	3 (0.840)	14 (3.919)	2 (0.560)	21 (5.879)
Total		17 (0.679)	2 (0.080)	24 (0.958)	82 (3.274)	21 (0.838)	146 (5.829)

Table 15 Annual mean fork lengths and whole weights of ATLANTIC SALMON sampled at West Greenland, 1969-1987 Fork length (cm); whole weight (kg). NA - North American; E - European.

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

Table 16a Sea age composition (%) from research vessel and commercial catch samples of ATLANTIC SALMON at West Greenland, 1969-1987.

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

Table 16b The sea age composition of samples from commercial catches at West Greenland, 1985-1987.

Year	Sea age composition (%)					
	North American			European		
	1SW	2SW	Previous spawners	1SW	2SW	Previous spawners
1985	92.5	7.2	0.3	95.0	4.7	0.4
1986	95.1	3.9	1.0	97.5	1.9	0.6
1987	96.3	2.3	1.4	98.0	1.7	0.3

Table 17 River age distribution (%) for all North American and European origin SALMON sampled at West Greenland, 1968-1987.

Year	1	2	3	4	5	6	7	8
North American								
1968	0.3	19.6	40.4	21.3	16.2	2.2	0.0	0.0
1969	0.0	27.1	45.8	19.6	6.5	0.9	0.0	0.0
1970	0.0	58.1	25.6	11.6	2.3	2.3	0.0	0.0
1971	1.2	32.9	36.5	16.5	9.4	3.5	0.0	0.0
1972	0.8	31.9	51.4	10.6	3.9	1.2	0.4	0.0
1973	2.0	40.8	34.7	18.4	2.0	2.0	0.0	0.0
1974	0.9	36.0	36.6	12.0	11.7	2.6	0.3	0.0
1975	0.4	17.3	47.6	24.4	6.2	4.0	0.0	0.0
1976	0.7	42.6	30.6	14.6	10.9	0.4	0.4	0.0
1977	-	-	-	-	-	-	-	-
1978	2.7	31.9	43.0	13.6	6.0	2.0	0.9	0.0
1979	4.2	39.9	40.6	11.3	2.8	1.1	0.1	0.0
1980	5.9	36.3	32.9	16.3	7.9	0.7	0.1	0.0
1981	3.5	31.6	37.5	19.0	6.6	1.6	0.2	0.0
1982	1.4	37.7	38.3	15.9	5.8	0.7	0.0	0.2
1983	3.1	47.0	32.6	12.7	3.7	0.8	0.1	0.0
1984	4.8	51.7	28.9	9.0	4.6	0.9	0.2	0.0
1985	5.1	41.0	35.7	12.1	4.9	1.1	0.1	0.0
1986	2.0	39.9	33.4	20.0	4.0	0.7	0.0	0.0
1987	3.9	41.4	31.8	16.7	5.8	0.4	0.0	0.0
Total	3.4	39.1	35.7	15.0	5.7	1.1	0.1	0.0
European								
1968	21.6	60.3	15.2	2.7	0.3	0.0	0.0	0.0
1969	0.0	83.8	16.2	0.0	0.0	0.0	0.0	0.0
1970	0.0	90.4	9.6	0.0	0.0	0.0	0.0	0.0
1971	9.3	66.5	19.9	3.1	1.2	0.0	0.0	0.0
1972	11.0	71.2	16.7	1.0	0.1	0.0	0.0	0.0
1973	26.0	58.0	14.0	2.0	0.0	0.0	0.0	0.0
1974	22.9	68.2	8.5	0.4	0.0	0.0	0.0	0.0
1975	26.0	53.4	18.2	2.5	0.0	0.0	0.0	0.0
1976	23.5	67.2	8.4	0.6	0.3	0.0	0.0	0.0
1977	-	-	-	-	-	-	-	-
1978	26.2	65.4	8.2	0.2	0.0	0.0	0.0	0.0
1979	23.6	64.8	11.0	0.6	0.0	0.0	0.0	0.0
1980	25.8	56.9	14.7	2.5	0.2	0.0	0.0	0.0
1981	15.4	67.3	15.7	1.6	0.0	0.0	0.0	0.0
1982	15.6	56.1	23.5	4.2	0.7	0.0	0.0	0.0
1983	34.7	50.2	12.3	2.4	0.3	0.1	0.1	0.0
1984	22.7	56.9	15.2	4.2	0.9	0.2	0.0	0.0
1985	20.2	61.6	14.9	2.7	0.6	0.0	0.0	0.0
1986	19.5	62.5	15.1	2.7	0.2	0.0	0.0	0.0
1987	19.2	62.5	14.8	3.3	0.3	0.0	0.0	0.0
Total	21.3	61.9	14.2	2.3	0.3	0.0	0.0	0.0

Table 18 Catch by weight (tonnes) and numbers (thousands of fish) at West Greenland, 1978-1987, with comparisons of years 1978-1982 and 1985-1987.

Harvest year	Quota (weight)	Catch (weight)	Mean weight (kg)	Catch (numbers)	Proportion North America origin	Catch of North American origin (numbers)	Catch of European origin (numbers)
1978	1,190	984	3.35	293.7	0.52[1]	152.7	141.0
1979	1,190	1,395	3.34	417.7	0.50[1]	208.8	208.8
1980	1,190	1,194	3.22	370.8	0.48[1]	178.0	192.8
1981	1,265	1,264	3.17	398.7	0.59[1]	235.3	163.5
1982	1,263	1,077	3.11	346.3	0.57	197.4	148.9
1983	1,190	310	3.10	100.0	0.40	40.0	60.0
1984	870	297	3.11	95.5	0.54	51.6	43.9
1985	852	864	2.87	301.0	0.47	141.5	159.6
1986	909	960	3.03	316.8	0.59	186.9	129.9
1987	935	966	3.16	305.7	0.59	180.4	125.3
x ± SD 1978-1982	1,220±41	1,183±160		365.4±48.8		194.4±31.2	171.0±29.0
x ± SD 1985-1987	899±42	930±57		307.8±8.1		169.6±24.6	138.2±18.6
% change	-26	-21		-16		-13	-19
t	10.670	2.568		1.981		1.167	1.727
p	<0.000	0.042		0.095		0.287	0.135

[1] Proportions from sample only; not weighted to catch.

Table 19 Nominal catches in the Faroese long-line fishery 1968-1987[a] officially reported (Tonnes round fresh weight).

Year	Catch	Season	Catch
1968	5		
1969	7		
1970	12		
1971	0		
1972	9		
1973	28		
1974	20		
1975	28		
1976	40		
1977	40		
1978	37		
1979	106		
1980	553		
1981	1025		
1982	865	81/82	796
1983	678	82/83	625
1984	628	83/84	651
1985	566	84/85	598
1986	530	85/86	545
1987[b]	510	86/87	520

[a]In some years part of the catch taken outside the EEZ of Faroes.

[b]Preliminary.

Table 20 Catch in number per unit effort (1000 hooks) by month in the Faroese longline fishery for salmon in the seasons 1982/83-1986/87.

Season	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	Mai.	Whole Season
82/83	83.9	133.7	73.2	48.5	46.0	39.1	34.1	46.9
83/84	75.1	81.0	78.6	52.5	38.9	23.1	31.5	51.3
84/85	41.7	34.6	30.7	35.0	37.4	41.5	37.0	35.8
85/86	54.7	57.2	65.0	45.3	63.1	73.0	95.6	58.4
86/87	36.9	44.2	33.3	62.2	83.5	101.2	74.2	63.9

Table 21 Numbers of tagged wild smolts released in North Esk in 1981-87 and numbers of recaptures in the Faroes salmon fishery

Year released	No. tagged	Year of recovery					Total no. of recaptures	Recaptures /1000 smolts tagged
		1983	1984	1985	1986	1987		
1981	10 367	18	4	1			23	2.2
1982	11 848	7	22	1			30	2.5
1983	1 456			1			1	0.7
1984	6 527				2	0	2	0.3
1985	6 210				1	3	4	0.6
1986	1 124							
1987	4 976							

Table 22 Recoveries of microtagged fish at Faroes 1986-87 season.

Country	No. tags	Age	Raising factor	Estimated Nos. in fishery	Number of tagged smolts	Number recovered per 1 000 tagged
1 Port sampling						
Ireland	2	2sw		5	220 000	0.02
Faroes	29	2sw	2.3	67	25 637	2.6
England& Wales	3	2sw		7	25 000(E)	0.28
Iceland	0		-	0	77 690	0
2. Discards						
Ireland	7	1sw		20	143 866	0.14
N. Ireland	4	1sw	2.9	12	21 847	0.50
England&Wales	3	1sw		9	25 000(E)	0.36
Iceland						

E = Estimates

Table 23 Estimated number of 1-sw and 2-sw salmon of the River Imsa stock available to the Norwegian Sea fishery and Norwegian home water fishery, and estimated exploitation rates. The number of salmon caught in the trap in River Imsa is considered to be the total river escapement. The estimates are based on 75% and 50% tag reporting rate in Norwegian Sea and Norwegian home waters respectively.

			1-SW					2-SW				
			Norw. Sea		Norw. home waters			Norw. Sea		Norw. home waters		
	Smolt type	No. tagged	No. of fish available	Expl. rate	No. of fish available	Expl. rate	No. in trap	No. of fish available	Expl. rate	No. of fish available	Expl. rate	No. in trap
Released 1981	R. Imsa wild	3214	776	0.00	555	0.88	66	177	0.25	127	0.93	9
	R. Imsa 2+	5819	757	0.01	586	0.80	114	125	0.38	74	0.92	6
Released 1982	R. Imsa wild	736	61	0.00	39	0.87	5	18	0.50	9	0.89	1
	R. Imsa 1+	5581	130	0.00	73	0.99	1	48	0.33	31	0.97	1
	R. Imsa 2+	8501	712	0.03	524	0.95	25	129	0.57	54	0.93	4
Released 1983	R. Imsa wild	1287	211	0.00	174	0.82	31	27	0.33	17	0.94	1
	R. Imsa 1+	5861	27	0.00	23	0.96	1	3	0.31	2	1.00	0
	R. Imsa 2+	6052	205	0.02	172	0.93	12	19	0.47	10	1.00	0
Released 1984	R. Imsa wild	936	150	0.00	113	0.73	30	29	0.38	17	0.82	3
	R. Imsa 1+	1863	40	0.00	21	0.76	5	16	0.19	12	0.83	2
	R. Imsa 2+	7445	413	0.04	335	0.86	48	43	0.40	25	0.96	1
Released 1985	R. Imsa wild	892	121	0.00	91	0.79	19	23	0.13	19	0.95	1
	R. Imsa 1+	9160	782	0.00	561	0.77	128	177	0.16	142	0.90	14
	R. Imsa 2+	1950	97	0.00	82	0.78	18	10	0.40	6	1.00	0
Released 1986	R. Imsa wild	477	19	0.00	18	0.56	8					
	R. Imsa 1+	10048	457	0.00	439	0.72	123					
	R. Imsa 2+	1976	69	0.01	65	0.89	7					

Table 24 Estimated number of 1-sw and 2-sw salmon of the River Imsa stock available to the Norwegian Sea fishery and Norwegian home water fishery, and estimated exploitation rates. The number of salmon caught in the trap in River Imsa is considered to be the total river escapement. The estimates are based on 75% and 70% tag reporting rate in Norwegian Sea and Norwegian home waters respectively.

			1-SW					2-SW				
			Norw. Sea		Norw. home waters			Norw. Sea		Norw. home waters		
	Smolt type	No. tagged	No. of fish available	Expl. rate	No. of fish available	Expl. rate	No. in trap	No. of fish available	Expl. rate	No. of fish available	Expl. rate	No. in trap
Released 1981	R. Imsa wild	3214	592	0.00	416	0.84	66	142	0.32	93	0.90	9
	R. Imsa 2+	5819	596	0.01	452	0.74	114	105	0.46	55	0.89	6
Released 1982	R. Imsa wild	736	48	0.00	29	0.83	5	16	0.56	7	0.86	1
	R. Imsa 1+	5581	98	0.00	52	0.98	1	39	0.41	22	0.95	1
	R. Imsa 2+	8501	549	0.04	382	0.93	25	115	0.63	40	0.90	4
Released 1983	R. Imsa wild	1287	163	0.00	133	0.76	31	22	0.41	12	0.92	1
	R. Imsa 1+	5861	20	0.00	17	0.94	1	2	0.50	1	1.00	0
	R. Imsa 2+	6052	154	0.03	126	0.90	12	16	0.56	7	1.00	0
Released 1984	R. Imsa wild	936	122	0.00	90	0.66	30	25	0.44	13	0.77	3
	R. Imsa 1+	1863	30	0.00	16	0.69	5	12	0.25	9	0.78	2
	R. Imsa 2+	7445	322	0.05	255	0.81	48	36	0.47	18	0.94	1
Released 1985	R. Imsa wild	892	93	0.00	70	0.73	19	18	0.17	14	0.93	1
	R. Imsa 1+	9160	645	0.00	438	0.70	128	138	0.21	105	0.87	14
	R. Imsa 2+	1950	77	0.00	64	0.72	18	8	0.50	4	1.00	0
Released 1986	R. Imsa wild	477	16	0.00	15	0.47	8					
	R. Imsa 1+	10048	363	0.00	349	0.64	123					
	R. Imsa 2+	1976	51	0.02	48	0.85	7					

Table 25 Estimated numbers of returning and spawning Atlantic salmon, egg depositions, ratios of MSW spawners to returns, and forecasts of MSW salmon to the Restigouche, Miramichi, Saint John and LaHave rivers.

Year	Returns 1SW	Returns MSW	Returns (predicted)	Spawners 1SW	Spawners MSW	Eggs (10^6)[1]	MSW spawners / MSW returns
Restigouche River							
1982	7,986	11,184		1,996	1,807	10.8	0.16
1983	3,355	10,230	(13,500)	627	1,448	8.6	0.14
1984	10,941	10,040	(11,300)	1,275	4,946	29.4	0.49
1985	6,987	13,486	(12,200)	2,462	9,128	54.4	0.68
1986	10,730	19,459	(14,800)	3,789	13,232	78.8	0.68
1987	10,475	11,309	(21,900)	3,548	7,138	42.5	0.63
Miramichi River							
1982	80,693	31,056		52,314	12,556	111.6	0.40
1983	25,412	28,191	(43,000)	11,077	7,725	49.7	0.27
1984	29,706	15,136	(10,200)	14,095	13,668	76.4	0.90
1985	46,417	24,323	(18,400)	23,432	22,707	127.5	0.93
1986	110,718	30,317	(28,400)	78,567	28,248	211.2	0.93
1987	97,130	13,453	(54,200)	75,266	11,319	155.7	0.84
Saint John River							
1982	14,309	11,772		8,400	4,800	33.6	0.41
1983	11,265	8,429		7,300	3,200	22.8	0.38
1984	13,022	14,722	(10,400)	9,400	11,500	78.2	0.78
1985	10,820	14,768	(15,500)	6,300	9,200	62.2	0.62
1986	16,468	11,260	(13,600)	11,900	7,600	52.9	0.67
1987	16,670	8,037	(18,000)	13,200	5,700	40.7	0.71
La Have River (Wild only)							
1983	3,406	567		3,287	379	5.6	0.67
1984	3,631	1,145	(688)	2,764	933	6.7	0.81
1985	3,290	1,830	(751)	2,430	1,654	11.6	0.90
1986	3,003	1,186	(1,326)	2,115	1,034	9.5	0.87
1987	6,301	1,174	(1,067)	4,518	1,028	14.2	0.88

[1] Egg depositions from both 1SW and MSW salmon of both hatchery and wild origin.

Table 26 Percentage of total commercial landings taken in Statistical Areas targeted to reduce interceptions by delaying the opening of the season and closure of J_2 under the 1984 Management Plan compared with those for non-target areas, for the years prior to and during the Plan.

Area	% of total catch				
	1978-82	1984	1985	1986	1987[1]
Non-target (A, B, C, K, L, M, N, O)	78.3	80.4	67.2	82.0	88.1
Target (D, E, F, G, H, I, J_1, J_2)	21.7	19.6	32.8	18.0	11.9
Total catch (t)	1,504	821	862	1,230	1,442

[1] 1987 figures are preliminary.

Table 27 Harvest by weight (tonnes) of 1SW (Year N) and MSW Atlantic salmon (Year N+1) by Canada for the years 1970-87.

Year N	1SW salmon (Year N)	MSW salmon (Year N+1)	MSW salmon (Year N+1) / 1SW salmon (Year N)
1969	-	1,562	-
1970	761	1,482	1.95
1971	510	1,201	2.36
1972	558	1,651	2.96
1973	783	1,589	2.03
1974	950	1,573	1.66
1975	912	1,721	1.89
1976	785	1,883	2.40
1977	662	1,225	1.85
1978	320	705	2.20
1979	582	1,763	3.03
1980	917	1,619	1.77
1981	818	1,082	1.32
1982	716	911	1.27
1983	513	645	1.26
1984	467	540	1.16
1985	593	779	1.31
1986	780	916[1]	1.17
1987	815[1]	-	-

[1]Preliminary.

$\bar{x}$ Ratio (1970-1982) = 2.05 $\pm$ 0.54

$\bar{x}$ Ratio (1983-1986) = 1.23 $\pm$ 0.07

$t = 3.001$

$P < 0.01$

Table 28 Harvest of Maine-origin 1SW Atlantic salmon in the Newfoundland-Labrador commercial salmon fishery before standard week 23 (4-10 June), subsequent to standard week 41 (8-14 October), and in Area J_2, 1967-86.

Year	Harvest before week 23	Prop.	Harvest after week 41	Prop.	Harvest in Area J_2	Prop.	Total
1967	0	0.000	142	0.556	0	0.000	255
1968	0	0.000	291	0.667	0	0.000	436
1969	0	0.000	98	0.333	0	0.000	295
1970	0	0.000	63	0.147	0	0.000	431
1971	0	0.000	153	0.483	0	0.000	317
1972	0	0.000	0	0.000	11	0.094	117
1973	0	0.000	33	0.139	0	0.000	240
1974	10	0.015	398	0.484	8	0.010	822
1975	12	0.012	335	0.313	0	0.000	1069
1976	35	0.015	175	0.071	0	0.000	2457
1977	0	0.000	71	0.070	0	0.000	1018
1978	0	0.000	0	0.000	0	0.000	341
1980	19	0.004	610	0.123	0	0.000	4970
1981	70	0.063	484	0.404	0	0.000	1199
1982	0	0.000	210	0.123	0	0.000	1712
1983	0	0.000	619	0.338	0	0.000	1830
1984	0	0.000	349	0.253	0	0.000	1382
1985	0	0.000	1471	0.627	0	0.000	2347
1986	0	0.000	0	0.000	0	0.000	549
Average		0.006	(1967-84)	0.285	(1967-85)	0.006	(1967-83)
Std. Dev.		0.015		0.209		0.023	

Table 29

Numbers of fishermen and gear units (1 unit = 50 fathoms or 91.5 m) licensed in the Atlantic salmon fishery, Newfoundland and Labrador, 1974-87.

Area	1974		1975		1976		1977		1978		1979		1980	
	Fishermen	Gear units	Fishermen	Gear units	Fishermen	Gear units	Fishermen	Gear units	Fishermen	Gear units	Fishermen	Gear units	Fishermen	Gear units
A	651	2,430	769	2,818	696	2,639	655	2,473	664	2,516	663	2,515	651	2,480
B	1,203	3,151	1,399	3,962	1,234	3,547	1,154	3,327	1,148	3,371	1,148	3,349	1,163	3,485
C	693	2,014	765	2,565	685	2,354	622	2,163	621	2,172	617	2,169	591	2,320
D	519	1,589	596	2,074	525	2,074	469	1,876	473	1,901	457	1,853	446	1,834
E	513	1,861	635	2,567	518	2,276	446	1,973	459	2,066	445	1,971	449	2,024
F	320	1,608	314	1,875	308	1,823	264	1,582	261	1,588	266	1,617	246	1,536
G	135	407	103	432	103	347	86	292	87	287	85	283	81	268
H	331	1,031	388	1,330	335	1,207	303	1,063	284	1,069	296	1,051	279	1,003
I	217	586	226	594	194	577	188	554	186	576	186	588	182	593
J_1	97	422	176	910	160	800	146	734	140	722	135	691	129	675
J_2	176	862	217	1,064	193	1,023	178	959	176	939	173	928	165	881
J	273	1,284	393	1,974	353	1,823	324	1,691	316	1,661	308	1,619	294	1,556
K	143	389	181	574	157	501	142	467	139	456	140	455	130	426
L	88	198	140	412	111	301	97	270	100	264	93	247	95	254
M	127	231	185	411	157	350	144	322	141	288	138	312	137	314
N	99	277	158	439	130	372	112	314	118	344	116	345	109	324
Insular	5,312	17,055	6,252	22,027	5,506	20,191	5,006	18,367	4,997	18,559	4,958	18,374	4,853	18,417
50	137	554	121	434	119	503	122	543	125	557	128	572	116	526
51	223	1,499	238	1,493	248	1,595	201	1,344	232	1,492	241	1,565	222	1,501
52	100	401	183	671	216	823	231	909	171	675	169	679	130	457
53	108	288	187	556	179	549	196	612	290	1,001	272	979	271	1,018
O	568	2,742	729	3,154	781	3,558	750	3,408	818	3,725	810	3,795	739	3,502
Provincial	5,880	19,797	6,981	25,181	6,287	23,749	5,756	21,775	5,815	22,284	5,768	22,169	5,592	21,918

Area	1981		1982		1983		1984		1985		1986		1987	
	Fishermen	Gear units	Fishermen	Gear units	Fishermen	Gear units	Fishermen	Gear units	Fishermen	Gear units	Fishermen	Gear units	Fishermen	Gear units
A	636	2,411	605	2,198	614	2,457	541	2,002	461	1,838	461	1,844	459	1,834
B	1,126	3,390	1,047	3,002	1,033	3,729	892	3,124	695	2,768	696	2,782	691	2,756
C	550	1,944	493	1,551	479	1,661	395	1,341	283	1,122	281	1,124	275	1,100
D	412	1,709	394	1,536	383	1,499	317	1,160	259	1,036	257	1,028	254	1,014
E	429	1,954	375	1,548	356	1,402	277	1,012	229	914	231	922	230	916
F	246	1,524	239	1,395	239	1,089	200	774	186	744	183	732	176	704
G	75	252	71	222	68	235	58	201	45	178	45	180	43	172
H	269	979	255	837	250	934	201	718	162	644	164	656	164	656
I	179	598	159	472	149	570	128	472	109	432	109	436	107	428
J_1	126	656	120	625	114	499	85	314	73	290	76	304	75	300
J_2	162	871	159	736	153	644	7	26	-	-	-	-	-	-
J	288	1,528	279	1,361	267	1,143	92	340	73	290	76	304	75	300
K	124	403	117	338	113	416	87	317	73	292	72	288	71	288
L	94	253	86	196	82	258	66	196	30	120	46	174	46	174
M	134	309	128	285	122	455	95	360	83	332	84	336	84	336
N	109	328	105	308	107	425	100	378	91	364	95	380	95	380
Insular	4,671	17,582	4,353	15,249	4,262	16,273	3,449	12,395	2779	11,074	2,800	11,186	2,770	11,058
50	115	521	115	506	111	473	101	385	89	356	79	316	62	248
51	220	1,470	201	1,309	278	1,307	253	980	231	924	241	964	249	1,026
52	130	478	138	519	139	572	125	491	120	478	115	460	113	449
53	266	981	262	1,046	273	1,080	248	992	234	936	212	848	213	852
O	731	3,450	716	3,380	801	3,432	727	2,848	674	2,694	647	2,588	637	2,575
Provincial	5,402	21,032	5,069	18,629	5,063	19,705	4,176	15,243	3,453	13,768	3,447	13,774	3,407	13,633

Table 30 The ratio of the Newfoundland-Labrador harvest of 1SW Atlantic salmon of Maine origin to the run size in Maine of 2SW Atlantic salmon in the following year for 1967-86.

YEAR (YEAR i)	HARVEST (YEAR i)	RUN (YEAR i+1)	RATIO (HARVEST/RUN)
1967	255	664	0.384
1968	436	634	0.689
1969	295	787	0.374
1970	431	637	0.676
1971	317	1328	0.238
1972	117	1378	0.085
1973	240	1306	0.183
1974	822	2183	0.377
1975	1069	1222	0.875
1976	2457	1920	1.280
1977	1018	3853	0.264
1978	341	1773	0.192
1979		5225	
1980	4970	4725	1.052
1981	1199	5440	0.220
1982	1712	1773	0.965
1983	1830	2793	0.655
1984	1382	4319	0.320
1985	2347	4892	0.480
1986	549	2107	0.260

$\bar{x}$ Ratio (1967-1983) = 0.532 ± 0.361

$\bar{x}$ Ratio (1984-1986) = 0.353 ± 0.114

Table 31 Estimated Carlin tag recoveries and run size in Maine waters. Ratio = tags to run size of 2SW salmon in homewaters. Ratio (year i) for use in estimation of distant water harvest (year i-1).

YEAR	TAGS	RUN	RATIO
1967	0.0	946.0	0.000000
1968	145.3	663.6	0.219013
1969	6.2	633.5	0.009822
1970	11.4	787.2	0.014538
1971	58.0	637.3	0.091016
1972	271.6	1327.6	0.204553
1973	175.6	1377.8	0.127417
1974	182.6	1305.8	0.139803
1975	384.9	2182.6	0.176341
1976	159.2	1221.7	0.130326
1977	83.3	1919.6	0.043412
1978	82.9	3852.6	0.021515
1979	30.6	1773.1	0.017233
1980	0.0	5225.0	0.000000
1981	403.0	4724.5	0.085300
1982	244.2	5439.7	0.044896
1983	118.6	1773.3	0.066856
1984	52.3	2792.6	0.018740
1985	158.2	4319.0	0.036634
1986	263.3	4891.8	0.053831
1987	101.8	2106.5	0.048315

Table 32 Estimated number of 1SW salmon of Maine origin harvested in Newfoundland-Labrador by year, standard week (STWK 99 = week unknown), and Statistical Area. OTH = Statistical Areas E to N. PTOT = total with UNK (unknown) assigned to weeks. (Estimates rounded to nearest fish.)

1967

STWK	A	B	C	D	OTH	O	UNK	TOT	PTOT
26	7	7	0	0	7	0	0	20	25
27	0	7	0	0	7	0	0	13	17
28	13	13	0	0	0	0	0	26	33
29	7	7	0	0	7	5	0	25	32
30	0	0	0	0	0	5	0	5	6
45	0	7	0	0	0	0	0	7	8
46	0	7	0	0	7	0	0	13	17
47	0	7	7	0	0	0	0	13	17
48	0	13	0	0	0	0	0	13	17
49	0	20	13	0	7	0	0	39	50
50	13	0	7	0	0	0	0	20	25
51	7	0	0	0	0	0	0	7	8
99	0	7	7	0	20	10	13	56	
TOT	46	91	33	0	52	20	13	255	255

1968

STWK	A	B	C	D	OTH	O	UNK	TOT	PTOT
27	0	0	145	0	0	0	0	145	
46	0	291	0	0	0	0	0	291	
TOT	0	291	145	0	0	0	0	436	

1969

STWK	A	B	C	D	OTH	O	UNK	TOT	PTOT
28	0	0	0	0	98	0	0	98	
31	98	0	0	0	0	0	0	98	
44	98	0	0	0	0	0	0	98	
TOT	197	0	0	0	98	0	0	295	

(cont'd)

Table 32 (continued)

1970

STWK	A	B	C	D	OTH	O	UNK	TOT	PTOT
26	0	0	0	0	16	0	0	16	17
27	63	31	0	0	0	0	0	94	101
28	63	0	0	0	0	0	0	63	67
29	31	16	0	16	0	0	0	63	67
30	31	16	0	0	0	12	0	59	63
31	0	0	0	0	0	24	0	24	26
32	0	0	0	0	0	12	0	12	13
35	0	0	0	0	0	12	0	12	13
44	0	16	16	0	0	0	0	31	34
49	0	0	0	0	16	0	0	16	17
52	0	0	0	0	0	12	0	12	13
99	16	0	0	0	0	12	0	28	
TOT	204	78	16	16	31	85	0	431	431

1971

STWK	A	B	C	D	OTH	O	UNK	TOT	PTOT
23	0	0	7	7	0	0	0	14	15
25	0	0	0	14	0	0	0	14	15
27	7	28	7	0	0	5	0	47	49
28	7	7	0	0	0	0	0	14	15
29	14	0	0	0	0	0	0	14	15
30	0	0	0	0	0	11	0	11	11
33	0	0	0	0	0	5	0	5	6
34	0	0	0	0	0	5	0	5	6
35	0	0	0	0	0	5	0	5	6
36	0	0	0	0	0	16	0	16	17
38	0	0	0	0	0	5	0	5	6
39	0	0	0	0	0	5	0	5	6
43	0	7	0	0	0	0	0	7	7
44	0	14	0	0	0	0	0	14	15
45	0	14	7	0	0	0	0	21	22
46	0	0	7	0	0	0	0	7	7
47	0	21	14	0	0	0	0	35	36
48	0	21	14	0	0	0	0	35	36
49	0	0	14	0	0	0	0	14	15
50	0	14	0	0	0	0	0	14	15
99	0	0	0	0	7	5	0	12	
TOT	28	126	70	21	7	65	0	317	317

(cont'd)

Table 32 (continued)

1972

STWK	A	B	C	D	OTH	O	UNK	TOT	PTOT
29	0	0	0	0	11	0	0	11	16
33	0	0	0	0	0	9	0	9	12
35	0	0	11	0	0	0	0	11	16
36	0	0	0	0	0	17	0	17	24
37	0	0	0	0	0	26	0	26	37
38	0	0	0	0	0	9	0	9	12
99	0	0	34	0	0	0	0	34	
TOT	0	0	45	0	11	61	0	117	117

1973

STWK	A	B	C	D	OTH	O	UNK	TOT	PTOT
23	10	0	10	0	20	0	0	41	44
24	0	20	0	0	20	0	0	41	44
25	0	0	0	10	0	8	0	18	20
27	10	0	0	0	10	0	0	20	22
28	20	0	0	0	10	0	0	31	33
30	0	0	0	0	0	8	0	8	9
31	0	0	0	0	0	8	0	8	9
33	0	0	0	0	0	16	0	16	17
39	0	0	0	0	0	8	0	8	9
44	0	10	0	0	0	0	0	10	11
48	10	10	0	0	0	0	0	20	22
99	10	0	0	0	0	8	0	18	
TOT	61	41	10	10	61	56	0	240	240

(cont'd)

Table 32 (continued)

1974

STWK	A	B	C	D	OTH	O	UNK	TOT	PTOT
21	0	0	0	0	8	0	0	8	10
23	0	0	0	0	16	0	0	16	20
24	0	0	0	8	8	0	0	16	20
25	0	0	0	8	8	0	0	16	20
26	0	0	0	0	24	0	0	24	30
27	8	0	16	8	32	6	0	71	87
28	41	8	8	8	8	0	0	73	89
29	24	16	0	8	0	13	0	61	75
30	8	8	0	0	8	6	0	31	38
32	0	8	0	0	0	0	0	8	10
33	0	0	0	0	0	6	0	6	8
36	0	0	0	0	0	6	0	6	8
38	0	0	8	0	0	0	0	8	10
42	8	8	0	0	0	0	0	16	20
43	0	0	8	0	0	0	0	8	10
44	8	24	0	0	0	0	0	32	40
45	0	24	0	0	0	0	0	24	30
46	0	41	0	0	0	0	0	41	50
47	8	32	16	0	0	0	0	57	70
48	16	24	0	0	0	0	0	41	50
49	0	24	16	0	0	0	0	41	50
50	0	24	16	0	0	0	0	41	50
51	0	8	8	0	0	0	0	16	20
52	0	8	0	0	0	0	0	8	10
99	41	49	8	41	8	6	0	152	
TOT	162	308	105	81	122	44	0	822	822

(cont'd)

Table 32 (continued)

1975

STWK	A	B	C	D	OTH	O	UNK	TOT	PTOT
21	0	0	11	0	0	0	0	11	12
23	0	11	0	0	11	0	0	22	23
24	0	0	22	22	0	0	0	44	46
25	0	0	0	0	11	0	0	11	12
26	0	33	11	0	11	0	0	55	58
27	44	22	11	0	22	9	0	107	113
28	44	22	0	11	22	9	0	107	113
29	22	33	0	11	11	17	0	94	99
30	22	33	11	0	0	17	0	83	87
31	0	0	0	11	0	26	0	37	38
32	11	0	0	11	0	9	0	30	32
33	0	11	0	0	0	9	0	19	20
34	0	0	0	0	0	9	0	9	9
35	0	0	0	0	0	17	0	17	18
36	0	0	0	0	0	26	0	26	27
37	0	0	0	0	0	9	0	9	9
38	0	0	0	0	0	9	0	9	9
40	0	0	11	0	0	0	0	11	12
42	0	22	0	0	0	0	0	22	23
43	0	22	0	0	0	0	0	22	23
44	11	44	0	0	0	0	0	55	58
45	0	33	11	0	0	0	0	44	46
46	33	33	0	0	0	0	0	66	69
47	0	22	0	0	0	0	0	22	23
48	0	44	22	0	0	0	0	66	69
49	0	0	11	0	0	0	0	11	12
50	0	0	11	0	0	0	0	11	12
99	11	11	11	0	11	9	0	52	
TOT	197	395	143	66	99	171	0	1069	1069

(cont'd)

Table 32 (continued)

1976

STWK	A	B	C	D	OTH	O	UNK	TOT	PTOT
22	0	0	33	0	0	0	0	33	35
23	0	33	0	0	33	0	0	66	70
24	0	0	0	0	33	0	0	33	35
25	33	0	0	0	0	0	0	33	35
26	132	33	33	33	33	26	0	289	308
27	165	33	33	33	33	0	0	296	315
28	99	0	33	33	33	102	0	300	319
29	165	66	0	0	0	26	0	256	273
30	132	0	33	0	0	102	0	267	284
31	66	66	0	66	0	128	0	325	347
32	0	0	0	0	0	77	0	77	82
33	33	33	0	0	0	51	0	117	125
36	0	0	0	0	0	26	0	26	27
38	0	0	0	0	0	26	0	26	27
44	0	33	0	0	0	0	0	33	35
45	0	66	0	0	0	0	0	66	70
46	33	0	0	0	0	0	0	33	35
47	0	33	0	0	0	0	0	33	35
99	33	66	0	0	0	51	0	150	
TOT	888	461	165	165	165	614	0	2457	2457

1977

STWK	A	B	C	D	OTH	O	UNK	TOT	PTOT
25	66	66	0	0	66	0	0	199	213
26	0	0	0	0	66	0	0	66	71
27	133	66	0	0	0	0	0	199	213
28	199	66	0	0	0	52	0	317	339
34	0	0	0	0	0	52	0	52	55
36	0	0	0	0	0	52	0	52	55
48	0	66	0	0	0	0	0	66	71
99	0	66	0	0	0	0	0	66	
TOT	398	332	0	0	133	155	0	1018	1018

1978

STWK	A	B	C	D	OTH	O	UNK	TOT	PTOT
28	83	0	0	0	0	0	0	83	
32	0	0	0	0	0	64	0	64	
33	0	0	0	0	0	64	0	64	
36	0	0	0	0	0	64	0	64	
37	0	0	0	0	0	64	0	64	
TOT	83	0	0	0	0	258	0	341	

(cont'd)

Table 32 (continued)

1980

STWK	A	B	C	D	OTH	O	UNK	TOT	PTOT
20	0	0	0	17	0	0	0	17	19
23	0	33	0	0	0	0	0	33	37
24	17	67	0	0	17	13	0	114	126
25	167	67	17	17	17	26	0	311	345
26	318	33	17	17	33	13	0	432	479
27	452	167	33	17	100	143	0	914	1014
28	402	151	84	17	117	78	0	849	942
29	151	33	17	0	17	91	0	309	343
30	117	50	0	0	33	117	0	318	353
31	33	17	0	0	0	65	0	115	128
32	0	0	0	0	0	143	0	143	159
33	17	17	0	0	0	78	0	112	124
34	17	0	0	0	0	117	0	134	149
35	0	17	0	0	0	13	0	30	33
36	0	0	0	0	0	13	0	13	14
37	0	17	0	0	0	13	0	30	33
38	0	17	0	0	0	26	0	43	48
39	0	0	0	0	0	13	0	13	14
42	0	0	0	17	0	0	0	17	19
43	0	17	0	0	0	13	0	30	33
44	17	100	0	0	0	0	0	117	130
45	0	17	17	0	0	0	0	33	37
46	17	100	33	0	0	0	0	151	167
47	17	0	0	0	0	0	0	17	19
49	0	84	33	0	0	0	0	117	130
50	0	33	17	0	0	0	0	50	56
51	0	0	17	0	0	0	0	17	19
99	134	167	84	0	0	91	17	493	
TOT	1876	1206	368	100	335	1068	17	4970	4970

(cont'd)

Table 32 (continued)

1981

STWK	A	B	C	D	OTH	O	UNK	TOT	PTOT
21	0	0	0	0	32	0	0	32	35
22	0	0	0	32	0	0	0	32	35
23	0	0	0	32	0	0	0	32	35
25	0	0	32	0	0	0	0	32	35
26	64	0	0	0	0	0	0	64	69
27	0	0	0	0	0	25	0	25	27
28	0	32	0	0	0	0	0	32	35
30	0	0	0	64	0	25	0	88	96
31	0	0	0	0	0	25	0	25	27
32	0	0	0	0	0	74	0	74	81
33	0	0	0	0	0	49	0	49	54
34	0	0	0	0	0	99	0	99	108
35	0	0	0	0	0	49	0	49	54
37	0	0	0	0	0	25	0	25	27
42	0	32	32	0	0	0	0	64	69
44	0	95	32	0	0	0	0	127	138
45	0	32	32	32	0	0	0	95	104
46	0	0	64	0	0	0	0	64	69
48	0	32	32	0	0	0	0	64	69
49	0	32	0	0	0	0	0	32	35
99	0	64	0	0	32	0	0	95	
TOT	64	318	223	159	64	371	0	1199	1199

1982

STWK	A	B	C	D	OTH	O	UNK	TOT	PTOT
24	21	0	0	0	0	0	0	21	23
25	21	21	43	43	0	0	0	128	140
26	43	21	0	43	21	0	0	128	140
27	85	43	43	0	107	0	0	278	303
28	64	64	21	0	64	33	0	247	270
29	0	64	0	21	0	33	0	119	130
30	43	85	0	0	0	0	0	128	140
31	21	0	21	0	0	50	0	93	101
32	0	0	0	0	0	116	0	116	127
33	0	0	0	0	0	50	0	50	54
35	0	0	0	0	0	33	0	33	36
36	0	0	0	0	0	17	0	17	18
38	0	0	0	0	0	17	0	17	18
42	43	21	0	0	0	0	0	64	70
44	0	21	0	0	0	0	0	21	23
46	21	0	21	0	0	0	0	43	47
47	21	43	0	0	0	0	0	64	70
99	43	64	0	21	0	17	0	145	
TOT	427	449	150	128	192	366	0	1712	1712

(cont'd)

Table 32 (continued)

1983

STWK	A	B	C	D	OTH	O	UNK	TOT	PTOT
26	76	152	0	0	0	0	0	229	239
27	152	0	0	0	0	0	0	152	159
28	76	76	0	0	0	0	0	152	159
29	76	0	0	0	0	0	0	76	80
30	76	0	0	0	0	59	0	136	141
31	0	0	0	0	0	59	0	59	62
32	0	0	0	0	0	178	0	178	186
33	0	0	0	0	0	59	0	59	62
34	0	0	0	0	0	119	0	119	124
42	76	0	0	0	0	0	0	76	80
43	76	0	0	0	0	0	0	76	80
45	0	76	0	0	0	0	0	76	80
46	76	152	0	0	0	0	0	229	239
48	76	0	0	0	0	0	0	76	80
49	0	0	0	0	0	59	0	59	62
99	76	0	0	0	0	0	0	76	
TOT	839	457	0	0	0	534	0	1830	1830

1984

STWK	A	B	C	D	OTH	O	UNK	TOT	PTOT
26	0	0	0	39	39	0	0	78	87
27	39	0	0	0	0	0	0	39	44
28	0	0	39	0	39	30	0	108	121
29	0	39	39	39	0	0	0	117	131
30	39	0	0	0	0	30	0	69	78
31	39	0	0	0	0	0	0	39	44
32	0	0	39	0	0	30	0	69	78
33	0	0	0	0	0	30	0	30	34
34	0	0	0	0	0	182	0	182	204
35	0	0	0	0	0	91	0	91	102
36	0	0	0	0	0	61	0	61	68
41	0	39	0	0	0	0	0	39	44
42	39	0	0	0	0	0	0	39	44
44	0	39	0	0	0	0	0	39	44
45	0	78	0	0	0	0	0	78	87
46	78	0	0	0	0	0	0	78	87
48	0	39	0	0	0	0	0	39	44
49	0	39	0	0	0	0	0	39	44
99	39	0	39	0	39	30	0	147	
TOT	273	273	156	78	117	485	0	1382	1382

(cont'd)

Table 32 (continued)

1985

STWK	A	B	C	D	OTH	O	UNK	TOT	PTOT
24	0	0	0	0	27	0	0	27	30
27	0	0	0	0	27	0	0	27	30
28	0	27	27	0	0	0	0	53	59
29	0	53	0	0	0	0	0	53	59
30	0	0	0	0	0	62	27	88	98
31	0	0	0	27	0	0	0	27	30
32	0	0	0	0	0	144	0	144	161
33	27	0	0	0	0	21	0	47	53
34	0	0	0	0	0	41	0	41	46
35	0	0	0	0	0	41	0	41	46
36	0	0	0	0	0	21	0	21	23
37	0	0	0	0	0	41	0	41	46
38	0	0	0	0	0	41	0	41	46
39	0	0	0	0	0	62	0	62	69
40	0	0	0	0	0	21	0	21	23
41	53	0	0	0	0	0	0	53	59
42	27	0	53	0	0	0	0	80	89
43	27	27	27	0	0	21	0	100	112
44	133	80	80	0	27	0	0	318	355
45	80	239	80	0	53	0	0	451	502
46	27	106	0	0	0	0	0	133	148
47	0	159	0	0	0	0	0	159	177
48	0	53	0	0	0	0	0	53	59
49	0	27	0	0	0	0	0	27	30
99	27	186	27	0	0	0	0	239	
TOT	398	955	292	27	133	516	27	2347	2347

1986

STWK	A	B	C	D	OTH	O	UNK	TOT	PTOT
24	30	0	30	0	0	0	0	59	63
27	30	0	0	0	0	0	0	30	31
28	0	30	0	0	30	23	0	82	87
29	59	30	0	0	0	0	0	89	94
30	0	0	0	0	0	69	0	69	73
31	0	0	0	0	0	46	0	46	49
32	0	0	0	0	0	46	0	46	49
33	0	0	0	0	0	23	0	23	24
34	30	0	0	0	0	23	0	53	56
38	0	0	0	0	0	23	0	23	24
99	30	0	0	0	0	0	0	30	
TOT	177	59	30	0	30	253	0	549	549

Table 33 Estimated number of 1SW salmon of Maine origin harvested in Newfoundland-Labrador by year and Statistical Area. OTH = Statistical Areas E to N.

YEAR	A	B	C	D	OTH	O	UNK	TOT
1967	46	91	33	0	52	20	13	255
1968	0	291	145	0	0	0	0	436
1969	197	0	0	0	98	0	0	295
1970	204	78	16	16	31	85	0	431
1971	28	126	70	21	7	65	0	317
1972	0	0	45	0	11	61	0	117
1973	61	41	10	10	61	56	0	240
1974	162	308	105	81	122	44	0	822
1975	197	395	142	66	99	171	0	1069
1976	888	461	165	165	165	614	0	2457
1977	398	332	0	0	133	155	0	1018
1978	83	0	0	0	0	258	0	341
1980	1876	1206	368	100	335	1068	17	4970
1981	64	318	223	159	64	371	0	1199
1982	427	449	150	128	192	366	0	1712
1983	839	457	0	0	0	534	0	1830
1984	273	273	156	78	117	485	0	1382
1985	398	955	292	27	133	516	27	2347
1986	177	59	30	0	30	253	0	549
TOT	6318	5840	1949	851	1649	5122	56	21785

Table 34 Comparison of annual estimates of harvest in Newfoundland-Labrador fisheries

HARVEST YEAR	PREVIOUS ESTIMATE	NEW ESTIMATE	PERCENT CHANGE
1967	240	255	6.3
1968	436	436	0.0
1969	327	295	-9.8
1970	431	431	0.0
1971	295	317	7.5
1972	117	117	0.0
1973	200	240	20.0
1974	830	822	-1.0
1975	1075	1069	-0.6
1976	2518	2457	-2.4
1977	1031	1018	-1.3
1978	330	341	3.3
1980	4956	4970	0.3
1981	1172	1199	2.3
1982	1712	1712	0.0
1983	1826	1830	0.2
1984	1382	1382	0.0
1985	2305	2347	1.8
TOTAL	21183	21238	0.3

Table 35 Tag returns of 1SW salmon of USA origin in provinces of Quebec, Nova Scotia, and New Brunswick by Statistical Area, 1967-87.

Recap.	Number of recoveries by Statistical Area[1]							Year
year	23	48	57	59	65	82	99	total
1967	0	2	0	1	0	0	1	4
1968	0	4	1	0	0	0	0	5
1969	0	1	0	1	0	0	0	2
1970	0	1	0	1	0	0	0	2
1971	0	2	0	1	0	0	0	3
1973	1	0	0	0	0	0	0	1
1974	2	1	0	0	1	0	0	4
1975	1	1	0	0	0	0	0	2
1976	5	5	0	2	1	0	0	13
1977	0	1	0	0	0	0	0	1
1978	1	0	0	0	0	0	0	1
1980	1	2	0	5	0	3	0	11
1981	0	0	0	1	0	0	0	1
1982	3	0	1	0	0	0	0	4
1983	0	0	0	1	0	0	0	1
1984	0	0	0	1	0	0	0	1
1987	0	0	0	0	0	1	0	1
Total	14	20	2	14	2	4	1	57

[1]Statistical Area 23 - Bay of Fundy, N.B.
48 - Bay of Fundy, N.S.
57 - Eastern Shore, N.S.
59 - Southwest Shore, N.S.
65 - Cape Breton east, N.S.
82 - North Shore, P.Q.
99 - unknown Canada

Table 36 Tag returns of MSW salmon of USA origin in the provinces of Quebec, Nova Scotia, and New Brunswick by Statistical Area, 1963-87.

Recap. year	Number of recoveries by Statistical Area[1] 23	32	48	57	59	65	66	82	Year total
1963	0	0	2	0	1	0	0	0	3
1965	0	0	0	0	2	0	0	0	2
1966	0	0	1	0	0	0	0	0	1
1967	0	0	0	1	3	1	0	0	5
1968	2	0	20	0	6	0	0	0	28
1969	0	0	1	0	1	0	1	0	3
1970	0	0	1	0	1	0	0	0	2
1971	0	0	1	0	0	0	0	0	1
1972	4	1	2	1	3	0	0	0	11
1973	1	0	0	0	0	0	0	1	2
1974	3	0	1	0	1	0	0	0	5
1975	2	0	1	0	1	0	0	0	4
1976	0	0	0	0	0	0	0	1	1
1977	2	0	0	0	0	0	0	0	2
1978	1	0	0	1	2	0	0	0	4
1979	0	0	1	0	1	0	0	0	2
1980	1	0	0	1	0	0	0	0	2
1982	5	0	0	0	0	0	0	0	5
1983	1	0	0	0	0	0	0	0	1
Total	22	1	31	4	22	1	1	2	84

[1] Statistical Area 23 - Bay of Fundy, N.B.
32 - Gulf Coast, N.B.
48 - Bay of Fundy, N.S.
57 - Eastern Shore, N.S.
59 - Southwest Shore, N.S.
65 - Cape Breton east, N.S.
66 - Cape Breton Gulf, N.S.
82 - North Shore, P.Q.

Table 37 Tag recoveries of MSW salmon of USA origin from Newfoundland-Labrador commercial fisheries by Statistical Area, 1963-87.

Recap. year	Statistical Area of recapture							Year total
	A	B	C	D	E-N	O	Unknown	
1963	0	0	0	0	5	0	0	5
1964	0	0	0	0	2	0	1	3
1965	0	2	0	0	3	0	0	5
1966	0	0	2	0	5	0	0	7
1967	2	5	2	0	13	0	0	22
1968	3	7	2	1	25	0	0	38
1969	0	2	0	0	7	0	0	9
1970	1	0	0	0	3	2	0	6
1971	2	3	1	3	6	3	0	18
1972	0	2	0	0	3	1	0	6
1973	3	2	2	0	12	2	0	21
1974	2	1	0	0	9	0	0	12
1975	1	1	2	4	6	4	0	18
1976	0	1	2	0	10	1	0	14
1977	1	1	0	1	3	1	0	7
1978	1	0	0	0	2	2	0	5
1979	2	0	0	0	20	2	0	24
1980	1	0	0	0	7	1	0	9
1981	2	4	1	0	15	6	0	28
1982	1	4	0	0	12	2	0	19
1983	0	3	0	0	5	2	0	10
1984	1	0	0	0	0	0	0	1
1985	0	0	0	0	2	2	0	4
1986	0	1	0	0	0	2	0	3
1987	1	1	0	0	0	0	0	2
Total	24	40	14	9	175	33	1	296

Table 38. Average percent by number of Maine-origin salmon in the total harvest of Newfoundland-Labrador commercial fishery.

	A		B		C		D		E-N		O		TOTAL	
	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE
STANDARDIZED WEEK														
23	0.00	0.00	0.31	0.19	0.00	0.00	0.12	0.12	0.02	0.01	0.00	0.00	0.05	0.02
24	0.10	0.06	0.08	0.08	0.10	0.08	0.04	0.03	0.05	0.03	0.02	0.02	0.08	0.03
25	0.12	0.06	0.12	0.07	0.16	0.09	0.25	0.19	0.04	0.03	0.01	0.01	0.10	0.04
26	0.19	0.09	0.25	0.17	0.21	0.17	0.66	0.34	0.08	0.03	0.01	0.01	0.13	0.04
27	0.42	0.15	0.21	0.10	0.41	0.19	0.18	0.14	0.12	0.05	0.04	0.03	0.18	0.06
28	0.67	0.31	0.49	0.16	0.82	0.38	0.31	0.22	0.24	0.11	0.07	0.02	0.26	0.07
29	0.77	0.42	0.49	0.17	0.43	0.32	0.36	0.20	0.05	0.04	0.05	0.03	0.20	0.06
30	1.70	0.61	0.29	0.16	0.52	0.46	0.92	0.92	0.10	0.09	0.28	0.08	0.35	0.01
31	2.38	1.15	0.32	0.24	0.41	0.41	0.80	0.48	0.00	0.00	0.33	0.11	0.37	0.12
32	0.17	0.17	0.06	0.06	1.25	1.25	0.73	0.73	0.00	0.00	1.24	0.32	1.01	0.23
33	2.42	1.43	0.83	0.54	0.00	0.00	0.00	0.00	0.00	0.00	1.06	0.20	0.89	0.18
34	1.94	1.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.29	0.68	1.64	0.49
35	0.00	0.00	0.36	0.36	0.00	0.00	0.00	0.00	0.00	0.00	1.65	0.63	1.06	0.38
36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.88	0.88	2.54	0.78
37	0.00	0.00	0.52	0.52	0.00	0.00	0.00	0.00	0.00	0.00	2.56	1.31	2.19	1.06
38	0.00	0.00	1.18	1.18	67.51	67.51	0.00	0.00	0.00	0.00	2.54	0.90	2.48	0.90
39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.43	1.07	1.05	0.80
40	0.00	0.00	0.00	0.00	4.15	4.15	0.00	0.00	0.00	0.00	0.31	0.31	0.89	0.75
41	1.64	1.64	6.25	6.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.55	2.05
TOTAL	0.38	0.11	0.28	0.07	0.29	0.09	0.31	0.11	0.07	0.02	0.27	0.06	0.34	0.22

Table 39 Characterization of accessible Atlantic salmon riverine rearing habitat in North America; areas listed in each column are subsets of the areas in the preceeding column.

Geographic area	Accessible riverine habitat (km^2)	Vulnerable to acidification[1] (km^2)	Habitat lost to acidification[2] (km^2)
	CANADA		
Newfoundland-Labrador	211.1	60.3	0.0
Quebec	562.3	30.0	0.0
New Brunswick	134.9	0.0	0.0
Prince Edward Is.	2.8	0.0	0.0
Nova Scotia	38.7	16.5	6.0
Subtotal	949.8	106.8	6.0[3]
	USA		
Maine	13.8	1.1	0.0
Connecticut R.	3.9	0.0	0.0
Merrimack R.	1.6	0.0	0.0
Pawcatuck R.	0.4	0.0	0.0
Subtotal	19.7	1.1	0.0
Total habitat	969.5	107.9	6.0

[1] Estimated vulnerable habitat in km^2 where vulnerability is assessed as alkalinity <50 μeq/l.
[2] Where pH <5.0 and juvenile salmonids absent.
[3] Rivers draining watersheds of 18 km^2 or less were excluded (equivalent to 1 km^2 vulnerable habitat).

Table 40 Harvest countries by country of origin for 1987, based on physical evidence.

	Denmark	Eng + Wales	France	Ireland	N. Ireland	Portugal*	Scotland	Spain*	Iceland*	Finland	Norway	Sweden	USSR	Canada	USA	Faroes*	Greenland*
Denmark	■										■	■					
Eng + Wales		■		■	■		■										
France			■														
Ireland		■		■	■		■				■	■					
N. Ireland		■		■	■		■										
Portugal						■											
Scotland		■					■				■	■					
Spain								■									
Iceland									■								
Finland										■							
Norway							■			■	■	■	■				
Sweden											■	■					
USSR													■				
Canada														■	■		
USA															■		
Faroes		■	■	■	■		■				■	■	■			■	
Greenland		■	■	■	■		■				■	■		■	■		■

*No information presented at WG meeting concerning harvest in other than country of origin.

■ Indicates presence; abundance not inserted.

Table 41 Nominal catch in tonnes of Atlantic salmon of all ages for Statistical Areas of Newfoundland-Labrador and Quebec North Shore commercial fisheries in 1986 and 1987. Figures for 1987 are preliminary.

Statistical Area	1986	1987
Nfld. & Lab		
A	195.2	371.2
B	200.0	185.8
C	61.0	60.0
D	53.6	46.8
E-N	287.9	254.7
O (Lab)	437.0	529.6
Quebec N. Shore	75.9	97.3
Total	1,310.6	1,545.4

Table 42 Nominal catches (tonnes) in Newfoundland and Labrador commercial Atlantic salmon fishery, 1971-87.

Year	Catch (tonnes)
1971	1,577
1972	1,394
1973	2,011
1974	2,010
1975	2,043
1976	2,013
1977	1,938
1978	1,180
1979	987
1980	2,103
1981	1,910
1982	1,321
1983	1,017
1984	821
1985	863
1986	1,235
1987	1,448[1]

[1]Preliminary.

Table 43 Number of microtags, external tags, and finclips applied to ATLANTIC SALMON by countries for 1987.

Country	Stock	Microtags	External tags	Finclips	Comments
Canada	Hatchery	62,900	71,200	1,088,500	
	Wild	-	22,300	2,400	
Faroes	Hatchery	-	-	-	
	Wild	-	75	-	
France	Hatchery	3,731	-	133,571	
	Wild	276	-	11,986	
Iceland	Hatchery	116,233	-	-	
	Wild	2,933	-	-	
Ireland	Hatchery	128,660	-	-	All tagging agencies
	Wild	3,240	-	-	included
Norway	Hatchery	-	129,002	-	
	Wild	-	2,641	-	
Sweden	Hatchery	-	7,834	-	
	Wild	-	-	-	
UK (Engl. & Wales)	Hatchery	178,830	-	-	All tagging agencies
	Wild	19,447	-	-	included
UK (Scotland)	Hatchery	17,192	325	-	Not all tagging
	Wild	3,684	5,815	-	agencies included
UK (N. Ireland)	Hatchery	17,208	478	3,431	All tagging agencies
	Wild	3,193	-	-	included
USA	Hatchery	640,400	145,200	84,021	Includes 45,200 double
	Wild	-	-	-	tagged
USSR	Hatchery	375	8,600	-	
	Wild	-	-	-	
Total	Hatchery	1,165,537	362,639	1,309,523	
	Wild	32,773	30,831	14,386	
Grand total		1,198,310	393,470	1,323,909	

Note: All microtagged fish are assumed to have been marked by excision of the adipose fin.

Figure 1 Graphic picture of Table 4 showing the output of the model for a European River (River 1) (N = year).

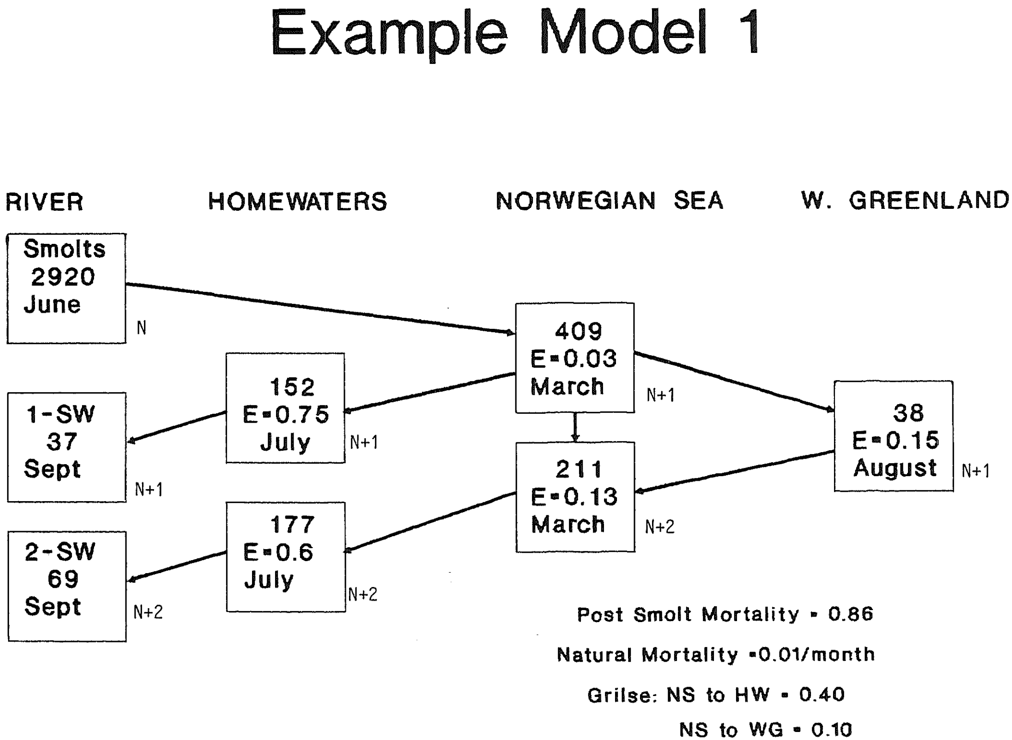
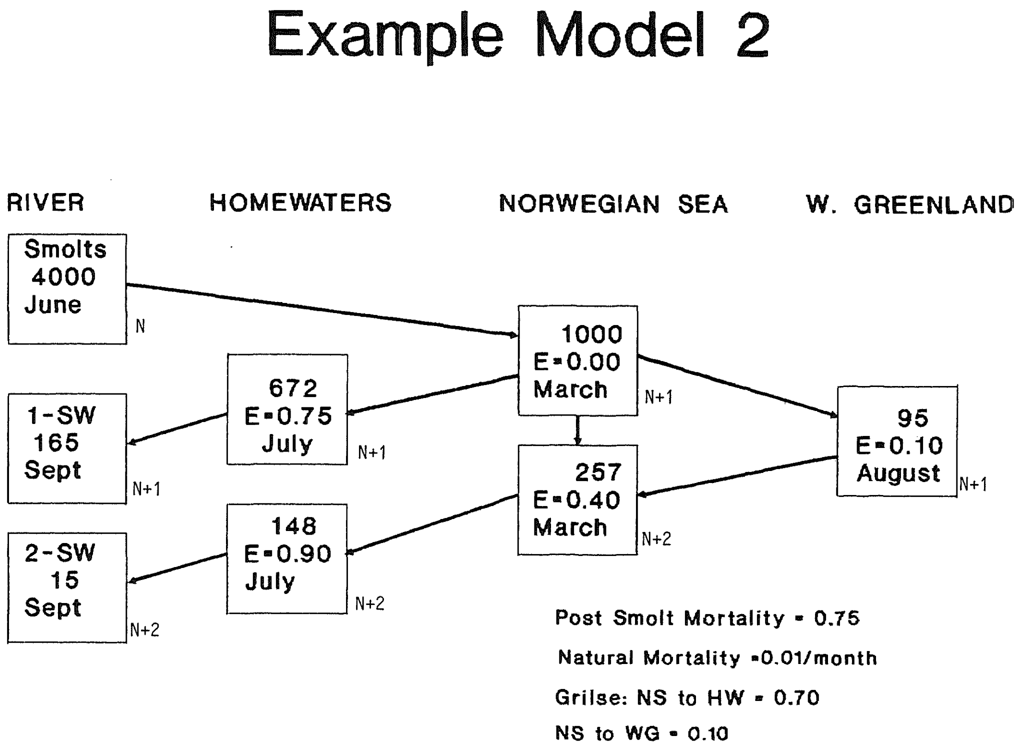


Figure 2 Graphic picture of Table 5 showing the output of the model for a European River (River 2) (N = year).



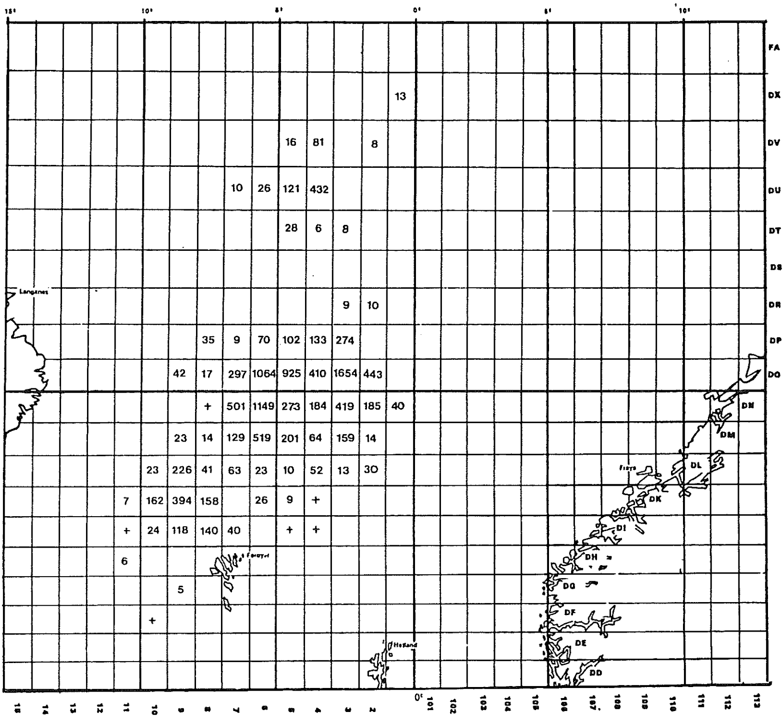


Figure 3. Catch in number*10^{-1} by statistical rectangle from logbooks, 1986/87 season.

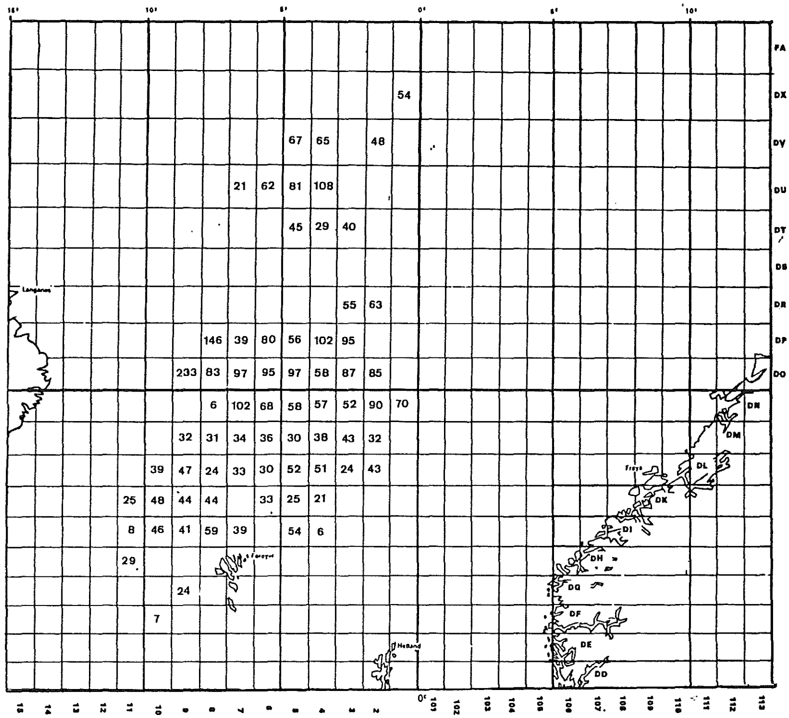


Figure 4. Catch in number per unit effort (1000 hooks) by statistical rectangle from logbooks, 1986/87 season.

APPENDIX 1

TERMS OF REFERENCE FOR NORTH ATLANTIC SALMON WORKING GROUP

1) With respect to Atlantic salmon in the West Greenland Comission area:

a) describe events of the 1987 fisheries with respect to gear, effort, exploitation rate, composition and origin of the catch, and assess the status of the stocks;

b) evaluate the effectiveness of new, existing, or proposed management measures for home waters and interception fisheries on stocks occurring in the Commission area;

c) discuss scientifically-based approaches for managing salmon in the context of existing fisheries;

d) specify data deficiencies and research needs.

2) With respect to Atlantic salmon in the North-East Atlantic Commission area:

a) describe events of the 1987 fisheries with respect to gear, effort, exploitation rate, composition and origin of the catch, and assess the status of the stocks;

b) evaluate the effectiveness of new, existing, or proposed management measures for home waters and interception fisheries on stocks occurring in the Commission area, in particular, the effect in the Faroese fishery zone of effort control compared to the control of catches on the level of exploitation.

c) discuss scientifically-based approaches for managing salmon in the context of existing fisheries;

d) specify data deficiencies and research needs.

3) With respect to Atlantic salmon in the North American Commission area:

a) describe events of the 1987 fisheries with respect to gear, effort, exploitation rate, composition and origin of the catch, and assess the status of the stocks;

b) evaluate the effectiveness of new, existing, or proposed management measures for home waters and interception fisheries on stocks occurring in the Commission area;

c) discuss scientifically-based approaches for managing salmon in the context of existing fisheries;

d) specify data deficiencies and research needs;

e) provide a table indicating the average percentage by number (and its variability) of US fish in the total harvest of the Newfoundland-Labrador commercial fishery; estimates should be broken down by standardized week and fishing area and include only standardized weeks from week 23 to week 41 inclusive;

f) with respect to the issue of acidification, consider the report of the Study Group on Acid Rain.

APPENDIX 2

DOCUMENTS SUBMITTED TO THE WORKING GROUP

1. Potter, E.C.E., Russell, I.C., Reddin, D.G., and Friedland, K.D. Recoveries of coded wire microtags from salmon caught at West Greenland in 1987.

2. Potter, E.C.E. and Kell, L. Preliminary application of a multifishery assessment model to Atlantic salmon.

3. Kennedy, G.J.A. and Crozier, W.W. Scientifically based approaches to management in the context of existing fisheries: Use of the R. Bush as an index river to provide input data for modelling.

4. Crozier, W.W. and Kennedy, G.J.A. Marine survival and homewater exploitation of R. Bush wild and hatchery-reared salmon (Salmo salar L.) derived from microtag returns in 1987.

5. Crozier, W.W. Difference in the proportion of microtagged and finclipped Atlantic salmon released from and returning to the R. Bush, N. Ireland.

6. Crozier, W.W. Exploitation and biological characteristics of R. Bush hatchery salmon (Salmo salar L.) in the Faroese fishery 1986/1987.

7. Shearer, W.M. Stock and recruitment in North Esk salmon, the fate of the fish derived from a single brood year.

8. Jákupsstovu, S.H. Effort in the Faroese longline fishery for Atlantic salmon.

9. Hoydal, K. Sea mortality of Atlantic salmon.

10. Møller Jensen, J. The salmon fishery at West Greenland 1987.

11. Møller Jensen, J. Notes concerning assessments of North Atlantic salmon in relation to West Greenland.

12. Friedland, K.D. and Kress, K. The feasibility of differentiating North American hatchery stocks of Atlantic salmon (Salmo salar L.) in a mixed stock fishery.

13. Friedland, K.D. and Reddin D.G. The potential use of otolith morphology in stock discriminations of Atlantic salmon (Salmo salar L.).

14. Bermingham, E., Friedland, K.D., Forbes, S., and Pla, C. Discrimination between Atlantic salmon (Salmo salar L.) of North American and European origin using restriction analysis of mitochordrial DNA.

15. Friedland, K.D., Forrester, J., and Stolte, L.G. Estimated harvest of USA-Merrimack River origin 1-SW salmon in Greenland in 1986.

16. Friedland, K.D. and Reddin, D.G. Coded wire tag scanning and field magnetization procedures utilized in 1987.

17. Rago, P.J. and Friedland, K.D. Real time closures to reduce the exploitation of selected stocks in North Atlantic salmon fisheries.

18. Reddin, D.G. Assessment of the accuracy of age determinations of hatchery-origin salmon.

19. Reddin, D.G. and Short, P.B. Identification of North American and European Atlantic salmon (Salmo salar L.) caught at West Greenland in 1987.

20. Reddin, D.G., Verspoor, E., and Downton, P.R. 1987 Data base for discrimination at Greenland.

21. Reddin, D.G. and Short, P.B. Length, weight and age characteristics of Atlantic salmon (Salmo salar L.) of North American and European origin caught at West Greenland in 1987.

22. Reddin, D.G. and O'Connell, M.F. Provision of scientific advice for a mixed stock commercial salmon fishery.

23. Doubleday, W.G. Science needed for future management of Atlantic salmon.

24. Thibault, M. and Prouzet, P. Atlantic salmon in France for 1987.

25. Browne, J. Exploitation rates in the Irish drift net fishery.

26. Lincoln, R. (editor). 1986. Genetic stock identification (GSI) of Chinook salmon: Status, needs and future.

27. Anon. 1988a. Report of the Study Group on the Norwegian Sea and Faroes Salmon Fishery. ICES, Doc. C.M.1988/M:2.

28. Anon. 1988b. Report of the Study Group on North American Salmon Fisheries. ICES, Doc. C.M.1988/M:4.

29. Anon. 1988c. Report of the Acid Rain Study Group. ICES, Doc. C.M. 1988/M:5.

30. Marshall, T.L. and MacPhail, D.K. Database - Atlantic salmon of the Saint John River, N.B.

31. Gudjonsson, S., Einarsson, S.M., Johannsson, M., and Isaaksson, A. Natural smolt production of Icelandic salmon rivers.

32. Lund, R.A. and Hansen, L.P. Estimates of reared salmon in commercial catches using direct observations and scale analysis.

33. Hansen, L.P. Estimates of exploitation rates of Atlantic salmon released as smolts in River Imsa, SW Norway, 1981-1986.

34. Lund, R.A., Hansen, L.P., and Järvi, T. Biological characteristics of Atlantic salmon from coastal fisheries at Otterøya and Kolgrov, western Norway.

35. Reddin, D.G. and Porter T.R. Harvest estimates of MSW salmon with river age of 3 years and younger.

36. Rago, P.J., Friedland, K.D., and Reddin, D.G. An update on the roportional harvest model to estimate the number of USA-origin salmon caught at West Greenland.

37. Rago, P.J. Estimation of population abundance and exploitation of Atlantic salmon at West Greenland for 1969-1986.

APPENDIX 3

REFERENCE LIST

1. Anon. 1984. Report of Meeting of the Working Group on North Atlantic Salmon. Aberdeen, 28 April-4 May 1984. ICES, Doc. C.M.1984/Assess:16.

2. Anon. 1985. Report of the Working Group on North Atlantic Salmon. ICES, Doc. C.M.1985/Assess:11.

3. Anon. 1986a. Report of the Working Group on North Atlantic Salmon. ICES, Doc. C.M.1986/Assess:8.

4. Anon. 1986b. Report of the Working Group on North Atlantic Salmon. ICES, Doc. C.M.1986/Assess:17.

5. Anon. 1987a. Report of the Working Group on North Atlantic Salmon. ICES, Doc. C.M.1987/Assess:12.

6. Anon. 1987b. Report of the Acid Rain Study Group, Copenhagen, 4-6 March 1987. ICES, Doc. C.M.1987/M:3.

7. Anon. 1988a. Report of the Study Group on the Norwegian Sea and Faroes Salmon Fishery. Dublin, 9-11 February 1988. ICES, Doc. C.M.1988/M:2.

8. Anon.1988b. Report of the Study Group on the North American Salmon Fishery. St. John's, Newfoundland, 1-4 March 1988. ICES, Doc. C.M.1988/M:4.

9. Anon. 1988c. Report of the Acid Rain Study Group. ICES Headquarters, Copenhagen, 15-19 March 1988. ICES, Doc. C.M.1988/M:5.

10. Anon. 1988d. Report of the Salmon Review Group. Framework for the development of Ireland's salmon fishery. Dublin, Stationary Office.

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12. Cochran, W.G. 1977. Sampling Techniques. John Wiley and Sons. New York.

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14. Scarnecchia, D.L. 1984. Climatic and oceanic variations affecting yield of Icelandic stocks of Atlantic salmon (Salmo salar). Can. J. Fish. Aquat. Sci. 41: 917-935.

15. Verspoor, E. 1986. Genetic discrimination of European and North American Atlantic salmon using a polymorphic loci: potential stock separation in West Greenland Fishery. ICES, Doc. C.M.1986/M:10.

16. Watt, W.D. 1986. The case for liming some Nova Scotia rivers. Water, Air, Soil Pollution, 31: 775-789.

APPENDIX 4

RECOMMENDATIONS OF THE STUDY GROUPS

1. Study Group of the Norwegian Sea and Faroes Salmon Fishery

The Study Group on the Norwegian Sea and Faroese Salmon Fishery, as a result of its work, makes the following recommendations:

a. Sampling and screening the landing at Faroes

The Study Group considered the current effort put into sampling and screening landings at Faroes to be adequate and recommends it be continued at a similar level. In view of the problem of collecting sufficient scale samples, however, it was recommended that historic data sets be examined to assess the possibility of using length distributions to estimate sea age composition of catches.

b. Country of origin by river age analysis

The Study Group recommended that scale samples collected in previous years be analyzed to assess the possibilities of using characteristics, including river age, to estimate the composition of the catch by country of origin.

c. Analysis of tagging data

It is recommended that tagging data should be presented in uniform fashion broken down by parr, reared smolt, wild smolt, and special group releases. These data should also be presented as wild smolt equivalents by year of migration. The number of untagged finclipped fish being released should also be reported as wild smolt equivalents.

d. Salmon of wild and reared origin

It was recommended that further work be carried out to test methods for distinguishing fish farm escapees from wild and ranched salmon and specifically that a report on the use of rare earth minerals as food additives be presented to the next meeting. Information on the incidence and estimated extent of escapes from fish farms should be compiled by each country and brought to the next meeting of the Study Group.

e. Acoustic survey

It was recommended that acoustic methods should be tested for estimating numbers of salmon in the Faroese area. This feasibility study should be carried out some time in January or April 1989.

f. Next meeting

It was recommended that the Study Group should meet for at least 3 days in the spring of 1989 and that this meeting should be scheduled at a time allowing the report to be finalized before the following meeting of the North Atlantic Salmon Working Group. An invitation was received to hold the next meeting of the Study Group in Finland.

2. The Study Group on the North American Salmon Fishery

The Study Group on the North American Salmon Fishery, as a result of its work, makes the following recommendation:

Tag recovery data for 1SW salmon of Maine origin captured in Canadian fisheries other than in Newfoundland-Labrador and for MSW salmon of Maine origin captured in all Canadian fisheries, 1968-1987, should be examined to determine the numbers caught by week and statistical area.

3. The Acid Rain Study Group

The Acid Rain Study Group, as a result of its work, makes the following recommendations:

a. Future effort

The major effort in North America should be devoted to the prevention of additional damage to existing Atlantic salmon stocks and habitat rather than toward mitigating damage after it occurs.

b. Vulnerability criteria

For North American Atlantic salmon habitat, at least, alkalinity values should be used to classify areas according to vulnerability to acidification. These values should be measured by Gran titration to the "inflection point" and meet one of the following criteria: a) a mean value of 75 μeq/l or less (derived from at least 8 measurements that include seasonal changes and a realistic range of water flows) or b) when sampling has been or must be limited, a value of 150 μeq/l or less derived from consistent measurements of low summer flows, preferably repeated over a 5-year period as an acceptable approximation of item a above.

c. Habitat surveys

Using the new chemical criterion recommended in item b above, surveys should be conducted in Atlantic salmon rivers to quantify the acidification of Atlantic salmon habitat and to classify it with regard to vulnerability. Assessments should be made of acidified habitat with the potential for water quality improvement or stocking.

d. Genome protection

Consideration should be given to the advisability of developing programs to protect the genomes of Atlantic salmon stocks at risk from acidification. Protection techniques may include creation of refuges and/or preservation of male and female gonadal products and other genetic material.

e. Long-term monitoring

Long-term monitoring of both chemical and biological parameters is encouraged so as to provide data series essential to the assessment of the impact of acidification on all salmon habitat.

f. Population assessments

Member countries should be requested to foster and encourage, particularly among scientists involved with anadromous fishes, the development, testing, and publication of models and methods of assessment designed to permit hindcasting and retrospective assessment of fish production and fish habitat to provide a foundation for determining effects of acidification.

g. Economic feasibility of liming

A study plan should be prepared to determine the economic feasibility of transferring the existing European river liming technology to North American acidic Atlantic salmon waters. Although such liming practices are technologically and economically feasible in Scandinavia, North American rivers differ with respect to hydrological, chemical, and biological characteristics, and, as a result, the technology may not be applicable to North America.

h. Publication of the report

The 1988 report of the Acid Rain Study Group should be published as a Cooperative Research Report after appropriate editing and/or revision including the application of the new criterion for determining vulnerability.

APPENDIX 5

DATA REQUIREMENTS FOR FUTURE MEETINGS

To assist the Working Group in answering the questions posed by NASCO, the following data are required.

1. Nominal catches broken into salmon and grilse, along with unreported catches.
2. Catch in number by sea age and details of how this is compiled.
3. A compilation of microtag, external tag, and finclip release data on the prescribed form, including data for the current year if possible.
4. Updates for the ICES data base on the prescribed form.
5. A written submission on the fishery of concern to the representative to include:

   a) A description of the fishery in the previous year, effort associated with the catch, composition and origin of the catch, and abundance and exploitation rates.

   b) Status of stocks to include commentary on spawning stock.

   c) The effectiveness of existing, new, or proposed management measures.

   The above should be in a form suitable for submission to the Working group rapporteur and should be as far as possible in the journal presented in the 1988 report of the North American Study Group.

6. Data on 'index' rivers suitable for the ICES salmon model.
7. Any other information relevant to the work of the Group.