This report not to be quoted without prior reference to the Council*

International Council for the
Exploration of the Sea

C.M.1990/Assess:11

REPORT OF THE NORTH ATLANTIC SALMON WORKING GROUP

Copenhagen, 15-22 March 1990

This document is a report of a Working Group of the International Council for the Exploration of the Sea and does not necessarily represent the views of the Council. Therefore, it should not be quoted without consultation with the General Secretary.

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

TABLE OF CONTENTS

Section		Page
1	INTRODUCTION	1
1.1	Participants	1
2	CATCHES OF NORTH ATLANTIC SALMON	1
2.1	Nominal Catches of Salmon	1
2.2	Catches in Numbers by Sea Age and Weight	2
2.3	Unreported Catches	2
3	THE DEVELOPMENT OF MODELS TO DESCRIBE FISHERY INTERACTIONS AND STOCK DYNAMICS	2
4	QUESTIONS OF INTEREST TO THE WEST GREENLAND COMMISSION	3
4.1	The Fishery at West Greenland in 1989	3
4.1.1	Description of the fishery at West Greenland	3
4.1.2	Composition and origin of the catch in 1989	4
4.1.3	Biological characteristics of the 1989 harvest	8
4.1.4	Composition of the catch from 1988	8
4.1.5	Stock abundance and exploitation at West Greenland	11
4.1.5.1	Exploitation on the extant stock of 1SW and 2SW Maine-origin salmon	12
4.1.5.2	Estimation of exploitation in the Newfoundland-Labrador and West Greenland fisheries for Saint John River and Maine stocks	14
4.1.5.3	Model calibration: comparison of Maine and Saint John stocks	17
4.1.5.4	Relationship between estimates of P and sea surface temperature	20
4.2	Effectiveness of management measures in the fishery at West Greenland	20
5	QUESTIONS OF INTEREST TO THE NORTH EAST ATLANTIC COMMISSION OF NASCO	20
5.1	The Fisheries in the 1988/1989 Season and in 1989	21
5.1.1	Description of the fishery	21
5.1.2	Origin of salmon in the Faroes fishery	21
5.1.3	Biological characteristics of the 1989 harvest	22
5.1.4	Exploitation rates at Faroes	23
5.2	Effectiveness of Management Measures	23
5.3	Possible Unrecorded Catches in International Waters	24
5.4	Reared Salmon in Fisheries and Spawning Populations	24
5.4.1	Behaviour of fish farm escapees	24
5.4.2	Farmed salmon in homewaters	26
5.4.3	Farmed salmon in the open ocean	28

Section		Page
5.4.4	Conclusion	28
6	QUESTIONS OF INTEREST TO THE NORTH AMERICAN COMMISSION OF NASCO	28
6.1	Canada	29
6.1.1	The fisheries 1989	29
6.1.2	Composition and origin of catch	29
6.1.3	Status of Canadian stocks, 1989	30
6.1.4	Exploitation rates on the Canadian stocks	32
6.1.5	Harvest estimates of USA-Origin salmon in Canada, 1967-1988	34
6.1.5.1	Comparison of Carlin tag and CWT harvest estimates of 1SW salmon in 1988	34
6.1.5.2	Historical harvest of 1SW and 2SW salmon	35
6.1.6	Effectiveness of new or proposed management measures	36
6.2	USA	37
6.2.1	The fisheries in 1989	37
6.2.2	Composition and origin of the catch	37
6.2.3	Status of the USA stocks	37
6.2.4	Exploitation rates	39
6.2.5	Effectiveness of management measures	39
6.3	France (Islands of St. Pierre and Miquelon)	39
7	HOMEWATER FISHERIES	40
7.1	Canada	40
7.2	North East Atlantic	40
7.2.1	The Fishery in 1989	40
7.2.2	Exploitation rates and the status of stocks in homewaters	41
7.2.3	Effectiveness of management measures	42
7.3	Effectiveness of Recent Management Measures in Norway	43
8	THE RATIO OF MICROTAGGED TO ADIPOSE FIN-CLIPPED SALMON	44
9	APPROPRIATENESS OF CONDUCTING FURTHER EXPERIMENTAL ACOUSTIC SURVEYS at SEA	45
10	METHODS TO OBTAIN DATA ON MOVEMENTS OF SALMON IN THE NORTH ATLANTIC, PARTICULARLY IN RELATION TO FISHERIES .	45
11	COMPILATION OF TAG RELEASES AND FIN-CLIP DATA FOR 1989	46
12	RESEARCH	47

Section		Page
12.1	Progress on Data Requirements and Research Needs . .	47
12.2	Progress on Recommendations from 1989	48
12.3	Requirements for Future Meetings	49
13	RECOMMENDATIONS	50
Tables 1 - 67	. . . .	51
Figures 1 - 23	. . . .	103
Appendix 1	. . . .	124
Appendix 2	. . . .	125
Appendix 3	. . . .	127
Appendix 4	. . . .	129
Appendix 5	. . . .	132

1 INTRODUCTION

At its 1989 Statutory Meeting, ICES resolved (C.Res.1989/2:4:8) that the Working Group on North Atlantic Salmon should meet at ICES Headquarters from 15-22 March 1990 to consider questions posed to ICES by NASCO (Appendix 1).

Two Study Groups met prior to the Working Group and submitted reports: The Study Group on the Norwegian Sea and Faroes Salmon Fishery, and the Study Group on the North American Salmon Fisheries. The Working Group endorsed the recommendations of these Groups which are listed in Appendix 2. The Working Group considered a further 27 papers submitted by participants (Appendix 3), and the references cited in the report are given in (Appendix 4).

1.1 Participants

E.T. Baum	USA
J. Browne (Chairman)	Ireland
W.G. Cazemier	Netherlands
M. Chadwick	Canada
W.W. Crozier	UK (N.Ireland)
D.A. Dunkley	UK (Scotland)
K. Friedland	USA
G. Gudbergsson	Iceland
L.P. Hansen	Norway
T. Hansen	Norway
J.A. Jacobsen	Faroe Islands
L. Karlsson	Sweden
T.L.Marshall	Canada
D.J. Meerburg	Canada
J. Møller Jensen	Denmark
E. Niemelä	Finland
T.R. Porter	Canada
E.C.E. Potter	UK (England and Wales)
P. Rago	USA
D.G. Reddin	Canada
A. Sharov	USSR
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 for 1960-1989 are given in Table 1 and shown in Figure 1, and nominal catches in homewater fisheries for 1960-1989 are given in Table 2.

Catch statistics in the Northeast Atlantic area also include fish farm escapees. The updated total catch for 1988 of 7,714 t is about 427 t less than the total catch in 1987 of 8,141 t. Figures for 1989 (5,777 t) are provisional, but it appears likely that the final data will show a substantial decrease from 1988. Total landings for 1989 are the lowest recorded and show decreases for most countries.

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. Management plans in several countries are designed to decrease catches.

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 1989 are provisional. The methods used by the different countries to break down their total catch by sea age are described in Anon. (1986a). However, in Anon. (1987), it was indicated that, for Canada, numbers of 1SW and MSW salmon were calculated using assumed mean weights 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 Canada, Iceland, West Greenland, and Ireland, a decline in catch from 1988 occurred in only the 1SW component. In Norway and Scotland, only the MSW component declined substantially.

2.3 Unreported Catches

The total unreported catch in 1989 was estimated to be approximately 2,000 t. This was 500 t lower than in 1988. This may reflect the lower total nominal catch by all countries which is 1,937 t lower than in 1988.

Instances of fishing in international waters in the Norwegian Sea are discussed in Section 5.3, and these unreported catches are not included in the above estimate or in the tables.

3 THE DEVELOPMENT OF MODELS TO DESCRIBE FISHERY INTERACTIONS AND STOCK DYNAMICS

NASCO asked ICES to continue the development of models to describe the fishery interactions and stock dynamics in order to estimate the effects of management measures, and in particular, provide the information required to refine the salmon run reconstruction model.

The Working Group presently uses models to describe the contribution and exploitation of several stocks in fisheries. One of these models, the run reconstruction model, is described in Appendix 4 of Anon. (1989a).

Comparisons of the outputs of the run reconstruction model for the Saint John River and Maine Rivers were useful in refining the exploitation rates and proportion of the population in the Newfoundland and Labrador and the West Greenland fisheries (see Section 4.1.5). The Working Group encourages countries to use the run reconstruction model to describe the combined stocks of their country.

Models of combined stocks may be derived from index river data scaled up according to estimates of total catches, smolt production, or spawning escapement. Where suitable index river data are not available, it was suggested that a model of a national stock could be constructed using catch data and estimates of exploitation, egg deposition, and survival rates.

The Working Group recommended that countries should develop run reconstruction models of their national stocks and bring appropriate data to the 1991 meeting. The results of these could be useful in refining the proportion of population available to the various fisheries and hence the exploitation rates. Analysis should also consider the timing of (1) smolt migration, (2) adult returns to rivers, and (3) harvests in the fisheries. Data on timing should be compiled in the format provided in Appendix 5.

4 QUESTIONS OF INTEREST TO THE WEST GREENLAND COMMISSION

NASCO asked ICES to describe the events of the 1989 fisheries with respect to gear, effort, composition and origin of catch, and to estimate exploitation rates and status of the stocks in homewaters and interception fisheries on stocks occurring in the Commission area.

4.1 The Fishery at West Greenland in 1989

4.1.1 Description of the fishery at West Greenland

In 1989, the fishery was opened on 1 August in NAFO Division 1F and on 18 August in NAFO Divisions 1A to 1E and ended 22 November, although the official closing date was 31 December. The total nominal catch was 337 t (Tables 4 and 5), which is 556 t less than in 1988, when the total landings were 893 t.

The landing in 1989 of 337 t corresponds to 313 t with an opening date of 1 August, taking into account a fishery in NAFO Division 1F with an opening date of 1 August and with a landing of 19 t, and a fishery in Subarea 1, starting on 18 August with a landing of 318 t. This calculation was made using the formula as previously given by the Working Group shown below:

$$y = 1,183.79 + 5.4398x - 0.0710x^2$$

where: y = allowable catch
x = opening date August 10 = 1.

The geographical distribution of the fishery in 1989 (Table 5) differs a little from previous years. The landings in NAFO Divisions 1A and 1B were lower, whereas the landings in NAFO Divisions 1C to 1F were nearly the same, i.e., between 70 and 80 t, with the highest landing in Division 1C. During the period 1976-1989, the distribution of landings has changed in a southward direction, especially in NAFO Divisions 1A and 1F. It has to be taken into account that the fisheries are influenced by the set TAC.

In 1989, a total of 81% or 273 t was taken by boats smaller than 30 ft. This figure is not exact, but it shows that the Greenland salmon fishery is a small-boat fishery, and it is supported by figures from the two previous years which were 77% and 81%, respectively.

No information on effort is available for 1989, but the landings during the two first weeks may have indicated a low abundance. The landings in the same period for 1980 to 1989 are given in the text table below. In 1988, the TAC was divided into boat quotas, which changed the pattern of the fishery compared to other years, when the TACs were divided into "free quotas" and "small boat quotas".

Year	Nominal catches in tonnes		
	First week	First two weeks	
1980	260	711	(01-14 Aug)
1981	465	735	(15-28 Aug)
1982	470	766	(25 Aug - 07 Sep)
1983	105	192	(10-23 Aug)
1984	17	58	(10-23 Aug)
1985	204	361	(01-13 Aug)
1986	509	848	(15-28 Aug)
1987	439	737	(25 Aug - 07 Sep)
1988	219	337	(25 Aug - 07 Sep)
1989	131	219	(18-31 Aug)

The Working Group noted (Anon., 1985) that the cooling of the surface temperature in the Labrador Sea during the first months of the year may deter salmon migration into the area of West Greenland and thereby influence their abundance.

The winters 1982/1983 and 1983/1984 were cold and the areas covered by the relatively warm surface water (4°C or more) in the Labrador Sea during the first months of those years were small compared to other years. The landings of salmon at West Greenland in those years were low. The same phenomenon took place in 1989; a cold winter resulting in a low surface temperature, followed by low landings of salmon.

4.1.2 Composition and origin of the catch in 1989

The Working Group examined the composition and origin of salmon caught at West Greenland based on discriminant analysis of scale samples from NAFO Divisions 1B, 1D, and 1E. An attempt was made to develop a discriminant function using known-origin salmon from that fishery (188 North American and 28 European). Origin was determined from electrophoretic analysis or the presence of tags, either coded-wire or external. Scale characters from the first sea zone from these fish were then analyzed by discriminant analysis. Because of differences in circuli counts between different river age salmon, and because there were too few European-origin salmon in the data base to form a discriminant function, it became necessary to use combined samples collected from 1980 to 1989.

The results of classifying a test sample of Atlantic salmon weighted to 1989 river age distributions at West Greenland showed misclassification rates of 21.5% and error rates of ±1.7%. This data base and the discriminant function were accepted by the Working Group for examination of the 1989 West Greenland fishery. The Working Group expressed concern over the lack of a suitable test sample of known origin. It is recommended that nuclear DNA patterns be used to classify samples already collected at Greenland in 1989, and scale samples should be collected in homewaters in 1990 in case the DNA analysis is not successful.

The results of classifying salmon in samples from commercial catches in 1989 indicated that the North American proportion was 56% (95% CL = 60,52), and the European proportion was 44% (95% CL = 48,40) (Table 6). In 1989, 73% of the catch was taken at the same time as the samples compared to 62% in 1988, and 85% in 1987. This suggests that the representativeness of the catch samples has improved over 1988. In 1989, 5.4% of the catch was sampled for determination of continental proportions compared to 3.8% in 1988 and 4.5% in 1987. Table 6 shows the variability in the proportions of North American and European salmon in the fishery since 1969.

An alternative estimate of the overall proportion of North American and European-origin salmon for the years 1982-1989 was derived by weighting NAFO division samples by catch in numbers. Pooled samples were applied to divisions with no sample. The table below gives the results:

Year	Weighted by-catch in numbers				Percentage of all samples combined	
	NA		EU			
	%	Wt(t)	%	Wt(t)	NA	EU
1982	57	-	43	-	62	38
1983	40	-	60	-	40	60
1984	54	-	46	-	50	50
1985	47	-	53	-	50	50
1986	59	537	41	423	57	43
1987	59	556	41	411	59	41
1988	42	349	58	544	43	57
1989	55	179	45	158	56	44

In 1989, the estimated number of fish caught were 64,957 from North America and 52,656 from Europe.

As in previous years, there were no spatial (north-south) or temporal trends in the proportions of fish by continent. Higher proportions of North American salmon were observed in Divisions 1B and 1D:

NAFO Division	Nominal catch (t)	% N. American origin	% European origin
1A	9	*	*
1B	28	62	38
1C	81	*	*
1D	73	71	29
1E	75	35	65
1F	71	*	*

*Not sampled.

Information on country of origin can be derived from recoveries of tags (both Carlin and coded-wire) at Greenland in 1989. The list of Carlin tags recovered from this fishery may not be complete for 1989 (although the USA reported 105 Maine-origin tags recovered in 1989 compared to 104 in 1988). Salmon landings at Greenland were again scanned in 1989 for adipose finclips and coded-wire tags (CWTs) using procedures similar to those in previous years (Anon., 1986a, 1987).

In 1989, a total of 15,588 salmon (13.3% of the West Greenland catch) was examined for adipose finclips and CWTs by Canadian, USA, and Danish scientists. In the sample, 331 (2.12%) had adipose finclips, and CWTs were recovered from 100 (30.2%) of the finclipped fish (Table 7). Thus, the overall proportion of the catch sample that was coded-wire tagged was 0.64%, compared to 0.50% in 1988 and 0.58% in 1987. The proportions of fish having CWTs sampled at each port were not uniformly distributed in common with the years 1985-1987 but differed from 1988 when the proportions were evenly distributed throughout the fishery. In 1989, the proportion of fish sampled at each port having adipose finclips was not evenly distributed ($\chi^2 = 55.4$) and the overall proportion was the highest recorded since scanning commenced in 1985.

CWTs recovered in 1989 were from 6 countries and were apportioned as follows: 70 (71%) from USA, 2 (2%) from Canada, 12 (12%) from Ireland, 12 (12%) from England and Wales, 2 (2%) from Scotland and, new in 1989, 1 (1%) from N. Ireland (Table 8). All of these tags came from 1SW salmon, most having been released as hatchery-reared smolts in 1988. Three fish from England and Wales were released as hatchery-reared parr in the spring of 1987, but did not migrate as smolts until 1988, and a further 12 fish (4 from Ireland, 1 from N. Ireland, and 7 from England and Wales) were tagged as wild smolts in 1988. Also 1 salmon was tagged in Scotland in 1987 as a wild parr but did not migrate until 1988.

The contribution by various countries to the 1989 West Greenland harvest cannot be determined at this time due to differential survivals of stocks tagged, as well as the proportion of coded-wire tagged fish relative to total smolt production in each country.

The Working Group considered an estimate of the number of USA salmon harvested at West Greenland, using the proportional harvest method (Anon., 1989a), based on the number of 1SW North American salmon of river age 1 in the West Greenland fishery, as apportioned by the relative proportions of age 1 smolts produced by USA and Canadian hatcheries. The proportional harvest method and a stock identification extension of the method described subsequently (referred to as the imaging method) are the only methods, that can provide current year estimates of the harvest of USA salmon at West Greenland. As noted in Anon. 1988a, estimates of harvest based on both Carlin and CWT recoveries require homewater recovery information the following year.

Input data for the proportional harvest method are shown in Tables 9 and 10. Canadian releases were reduced by the proportion of smolts less than 12 cm fork length. Only Maine smolts were considered in the estimation. Based on this method, the estimate of Maine salmon harvested at Greenland in 1989 was 4,547 (Table 11). The formula used is as follows:

$$H = NA1 \frac{U1 + U2}{U1 + C1} * \frac{1}{1 - NC}$$

where: H = harvest of all 1SW USA-origin fish at Greenland in year i;

NA1 = number of North American river-age 1, 1SW at West Greenland in year i;

U1 = number of USA 1-yr smolts released in year i-1;

U2 = number of USA 2-yr smolts released in year i-1;

C1 = number of Canadian 1-yr smolts released in year i-1;

NC = non-catch fishing mortality.

The extension or imaging method was based on identifications of North American 1SW, river age 1 salmon in 1989 by a discriminant function based upon circuli spacing data of age 1 smolts produced by the various North American hatcheries in 1988. This procedure allowed the Working Group to test assumptions concerning contribution rates of these hatcheries to the West Greenland fishery and was used to classify 1SW North American salmon of 1 river-year from the sampling programme at West Greenland directly. Although preliminary, the total harvests of USA and Canadian 1-year-old hatchery-origin salmon were estimated to be 2,985 and 3,265, respectively (Table 12) by the formula below:

$$H = [(\frac{USG}{SS}) * TS) / (1-NC)]$$

where: NC = Non-catch fishing mortality of 0.2

It should be noted that this method does not allocate all age 2 smolts from the respective stocks and contains a potential unquantified bias caused by the misclassification of continental group membership. Comparison of the various harvest estimates are made in Section 4.1.4.

4.1.3 Biological characteristics of the 1989 harvest

Biological characteristics (length, weight, and age) were recorded from samples of commercial catches from NAFO Divisions 1B, 1D, and 1E in 1989 using the results of discriminant analysis to divide samples into North American and European components. A summary of these data is provided in Table 13.

As previously observed, North American 1SW salmon were significantly shorter and lighter than their European counterparts, both overall and on an individual NAFO Division basis. However, the small sample of 2SW salmon of North American origin examined were not different in length and weight when compared to European-origin salmon, either overall or at the Division level. Samples from coded-wire tagged salmon also confirmed that North American 1SW salmon were shorter and lighter than their European counterparts.

The sea age composition in 1989 (Tables 14a and 14b) of 93.8% 1SW, 4.6% 2SW, and 1.6% previous spawners indicated that there were proportionally fewer 1SW salmon and more 2SW and previously spawned salmon than in 1988. In 1989, the 2SW components for both North American (5.2%) and European (3.8%) salmon were the highest since 1985.

Based on 55% North American salmon by number in the 1989 West Greenland salmon catches, the catch at age by continental origin was as follows:

Sea age	NA	EU	Total
1	60,020	50,339	110,359
2	3,378	2,001	5,379
PS	1,559	316	1,875
Total	64,957	52,656	117,613

The mean smolt age of salmon of North American origin has varied more than that of European fish (Table 15). There are no trends in the mean smolt ages of European origin salmon between 1968-1989.

4.1.4 Composition of the catch from 1988

There are four methods for estimating the harvest of USA-origin salmon in the fishery at West Greenland (Anon., 1989a). Two of these methods, the proportional harvest model and the image analysis method, provide estimates for the current fishery year. Two other approaches, the Carlin tag harvest model and the CWT harvest model, rely on the fraction of tags in the homewater run in the following year. Therefore, the Carlin and CWT methods can only provide estimates in the year after the fishery.

The parameters in the Carlin tag harvest model for 1SW salmon remain as reported in the previous assessment (Anon., 1989a). For 2SW harvest estimates, reporting rate, non-catch fishing mortality, and tag loss rate were set at the same levels as used in the 1SW model. All 1SW returns in year i are raised to harvest estimates with the ratio of tagged to untagged 2SW returns in homewaters in year i + 1 (RATIO). All 2SW returns in year i are raised to harvest with the RATIO value for year i. For non-maturing 2SW salmon, the best estimate of RATIO for a cohort is from the RATIO determined from the 2SW returns of that cohort (Anon., 1990a). The alternative of using the RATIO from 3SW returns the following year would not be practical.

Two changes which were made in the estimation of the RATIO parameter for the assessment of the Newfoundland commercial fishery are also applied to the assessment of the West Greenland assessment. As described in Anon. 1990a, the exploitation rate for Carlin-tagged salmon was found to be lower than exploitation for untagged salmon in the Penobscot River. This discrepancy could be explained in part by differences in run timing, but an adjustment of the reporting rate (formerly 90%) was now set at 80% for tagged salmon in Maine Rivers. The second adjustment to the RATIO estimation model was the incorporation of a fishway passage efficiency (set at 85% from experimental data) for trap counts of tagged and untagged salmon (Anon., 1990a). Because of the preliminary nature of the fishway efficiency data and considering the potential importance of the factor to the subsequent use of the harvest and run size estimates in exploitation rate calculations, harvest calculations were computed at both 100% and 85% passage efficiency.

Trap counts and angling catch data used to calculate the RATIO parameter for the 1989 run and updated data for previous years are presented in Table 16. Estimates of tag returns and the total run of 2SW salmon to Maine rivers for the two levels of fishway efficiency can be found in Table 17. Assuming a passage efficiency of 100%, the 1989 estimate of tag returns and total 2SW run are 164 tags and 2,600 fish, respectively. Assuming an efficiency of 85%, the estimates were 190 tags and 2,941 fish. The RATIO parameter, as determined for 100% passage efficiency is 0.06298 and for 85% passage efficiency is 0.06469.

The updated time series of tag returns for USA origin 1SW salmon in West Greenland can be found in Table 18. Tag returns (to date) for the 1989 fishery total 105 tags, with the largest recovery occurring in NAFO Division 1C. Estimated harvest of 1SW salmon in West Greenland is summarized by year for both 100% and 85% passage efficiency in Tables 19 and 20. Estimates based on 85% efficiencies are approximately 5% lower than the 100% efficiency estimates overall, although the percent difference varies among years. The harvest estimates for the 1988 fishery totalled 2,261 salmon at 85% efficiency and are primarily distributed in NAFO Divisions 1B to 1E.

Tag returns from 2SW salmon of Maine origin intercepted in West Greenland are summarized in Table 21. For the purposes of harvest estimation and run reconstruction modeling, the MSW components are reported separately. Tag returns are distributed among NAFO divisions similarly to 1SW returns and have averaged approximately 5 tags per year, with a larger number of recoveries occurring in the early 1970s. As for 1SW returns, harvest estimates are presented by year and computed with 100% and 85% fishway passage efficiency factors in Tables 22 and 23, respectively. Twenty-two 2SW salmon of Maine origin were harvested in West Greenland in 1989.

Tag returns from previous spawners intercepted in West Greenland are summarized in Table 24. Since these returns do not enter directly into the run reconstruction modeling, and considering the difficulty determining the appropriate harvest raising values, harvest estimates are not calculated at this time. There has been a total of 5 tagged 3SW salmon of Maine origin intercepted in West Greenland, all occurring between 1973 to 1977.

A small number of Maine-origin tagged fish were recaptured in a small area in East Greenland (Table 25). This could imply a relatively high number of Maine origin fish over the entire East Greenland area. This assumption is not inconsistent with conclusions in Section 4.1.5.1.

Using the methodology in Anon. (1988a), the Working Group estimated harvests based on the CWT sampling programmes at both West Greenland and in homewaters. Ratios of coded-wire tagged to total returns of 2SW salmon in homewaters were 0.453 and 0.216 in the Connecticut and for Maine rivers, respectively (ratio for Maine rivers computed using 85% passage efficiency estimates). CWT harvest estimates were computed as time-stratified estimates (Anon., 1989a) and are presented with updated values for the 1987 fishery:

Stock	Harvest (variance)	
	1987	1988
Connecticut	112 (802)	230 (3,601)
Merrimack	52 (560)	0
Maine	5,538 (102,166)	4,236 (105,593)
Total	5,702	4,466

The estimates of USA origin fish in catches in the 1988 West Greenland fishery using proportional and imaging harvest models were 4,812 salmon (all river ages, Maine only) and 5,802 (river age 1), respectively (Table 11). Because these estimates are of different portions of the stock, they are not strictly comparable.

The different harvest estimates for USA stocks were compared by the Working Group. For the time series 1976 to 1988, the Working Group compared the Carlin tag and proportional method estimates (Figure 2). The correlation between the estimates was 0.409 (P = .186). The relatively low correlation might be attributable to high variability in the early years of the time series for the proportional harvest method. Since 1983, the coefficient of variation of the estimate has been reduced by more than 50%. The reduced variation is coincident with the decline in the numbers of river age 2 smolts stocked. Thus, the assumption that the harvest estimate of all river-age salmon of Maine origin is strictly proportional to the ratio of 2-yr to 1-yr smolts might not be true.

In the latter part of the times series, comparisons may be made between estimates derived from the Carlin model, the CWT model, the proportional model (PM), and the image analysis (IA) method (Figure 3). The close agreement among the CWT, IA, and PM for 1987 onward provides strong evidence that Carlin tag estimates may be low by at least 50%. Comparison of the variability of the estimators demonstrates that the probability of detecting a significant difference between the PM and CWT estimates is low. The lack of agreement between the PM and IA estimates is due to the slightly different harvest they estimate, but may also indicate positive bias in the PM method or possible discrimination errors in the IA estimate. Nonetheless, the results over the last 3 years consistently suggest that over 4,500 Maine-origin salmon have been harvested each year.

Unlike the Carlin harvest estimate, CWT estimates for Greenland do not require an assumed reporting rate for tags. Because the Carlin model is sensitive to the assumed reporting rate (Anon., 1985b), the CWT estimate is more accurate if the fishery is representatively sampled. The Greenland CWT estimates come from a well stratified sampling programme and are precise (coefficients of variation for these estimates are usually <10%). If the entire difference between the two estimates can be attributed to the reporting rate parameter used in the Carlin model, the ratio between them can give an estimate of the actual reporting rate for Carlin tags in the fishery. The ratios between the two harvest models are 2.65 and 1.87 for the 1987 and 1988 fisheries, respectively. These two ratios give estimates of adjusted reporting rate of 30% in 1987 and 43% in 1988 (adjusted reporting rate-assumed reporting rate/ratio of two harvest models) as compared to the currently assumed rate of 80% reporting.

4.1.5 <u>Stock abundance and exploitation at West Greenland</u>

The Working Group had addressed previously the problem of estimating exploitation rates of 1SW Maine-origin salmon in the West Greenland fishery (Anon., 1987, 1988a, 1989a). Development of run reconstruction models has aided the Working Group in comparing alternative hypotheses of migratory pathways and possible effects of various fisheries. The critical parameter in these assessments was the so-called "P" parameter which defines the fraction of the 2SW returns coming from the Newfoundland-Labrador fishery. The fraction of 2SW salmon returning from the Greenland fishery is defined as 1-P. Within a given year the exploitation rate in Canada is inversely related to the exploitation rate in West Greenland. For a given set of 1SW harvest estimates and 2SW returns, estimated exploitation rates decreased in Canada and increased in West Greenland as P increased (Anon., 1989a). Owing to uncertainty in P, the Working Group was only able to make qualitative statements about trends in exploitation in Greenland and Canada (Anon., 1989a).

To reduce the uncertainty in estimation, the Working Group noted that the following additional information would be required: (1) reporting rates for external tags; (2) independent estimates of exploitation rates in one or more fisheries; and (3) data on proportions of fish migrating to different fisheries (Anon., 1989a). The Working Group reviewed a method that allowed refinement of the run reconstruction model for Maine stocks.

Section 4.1.5.1 provides estimates of exploitation rates for the total extant stock of 1SW and 2SW salmon of Maine origin for the period 1969-1988. Revised estimates of run size and harvests, reported in Anon. (1990a), are used in this approach. In Section 4.1.5.2, exploitation rates for the Canadian and West Greenland fisheries are partitioned by assuming values of P and illustrating the resulting range of exploitation rates. Results for Maine stocks are compared with a similar set of harvest estimates developed for the Saint John River stock for the period 1974-1988. In Section 4.1.5.3, an approach is developed that allows for calibration of the models for the Maine and Saint John River stocks. The calibration approach permits estimation of exploitation rates in the fisheries and provides an estimate of the stock fraction in each fishery. Section 4.1.5.4 examines the relationship between the predicted fractions of the stock in the fisheries and temperature variations in the Northwest Atlantic and Labrador Sea.

4.1.5.1 Exploitation on the extant stock of 1SW and 2SW Maine-origin salmon

Estimation of exploitation rates on the extant stock does not require information on migratory pathways. Exploitation rates on the extant stock of one- and two-sea winter salmon originating from Maine rivers were computed using the schematic model depicted in Figure 4. The post-fishery population following the 1SW fishery (PFP1) is computed by projecting the maturing (M1SW) and non-maturing salmon (NM1SW) backwards to the time of the fishery. For this discussion, maturing 1SW are defined as those returning home as 2SW salmon. Non-maturing salmon are those destined to return as 3SW salmon. The number of maturing salmon in PFP1 are estimated by backward projections of the run of 2SW salmon to Maine (R2) and the coastal catches of 2SW salmon in the USA coast (USAC2). Non-maturing salmon are the sum of the run of 3SW salmon (R3), and the 2SW catches in Canada (CH2) and Greenland (GH2), each adjusted for appropriate natural mortality rates. A factor influencing the size of PFP1 is the fraction of the stock that might not be accounted for in any fishery. This parameter (FU), relates to observations of 1SW salmon in the Labrador Sea during the fisheries, the presence of Maine salmon in East Greenland and other very distant fisheries and straying of returning salmon from their natal waters. The actual fractions for FU are unknown but assumed to span the interval 0 to 0.1. It is also known that not all Carlin tags are returned. While reporting rates are incorporated into the estimation of harvests, recent information from coded-wire tagged salmon in Greenland and Canada suggests that reporting rates may be 50% lower than assumed. To account for this uncertainty a Carlin tag adjustment factor (CA) was introduced in the model.

The computational formula for PFP1 are presented below:

(1) $PFP1 = (M1SW + NM1SW)*(1-FU)$

where

(2) $M1SW = R2/\exp(-M*47/52) + CA*USAC2/\exp(-M*39/53)$

(3) $NM1SW = CA*GH2/(\exp(-M*47/52)) + CA*CH2/\exp(-M*52/52) + R3/\exp(-M*99/52)$

The exploitation rate on the 1SW extant stock (E1) is estimated as

(4) $E1 = CA*(CH1 + GH1) /(PFP1 + CA*(CH1 + GH1))$

Exploitation rates for the 2SW extant populations (E2) are simply defined by backing up the 3SW run to Maine rivers (R3) and computing the total harvests of 2SW salmon in the Canada and Greenland fisheries, CH2 and GH2, respectively.

(5) $PFP2 = R3/\exp(-M*47/52) * (1-FU)$

(6) $E2 = CA * (GH2+CH2)/(PFP2 + CA*(CH2 + GH2))$

For modeling purposes, natural mortality has been assumed to be 0.12 per year. During the period of the fishery, natural mortality is assumed to be negligible.

Data used to estimate equations (1) to (6) are summarized in Tables 26 and 27. Methods for estimating harvest and run sizes are described in Anon. (1987, 1990a). Model sensitivity to the assumed rates was tested by varying the natural mortality rate M {0.12; 0.24}, the percent FU in the fisheries {0; 0.1} and the Carlin adjustment factor CA{1; 2}.

Estimated exploitation rates for extant 1SW and 2SW populations of Maine-origin salmon are presented in Tables 28 and 29, respectively. Using the Carlin tag data with no adjustment for reporting, exploitation on the extant 1SW population averaged about 43%. Variations in the percentage of the stock unaccounted for, and in natural mortality had little effect on average exploitation. When the Carlin based harvests were increased twofold (i.e., CA = 2), average exploitation rate increased to 57%. Once again, variation in natural mortality rate and unaccounted fraction (FU) had little effect. If Carlin estimates are low by 50%, exploitation rates during 1986-1988 exceeded 60% of the extant Maine-origin stock (Table 28).

Average exploitation rates for the 2SW extant stock exceeded 74% regardless of the assumptions about reporting rates, natural mortality, or the fraction of the unaccounted stock (Table 29). As with the 1SW population, exploitation estimates for the 2SW population are strongly influenced by the Carlin adjustment factor. When Carlin-based harvest estimates are doubled, the average exploitation rate exceeds 82% in all scenarios. While the numbers of fish affected by these high rates of exploitation are relatively small, the absence of 3SW salmon in Maine rivers could be due to high exploitation on 2SW salmon in both fisheries.

Estimates of exploitation based on Carlin tag recovery data are relatively insensitive to variations in natural mortality rates and the proportion of the stock available to the fisheries. This method does not rely on migratory pathways or the fraction of the stock present in each fishery. Reporting rates exert a strong effect on exploitation estimates. Since 1967, exploitation rates on the extant 1SW stock have varied between 30% and 75%. Exploitation rates on the 2SW population have been considerably higher (>75%).

4.1.5.2 Estimation of exploitation in the Newfoundland-Labrador and West Greenland fisheries for Saint John River and Maine stocks

Maine stocks

The analyses in Section 4.1.5.1 estimate total exploitation rates on the extant stock of one- and two-sea winter salmon of Maine origin. These results demonstrated that exploitation on the extant 1SW salmon (E1) is greatest for fish destined to return as 2SW salmon. Over the past 10 years, the fraction of the post-fishery 1SW stock destined to return as 3SW fish has averaged less than 4%. Thus the model was simplified by ignoring the contribution of non-maturing salmon to the total extant stock.

Model analyses assumed that 2SW salmon returning to Maine rivers were the survivors of either the West Greenland fishery or the Canadian fishery but not both (Figure 5). Møller Jensen (1980) reported no same year recaptures in Canada of 2,364 salmon tagged in Greenland. Similarly, there is no direct evidence indicating migrations between the Canadian spring fisheries and the Greenland fishery. Tagging studies reported in Anon. (1990a) revealed no same-year recaptures in Greenland of salmon tagged in Newfoundland, Labrador, and the Labrador Sea. Therefore, it was assumed that no within-year mixing of salmon cohorts occurs between the Newfoundland-Labrador and Greenland fisheries.

The computations for exploitation rates of 1SW salmon in the Canada (EC1) and Greenland (EG1) fisheries are defined as

(7) $EC1 = (CA * CH1)/(P*R2/\exp(-45/52*M) + CA * CH1)$

(8) $EG1 = (CA * GH1)/((1-P)*R2/\exp(-49/52*M) + CA * GH1)$

where P defines the fraction of the stock returning from the Canadian fishery and CA is the adjustment factor for non-reporting of Carlin tags.

Since 1983, exploitation rates have decreased in Canada and increased in Greenland (Figure 5). This conclusion holds regardless of the underlying fraction of salmon assumed to be coming from either fishery. Over the range of P values examined, exploitation rates in Canada ranged from about 0.15 to 0.55, while rates in Greenland ranged from about 0.45 to 0.85.

As expected, adjustment of the Carlin tagging data for non-reporting (CA = 2) markedly increased the exploitation rates in both fisheries (Table 30). Percentage increases in exploitation depend on P. For the Newfoundland-Labrador fishery, average exploitation increased from 0.72 to 0.83 when P = 0.1, i.e., when a small fraction of the stock was present in Canada. When P = 0.9, however, average exploitation increased by 54%, i.e., from 0.26 to 0.40. A similar pattern held for the West Greenland fishery. For 1-P = 0.9, and 0.1, the percent increases in average exploitation rates were 13% (i.e., 0.77 to 0.85) and 48% (i.e., 0.35 to 0.50), respectively.

Saint John River

Tagging data and harvest estimates for Saint John River, New Brunswick stocks in Canada and West Greenland were presented in Anon. (1990a). These data spanned the period 1974 to 1988. Exploitation rates for the Saint John River stock in the Newfoundland-Labrador and West Greenland fisheries were computed using a variety of P values (Figure 6). The correlations between the estimated exploitation rates for the two stocks vary by fishery and by assumed value of P as follows:

Fishery	P Value	Correlation (Saint John, Maine)
Newfoundland-Labrador	0.1	0.485
	0.5	0.281
	0.9	0.211
West Greenland	0.1	0.885
	0.5	0.899
	0.9	0.886

The absolute value of exploitation for the Saint John stock was indeterminable due to uncertainty in P. Additional information is provided in Section 6.1.4.

The difficulties in characterizing exploitation rates for the Greenland fishery are inherent in all run reconstruction models (Starr and Hilborn, 1988). The major advantage of these models is that they narrow the range of plausible exploitation rates. For example, consider the last two years (1987 and 1988) of the above analysis in more detail. The significance of these two years lies in the availability of three independent estimates of harvest of Maine-origin salmon in the Greenland fishery. The ratio of the CWT to Carlin estimates in these years justified the Carlin adjustment factor (CA = 2) described above. Again, substituting the harvest estimates for Greenland and Canada (Table 31) into Equations 7 and 8 yields the following exploitation rates:

Year	P	Canada	Greenland
1987	0.1	0.78	0.59
	0.3	0.55	0.65
	0.5	0.42	0.72
	0.7	0.34	0.81
	0.9	0.29	0.93
1988	0.1	0.71	0.60
	0.3	0.44	0.66
	0.5	0.32	0.73
	0.7	0.25	0.82
	0.9	0.21	0.93

The lowest plausible value for the exploitation rate in Greenland is 60% for both years. Such exploitation rates in Greenland imply unlikely values in excess of 70% in Newfoundland-Labrador. If the scaling factor of 2 for the harvest in Canada is not appropriate, i.e., CA <2 for Canada only, then estimated exploitation rates in Greenland would be higher than listed above. If some fraction of the stock is not available to either fishery (FU >0) the exploitation rates would increase for both fisheries.

The table below is an application of the same rationale, i.e., CA = 2, to the Saint John River stock (see Table 32):

Year	P	Canada	Greenland
1987	0.1	0.94	0.58
	0.3	0.85	0.64
	0.5	0.77	0.71
	0.7	0.70	0.80
	0.9	0.65	0.92
1988	0.1	0.00	0.62
	0.3	0.00	0.67
	0.5	0.00	0.74
	0.7	0.00	0.83
	0.9	0.00	0.94

As before, the lowest plausible value for exploitation rate in Greenland is about 60% in both years. Close agreement between exploitation estimates in West Greenland for the extant Saint John River and Maine stocks for all values of P in both years suggests that similar exploitation rates operate on both stocks in the fishery.

The consequences of these exploitation rates and P values in home waters were examined by the Working Group.

The numbers of 1SW salmon of European, Canadian, and Maine origin caught in West Greenland in 1987 and 1988 and in home waters a year later are shown in Table 33. From this can be derived the numbers present at West Greenland before the fishery if the 3 rates of exploitation shown are assumed. The returns to home waters are calculated assuming a natural mortality rate between the fisheries of 0.10. The numbers of salmon returning from West Greenland in 1987 and 1988 (Table 34) can be compared with a rough compilation of the numbers of salmon caught in homewaters (Table 34).

It is assumed that all stocks at West Greenland are exploited at the same rate as Maine stocks. Assuming higher or lower levels of exploitation on MSW salmon in homewaters would reduce or increase the proportion of fish returning from feeding areas other than West Greenland.

Assuming an exploitation rate of 50% for both continents in both years, then the contribution from West Greenland to the homewater MSW stocks can be calculated. It ranged from 3-42% for Canada and the corresponding figure for Europe was 1-20%, depending on the exploitation rate at West Greenland.

This would mean that 58 to 97% of the Canadian MSW salmon derived from feeding areas other than West Greenland, the European figure would be from 80-99%.

4.1.5.3 Model calibration: comparison of Maine and Saint John stocks

A method for estimating P indirectly is described below. To facilitate the presentation of equations for two stocks, the notation is modified slightly from that used in Section 4.1.5.2. The reduced model (Figure 6), which considers only the harvest of 1SW salmon and the run of 2SW salmon, is once again used to describe the populations.

Let

HGC = Harvest of 1SW salmon in Greenland of Saint John-origin

HCC = Harvest of 1SW salmon in Canada of Saint John-origin

HGU = Harvest of 1SW salmon in Greenland of USA-origin

HCU = Harvest of 1SW salmon in Canada of USA-origin

RU = Run of 2SW salmon to USA (Maine) rivers

RC = Run of 2SW salmon to Canadian (Saint John) River

SU = Survival of USA (Maine) salmon from closure of Greenland fishery to return to Maine Rivers = exp(-45/52*M)

SC = Survival of Canadian salmon (Saint John) from closure of Greenland fishery to return to Saint John River = exp(-45/52*M)

SPU = Survival of USA (Maine) salmon from closure of Newfoundland-Labrador fishery to return to Maine rivers = exp(-49/52*M)

SPC = Survival of Saint John salmon from closure of Newfoundland-Labrador fishery to return to Saint John River = exp(-49/52*M)

PU = Proportion of USA (Maine) salmon returning from the Newfoundland-Labrador fishery

PC = Proportion of Saint John salmon returning from the Newfoundland-Labrador fishery

Using the above definitions, the exploitation rates for each stock in each fishery are defined as

(9) EGC = (CA * HGC)/((1-PC)*RC/SC + CA * HGC)

(10) EGU = (CA * HGU)/((1-PU)*RU/SU + CA * HGU)

(11) ECC = (CA * HCC)/((PC)*RC/SPC + CA * HCC)

(12) ECU = (CA * HCU)/((PU)*RU/SPU + CA * HCU)

where:

EGU = Exploitation rate in Greenland of USA (Maine) fish

ECU = Exploitation rate in Newfoundland-Labrador of USA (Maine) fish

EGC = Exploitation rate in Greenland of Newfoundland-Labrador fish

ECC = Exploitation rate in Canada of Newfoundland-Labrador fish

To estimate the values of PU, PC, and the exploitation rates, the following assumptions were made.

1. Exploitation rates for fractions of the Maine and Saint John stocks available to the West Greenland fishery should be about equal.

2. Given the close proximity of the Saint John and Maine rivers, factors that influence the migratory pathways for these stocks should be similar. Therefore, PU should approximately equal PC for a given year.

3. Wide fluctuations in harvests levels and the imposition of quotas have almost certainly resulted in varying exploitation rates in the West Greenland fishery. In contrast, yields in Canada should be roughly proportional to abundance and exploitation should be relatively constant. The Working Group decided that an exploitation rate of 0.60 was not unreasonable for Saint John and Maine stocks in the Newfoundland-Labrador commercial fisheries. This decision was based on estimates for stocks in Newfoundland-Labrador, given below:

Stock	Exploit.rate		Years of study	Reference
	1SW	MSW		
Little Codroy	0.48	0.75	1954-1963	Murray (1968)
Sand Hill	0.38	0.90	1968-1971	Pratt et al. (1974)
Western Arm	0.65	-	1978	Chadwick et al. (1985)
Exploits	0.60	-	1989	Anon. (1990a)
Conne	0.03	-	1989	Anon. (1990a)

Apart from uncertainty about the wide range of exploitation rates and the use of old data sets, the Working Group noted that the two major biases of these estimates should cancel out. Because about 50% of the exploitation on Newfoundland stocks occur within bays and near to the river mouth, these rates could overestimate the exploitation rate of mainland stocks which migrate outside these bays. On the other hand, salmon of USA-origin are larger and exposed to more fisheries and should have higher exploitation rates in fisheries outside bays than local, Newfoundland stocks. More work on exploitation rates in Newfoundland commercial fisheries is needed. However, exploitation rates for Saint John and Maine stocks available to these fisheries should be about equal.

The above assumptions can be translated into three hypotheses:

1) H_o: EGU = EGC

2) H_o: PU = PC

3) H_o: ECU = ECC = 0.6

Sampling variability and slight variations among the Saint John and Maine stocks do not permit one to incorporate assumptions 1) to 3) into Equations (10) to (13) and algebraically solve for PU and PC. Instead, if assumptions 1) to 3) are true, then the differences between EGU and EGC, between PU and PC, and between ECU and ECC should be minimal. This suggests that an appropriate way to estimate PU and PC is to minimize the following objective function:

(13) Minimize $(EGU-EGC)2 + (0.6-ECU)2 + (0.6-ECC)2 + (PU-PC)2$
subject to the constraint that $0<PU<1$ and $0<PC<1$.

Evidence from recoveries of fish with CWTs in Newfoundland-Labrador and Greenland suggest that reporting rates currently used in the Carlin harvest model may be low by a factor of 2 (see Section 4.1.4). Equation 13 was solved for CA = 1 and CA = 2, using a numerical technique known as the simplex method (Wilkinson, 1988). Input data for the Maine stocks are presented in Table 31 and for Saint John stocks in Table 32.

Assuming that the Carlin adjustment factor is 1.0 (i.e., assumed reporting rates of about 80% are correct), the calibrated estimates of P, exploitation in Greenland, and exploitation in Newfoundland-Labrador for both stocks are summarized in Table 35. The value of the objective function (Eq. 13) suggested close agreement between the estimated rates. This would be possible only if similar processes were affecting the stocks. Correlations between the rates for each stock were as follows: PC, PU, $r = 0.871$, Prob. <0.001; EGC, EGU, $r = 0.895$, Prob. <0.001; ECC, ECU, $r = -0.268$, Prob.= 0.355.

Results suggest that exploitation rates in Greenland have been slightly higher for Maine stocks than for the Saint John River population (Figure 7). Average exploitation rates for Maine stocks and the Saint John River stock were 37% and 31%, respectively.

Similar results were obtained when the Carlin-based harvest estimates were increased two-fold (Figure 8). Correlations between the rates for each stock were as follows: PC,PU, $r = 0.990$, Prob.<0.001; EGC, EGU, $r = 0.961$, Prob. <0.001; ECC,ECU, $r = -0.370$, Prob.= 0.193. Low exploitation rates were experienced by both stocks during the poor 1983 and 1984 harvest years at West Greenland. The average exploitation rate for the Maine stock was slightly higher than for the Saint John stock in Greenland (Table 34). For the period 1986 to 1988, exploitation rates in the West Greenland fishery averaged 62% for the St. John River stock and 65% for the Maine stocks. Over the entire time series this analysis suggests that exploitation in Greenland has been higher for Maine stocks (61%) than for the Saint John stock (56%).

The model calibration approach provides an objective way of incorporating additional biological information into the estimation of exploitation rates. The Working Group concluded that the model calibration approach might be applicable to other North Atlantic salmon stocks.

4.1.5.4 Relationship between estimates of P and sea surface temperature

In recent years, it has been shown that marine surface temperatures strongly influence the sea migrations of Atlantic salmon (Reddin and Shearer, 1987). The Working Group reviewed the relationship between the derived P values and sea surface temperatures for the period 1974 to 1986. In warmer years, a greater proportion of the stock appeared to go to Greenland while in colder years, a greater proportion remained in Canadian waters. The statistical significance of these relationships was not determined but the Working Group recommended further analyses. Development of a mechanistic basis for variation of P values could lead to general predictions of salmon movements.

The Working Group considered the question of the availability of temperature data because of the influence of temperature on salmon migrations and catches. Data on temperature were presented from the Labrador and the inshore Newfoundland areas which indicated that data were available but not being utilized by the Working Group.

Software being developed in Ireland for microcomputers to analyze temperature data from satellite images was demonstrated. A project was being organized to relate temperature data from the area of the Faroes fishery with catch and CPUE data. This type of work could be useful in the Greenland area.

4.2 Effectiveness of management measures in the fishery at West Greenland

The TAC agreed for the period 1988-1990 was a total of 2,520 t, with an annual opening date of 1 August. In addition, the annual catch was not permitted to exceed the annual average (840 t) by more than 10%.

In 1989 the TAC was set to 900 t, and after one year, 1988, with individual boat quotes, the TAC was again divided into a "free quota" of 447 t and into a "small boat quota" of 453 t. Because of the small landings in 1989, it was not possible to measure the effect of that change.

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

NASCO asked ICES to describe the events of the 1989 fisheries with respect to gear, effort, composition and origin of catch and to estimate exploitation rates and status of the stocks in homewater and interception fisheries on stocks occurring in the Commission area.

5.1 The Fisheries in the 1988/1989 Season and in 1989

5.1.1 Description of the fishery

The fishery in the 1988/1989 season was rather poor (Table 37). The total landings of 309 t amounted to about half of the annual quota and only the catch in 1987/1988 was lower (208 t). Catches in January and February 1989 were very low (Table 38) because vessels could not fish as a result of bad weather. Furthermore, a few of the vessels which managed to fish, may have kept their catches frozen on board and landed them with the March catch.

The catch in numbers by statistical rectangle from log-books for the whole season is shown in Figure 9. In the 1988/1989 season, no Faroese vessels fished outside the Faroese EEZ. In November and December, fishing was concentrated within about 100 miles and to the northwest of the islands. Fishing effort in January and February was scattered throughout the Faroese EEZ, but in March and April, most fishing took place to the northeast of the EEZ, at a distance of more than 100 miles from the islands.

Catch per unit effort (CPUE) for the whole season (expressed as catch per 1,000 hooks) was calculated for the whole fishery for the seasons 1982/1983 to 1988/1989, and for the fishery within the Faroese EEZ for the seasons 1986/1987 to 1988/1989 (Table 39). CPUE was also calculated for the fishery in 1988/1989 by degree latitude per month (Table 40), and is shown by statistical rectangle in Figure 10. The extent of the Faroese EEZ is shown in Figure 11. CPUE was high at the beginning of the season, decreased in January and February but improved again for the remainder of the season. The highest CPUE in November and December was recorded between latitude 62°N and 63°N, and close to the islands. However, as the season progressed, the best catch rates were recorded further to the northeast of the islands.

On eight trips in the 1988/1989 season, skippers were requested to land their total catch in order to provide data on discards. In addition, an observer accompanied one fishing trip. The overall discard rate was 10.7% by number with totals for individual trips ranging from 0.4% to 32%. A Faroese Coast Guard vessel inspected two sets fished by fishing vessels during the season and reported no evidence of undersized fish (<60 cm) being caught.

5.1.2 Origin of salmon in the Faroes fishery

The number of microtags recovered in the Faroes market sampling programme is given below:

Season	No.sampl.	Catch	Samples			Adipose	Tags	
			Obs.	Scale	Meas.	Finc.	Micro	Extern
1986/87	33	63,723	47,347	837	2,664	481	36	85
1987/88	20	28,904	24,160	988	1,924	247	34	31
1988/89	34	65,289	51,562	895	2,186	421	59	76

The number of microtags recovered in 1988/1989 (59) greatly exceeded recoveries in all previous seasons (Table 41). This reflects a substantial increase in the number of tags from Ireland, Iceland, and England and Wales. Tags from salmon of Icelandic origin have appeared in the fishery previously but the higher number in the 1988/1989 season may just reflect the higher numbers of fish tagged there in 1987.

The recaptures of microtagged fish in the Faroes fishery have indicated that those released in Ireland tend to be caught in Faroes as 1SW fish while those from England and Wales tend to be caught as 2SW fish. Nearly all of the Faroese fish caught have been 2SW salmon. It was noted that the 1985 to 1987 releases of North American smolts have contributed to the Faroes fishery, mostly as 2SW fish.

The recapture rates at Faroes per 1,000 fish released (Table 42) and exploitation rate data from Norway (River Imsa) (see Section 5.1.4) suggest that the contribution to the fishery by Norwegian stocks has remained relatively stable and considerably higher than that of UK and Irish stocks. However, in the last few years, when catches at Faroes have been low, there has been a reduction in the exploitation rate at Faroes on River Imsa stocks. There are insufficient data to determine whether there has been any real change in the relative contributions by the various homewater stocks to the Faroese fishery.

Tag recoveries rates of Irish, Northern Irish, and English and Welsh-origin salmon have not been numerous during the period examined. Exploitation rates for these fish did not exceed 1% for 1SW or 2SW fish in any year. As noted previously (Anon., 1989c), stocks from these countries contribute at a lower rate than Norway and Sweden, while the contribution rate from Sweden is high overall, smolt production is relatively low.

The Working Group recommended that the data on microtags should be analyzed in more detail. The data could be used in a more constructive fashion if exploitation rates in homewaters could be established for some of the stocks.

5.1.3 Biological characteristics of the 1989 harvest

Catches from 33 landings were examined in the 1988/1989 market sampling programme at Faroes. During this programme, scales were taken from two samples of fresh-landed fish in November 1988 and one in April 1989. In addition, samples were taken by an observer on board a Faroese fishing vessel during January 1989. The age composition of the catch in the fishery during the 1988/1989 season was 1% 1SW, 92% 2SW, and 6% 3SW (Table 43). Age composition was also estimated from a split of the length frequency distribution of 2,188 fish measured in the market samples. This gave similar results to the age/length key above.

Table 44 summarizes the sea age distribution of landings in the 1983/1984 to 1988/1989 seasons. In all years, the total landings were dominated by the 2SW age class with the 3SW group next most numerous in all seasons except 1987/1988, when the 1SW group was second largest. The 4SW component appeared in samples in only three seasons (1983/1984, 1985/1986, and 1986/1987). The sea age distribution by month was similar in all seasons except for

1987/1988, when the proportion of 1SW fish in the landings increased from 3% to 20% in the second half of the season. There was a corresponding decline in the 2SW component.

Table 45 gives the smolt age distribution of the fish from which scale samples were taken during the 1984/1985 to 1988/1989 seasons. These samples were not weighted according to the catches, but it is interesting to note the increase in the proportion of river-age 1 and 2 fish caught in the fishery in the 1988/ 1989 season, which may reflect a change in the stocks being exploited.

5.1.4 Exploitation rates at Faroes

Data on tag recoveries were re-examined to derive exploitation rates in the fishery during the 1988/1989 season. Similar data were collated for earlier fishing seasons and are presented together in Table 46.

For two Norwegian stocks during the seasons 1981/1982 to 1988/ 1989, exploitation on 1SW salmon has ranged from 0.5% to 5% and for 2SW salmon from 3% to 56%. Exploitation on wild fish of all sea ages tended to be lower than for comparable hatchery releases. In the same period, exploitation rates on North Esk (Scotland) fish remained low for 1SW fish (<1%), ranging from 4% to 13% for 2SW fish, and between 7% and 29% for 3SW fish.

In recent seasons, exploitation rates on stocks from the River Imsa (Norway) and the North Esk (Scotland) have decreased and those on Irish and Northern Irish stocks have remained low.

5.2 Effectiveness of Management Measures

At the 4th 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 calendar years (1987-1989) such that the total nominal catch should not exceed 1,790 t and, in any given year, the annual catch should not exceed the annual average by more than 5% (i.e. 626.5 t). The other regulatory measures in force are described in Anon. (1988a).

In 1989, the catch of 364 t was well below the permitted maximum. The overall catch for the whole trial period was thus 1,183 t, 66% of the TAC.

Although there was a permitted maximum of 26 licences for the 1988/1989 season, only 19 were issued and of these, only 12 were used. The total effort for the season was 1,042,040 hooks. These were fished during 525 sets, which was only a third of the permitted maximum of 1,600 each year. Since effort was voluntarily restricted it was not possible to assess the effectiveness of mandatory effort restriction as a management measure.

In the 1988/1989 season and in 1989, no Faroese vessels fished outside the Faroese EEZ.

The Faroes fishery is subject to a regulation which allows the closure to fishing of areas where vessels are catching salmon of less than 60 cm in length. This regulation is difficult to enforce without extensive monitoring, and to date this regulation has never been invoked.

A total of 14 licences was issued for the 1989/1990 season. The fishery opened on 1 November 1989 as agreed. The Christmas closure extended from 20 December 1989 to 3 January 1990.

5.3 Possible Unrecorded Catches in International Waters

During the 1989/1990 season, there have been a number of reports of foreign vessels, registered in countries that are not Parties to the NASCO Convention, on long-lining for salmon in international waters to the north of the Faroese EEZ. NASCO (CNL.14.175) reported receiving information on such activities during the winter of 1989/1990 from the Faroese authorities and additional evidence came from Icelandic sources. The Danish Ministry of Fisheries reported that at least 7 vessels were thought be involved.

One vessel was inspected by a Scottish fisheries protection vessel in December 1989. It had 30 t of salmon on board, said to have been taken to the north of the Faroes EEZ and had a total capacity for 45 t. The vessel's skipper reported making 3 trips per year.

A report of an inspection by the Faroese authorities in Torshavn on a second vessel revealed that it had taken 5 t of salmon in 7 sets just outside the Faroese EEZ in January 1990. The intention was to take 25 t of salmon on the trip.

If it is assumed that all 7 vessels make 3 trips per year and take an average of 30 t of salmon per trip, the total potential unreported catch from this source may be of the order of 630 t. This is unlikely to have been achieved in 1988/1989 because of the adverse weather.

5.4 Reared Salmon in Fisheries and Spawning Populations

The Working Group considered the impact of fish aquaculture escapees on wild salmon stocks.

5.4.1 Behaviour of fish farm escapees

The rapid increase in salmon farming (production figures for 1988 and 1989, see table below), particularly in Norway and UK (Scotland), has led to an increased proportion of escaped salmon in both marine and freshwater fisheries, and also in spawning populations.

Production of farmed Atlantic salmon (t round weight) in the North Atlantic

Country	1988	1989
Canada	3,800	5,600
Faroes	3,300	8,000
France	60	N/A
Iceland	1,000	3,000
Ireland	4,900	7,200
Norway	80,233	117,000
Sweden	363[1]	N/A
UK (Scotland)	18,000	28,500
Others	1,000	-
Total	112,656	169,300

[1] Includes some farming in the Balic.

Salmon may escape from hatcheries and fish farms at all life stages. In the sea, experimental releases of farmed Atlantic salmon have shown that there is a seasonal variation in survival (Figure 12). Survival of salmon that escaped during the spring of their first sea year was much higher than for those escaping during the rest of that year (Hansen and Jonsson, 1986, 1989). Older fish escaping during the summer seem to enter rivers at random (Hansen et al., 1987). Smolts which escape from sea cages return to the same area from which they escaped and enter local rivers to spawn (Hansen et al., 1989).

There are few data on the reproductive success of fish farm escapees. Recent data from the River Imsa, however, suggest that spawning success of ranched salmon of the River Imsa stock is lower than for wild fish (Jonsson et al., 1990).

The Department of Agriculture and Fisheries for Scotland, jointly with the Atlantic Salmon Trust, carried out studies in the River Polla in Northern Scotland in 1989. As the result of storm damage in February 1989, almost 200,000 salmon escaped into nearby Loch Eriboll, a sea loch. By August, it had become clear that farmed escapees were entering the River Polla with the run of native wild fish. Observations were made on the behaviour of wild and farmed fish in the river, until the completion of spawning in December.

The study is not yet complete but the following is a summary of the observations made to date:

1) Farmed and wild fish could be distinguished by their appearance. The accuracy of these identifications is being assessed by pigment analysis of samples of muscle taken from some of the fish.

2) All the fish entering the River Polla were sexually mature.

3) Farmed fish of both sexes were observed to spawn and all the females captured towards the end of the year were spent.

4) Farmed and wild fish were observed spawning together. Attempts are being made to confirm this biochemically.

5) Wild fish were observed to distribute themselves throughout the length of the river, but farmed fish tended to be more restricted to the lower part of the river.

6) Spawning of farmed fish was concentrated in the lower reaches of the river. This was particularly marked in the case of farmed females. This difference between farmed and wild females will be further examined by biochemical means.

7) In general, farmed females spawned later than wild ones.

8) Farmed females cut redds on areas of gravel which had been used already by wild fish. Whether this over-cutting disrupted existing redds made by wild fish will be established biochemically.

Further studies are underway to determine whether these observations can be generalized between sites and/or between years. The Working Group noted these interaction studies. Some doubts were expressed as to the practicality of some aspects, but the results are awaited with interest.

5.4.2 Farmed salmon in homewaters

The Working Group reviewed available data on the numbers of escaped farmed fish in homewaters in the North East Atlantic.

Iceland

In Iceland, the contribution of reared fish to catches has been increasing for the last few years. In the River Ellidaat, the contribution to rod catches was estimated in 1988 and 1989. The estimates are based on scale readings and are as follows:

Year	Total salmon catch	Number of scales analyzed	Percentage of reared fish
1988	2,006	542	17
1989	1,773	565	30

It is not known whether farmed and wild fish are equally vulnerable to rods. Most of the reared salmon observed were escapees from fish farms, although there were also some strays from sea ranching. Almost all the fish were sexually mature, and scale analyses revealed that some fish had spawned previously in the wild. The proportion of reared fish is highest at the lower parts of the river, and the reared fish enter the river later than the wild fish.

Ireland

Between June 1989 and January 1990, five accidents resulting in escapees from salmon farms were reported from Ireland (Table 47). In total, about 140,000 to 160,000 fish escaped.

In the Irish drift-net fisheries, the percentage of farmed escapees varied considerably, ranging in samples from 0.5% in the north to 6.0% in the Galway region. These were local area samples and cannot be raised to the total drift net catch.

In the Burrishoole River in 1988, 638 fish farm escapees were taken entering the system, 421 at the trap and 54 by angling This is compared to a wild run of 475. In 1989, 44 fish farm escapees were taken, 36 at the trap and 8 by rod and line compared to a wild salmon run of 640.

Norway

During the 1989 fishing season, which lasted from 1 June to 21 July, salmon caught at 11 marine localities were examined. A combination of external morphology and scale analysis was applied to identify the reared salmon in the catches (Lund et al., 1989). Figure 13 gives the geographical locations of these fisheries. In general, the proportion of reared salmon in fisheries in the outer coastal areas (Figure 14) was higher than in the fjords. The percentage of reared fish ranged from 6.9% to 66.0%. These fish were mainly of farmed origin. At six locations, data are also available from earlier years (Figure 15). At most localities, there was an increase in the proportion of reared salmon in catches in recent years.

In 1989, salmon were sampled from angling catches in 57 rivers, but to date, data have been analyzed for only 34 rivers. The geographical location of the rivers is shown in Figure 16, together with point estimates of the proportion of reared salmon in the samples. Data collected in some of these rivers in 1988 are also presented (Moen and Gausen, 1989). There were large variations in the proportion of reared salmon between samples, but the proportion of reared salmon increased from 1988 to 1989 in the majority of the rivers sampled.

Point estimates of the proportions of reared salmon among fish collected for brood-stock in Norway in 1989 (Figure 17) suggested that this proportion is much higher just prior to spawning than during the angling season. Although gear selection may influence these figures, the main explanation for this difference is probably the later upstream migration of reared salmon.

It is important to note that the data presented above could not be used to estimate the overall proportion of reared salmon in Norwegian homewater fisheries and spawning stocks. This is because the sampling sites and sampling methods are not representative for the country. Furthermore, the freshwater samples have been collected with selective gear, and only samples from restricted areas within rivers are available. The estimated proportion of reared salmon in rivers are, therefore, probably not representative of the whole river and their spawning stocks.

UK (England and Wales)

In England and Wales, there are few cage-rearing sites. No fish farm escapees have been identified from samples of scales collected.

UK (Scotland)

Based on scale analysis and external morphology, the proportion of reared salmon was estimated in samples from five commercial fisheries in 1981-1989 (Table 48). In most years, reared salmon were absent from the samples. However, in recent years, an increased proportion of reared salmon has been observed, and these are thought to be farm escapees. The highest proportions of reared fish occurred in areas nearest to the fish farms.

UK (Northern Ireland)

No programme for assessing the proportion of farm escapees in the Northern Ireland fishery was carried out in 1989, but observations of salmon runs in the River Bush, and examination of a small number of commercially caught salmon at fish dealers suggest the proportion was negligible.

5.4.3 Farmed salmon in the open ocean

In 1988, 25 (8.2%) fish from a sample of 304 fish caught in the fishery at Faroes were classified as reared on the basis of abnormal fins. Fifteen of these fish (5%) were classified as reared by scale analysis, but only 6 were common to both groups. These approaches may overestimate the numbers of fish farm escapees in the fishery as some of the reared fish identified are likely to have been stocked into rivers as parr or smolts. No new data were collected in 1989.

No farmed fish could be detected from scale samples taken in the Greenland fishery in 1989. However, smolts escaping from fish farms would not be identified as farmed, but as stocked smolts.

5.4.4 Conclusion

The Working Group recommends that at future meetings countries should present data on the production of farmed salmon, number of salmon that have escaped from specific localities, size and age of the fish, and the time of escape. Furthermore, countries should present estimates of the proportion of farmed salmon in fisheries and spawning populations in their home waters, where possible.

6 QUESTIONS OF INTEREST TO THE NORTH AMERICAN COMMISSION OF NASCO

NASCO asked ICES to describe the events of the 1989 fisheries with respect to gear, effort, composition and origin of catch and to estimate exploitation rates and status of the stocks in home-waters and interception fisheries on stocks occurring in the Commission area.

6.1 Canada

6.1.1 The fisheries 1989

No new management measures were introduced in the Canadian fisheries in 1989. A detailed description of the commercial fisheries was provided in Anon.(1985b) and updated annually by the Working Group (Anon., 1986a,b, 1987, 1988b, 1989a,b).

The total salmon landings for Canada in 1989 were 1,166 t (Table 2). The landings of 1SW salmon (≤ 2.7 kg or ≤ 63 cm) (550 t) in 1989 were 19% below the 1988 landings (677 t) and 18% below the previous 5-year mean (670 t). The landings (616 t) of 2SW salmon (> 2.7 kg or > 63 cm) in 1989 were only 3% below the landings of 2SW salmon in 1988 and 13% below the previous-year mean (710 t). Of the total Canadian landings by weight, 12% were in Quebec, 80% in Newfoundland and Labrador, 5% in the Maritimes, and 3% in the Native fisheries. The recreational, commercial, and native composition was as follows:

Fishery	% of 1989 catch
Recreational	13.6
Commercial	83.8
Native	2.6

The decline in total commercial landings from 1,596 t in 1987 to 914 t in 1989 was spread over all Salmon Fishing Areas of Newfoundland and Labrador and the Quebec North Shore (Table 49). Landings in Newfoundland and Labrador of 832 t were the lowest since 1984 and the second lowest of a 19-year data set (Table 50). Commercial landings of small salmon in 1989 were down in Labrador and the south coast of Newfoundland relative to years since 1985.

Detailed descriptions of the Canadian fisheries and landings are provided for 10 geographic areas (Figure 18) in the North American Study Group Report (Anon., 1990a). The landings in the recreational and commercial fisheries by these 10 areas are summarized in Figures 19 and 20.

6.1.2 Composition and origin of catch

The Canadian fishery in 1989 captured salmon of Canadian and USA origin. Recaptures of tagged 1SW salmon of USA and Canadian origin occurred in the Newfoundland and Labrador fisheries.

Salmon in ten commercial salmon fishing ports in Newfoundland and Labrador were scanned for CWTs. These locations were in the southern position of SFA2 and in SFAs 3 + 4 (Figure 18). A total of 17,359 salmon was examined from the landings of commercial vessels in Canada during 1989. Of this sample, 100 salmon were found to be adipose-clipped, of which 28 contained CWTs. Approximately 11% of the salmon examined were from catches in Square Islands, Labrador with the balance coming from Newfoundland. The highest percentage of tagged salmon was observed at Square Islands. The CWTs recovered in Canada were of United States and Canadian-origin. Of the 28 tags recovered, 24 were from 1988 USA-origin hatchery releases in the Penobscot, Connecticut, and Merrimack rivers. Two tags were from 1987 releases, one each from the Connecticut and Miramichi rivers. The remaining two tags were from releases in the Miramichi River in 1988. The number of salmon examined for CWTs and periods of sampling were as follows:

Location	Sampling period	Number examined	Per cent clipped	Origin Can	Origin USA	Total CWT	% CWT
Square Islands	01 Jul - 25 Jul	1,867	0.86	0	6	6	0.32
Goose Cove	16 Jun - 24 Jul	1,990	0.40	0	4	4	0.20
Croque	15 Jun - 31 Jul	1,398	0.72	1	3	4	0.29
Conche	15 Jun - 22 Jul	3,712	0.48	0	7	7	0.19
Englee	15 Jun - 04 Aug	1,403	0.07	0	1	1	0.07
Harbour Deep	15 Jul - 04 Aug	1,224	1.14	0	3	3	0.25
Campbellton	05 Jun - 22 Jul	1,061	0.00	0	0	0	0.00
Leading Tickles	06 Jun - 26 Jul	1,046	0.86	0	0	0	0.00
Shoe Cove	05 Jun - 14 Jul	1,941	0.36	0	0	0	0.00
Twillingate	05 Jun - 02 Aug	1,717	0.99	2	1	3	0.17
Total		17,359		3	25	28	
Average			0.59				0.15

Carlin tags reported in 1989 from Penobscot River smolts totalled 45, which is a 125% increase from the 1988 return. Most tags were recovered in Labrador, SFAs 1 + 2, with the highest recoveries in Insular Newfoundland occurring in SFA 3. No Connecticut River tags from the 1988 releases have been reported in Canada. Estimates of USA-origin salmon harvested in the 1989 fishery will not be available until after 1990 returns to homewaters.

	Salmon fishing areas 1	2	3	4	5	6	7-14	Total
Penobscot Carlin tags	21	4	10	4	2	1	3	45

It would be inappropriate to infer differential exploitation on the USA and Canadian tagged salmon because of the differences in relative numbers of tags at large, location and time of sampling and the number of fish scanned for tags.

6.1.3 Status of Canadian stocks, 1989

Estimates of spawning escapements relative to target values were derived for the Restigouche (Geographic Area 7; Figure 18), Miramichi (Geographic Area 7), and Saint John (Geographic Area 9) in New Brunswick, Margaree (Geographic Area 7) and LaHave (Geographic Area 8) in Nova Scotia, and Conne River (Geographic Area 3) in Newfoundland as in previous years (Anon., 1989b).

River	Target values			1989 spawning escapement		
	Eggs (10^6)	Fish		Eggs (10^6)	Fish	
		MSW	1SW		MSW	1SW
Restigouche	71.4	12,200	2,600	39.2	6,569	2,559
Miramichi	132.0	23,600	22,600	124.1	14,636	50,641
Saint John[1]	29.5	4,400	3,200	21.1	3,130	7,356
Margaree	6.7	1,036	579	7.8	1,219	606
LaHave[2]	1.7	94	575	4.3	450	2,466
Conne	7.8	-	4,000	7.6	303	3,386

[1] Above Mactaquac; wild and hatchery fish.
[2] Above Morgan Falls; wild fish only.

Estimates of egg deposition in 1989 approximated (Miramichi and Conne) or exceeded (Margaree and LaHave) target egg requirements in 4 rivers. In the Miramichi River, the deficit of eggs from MSW spawners (approximately 30%) was compensated for by the large escapement of 1SW salmon. On the Saint John and Restigouche rivers, the egg deposition rates were only 70% and 55% of the target levels, respectively. Targets have been approximated or exceeded in none of the last 8 years on the Restigouche, 6 of the last 8 years on the Miramichi, 2 of the last 8 years on the Saint John, 4 of the last 7 years on the Margaree, and in all years on the LaHave (Anon., 1990a). Returns of MSW fish to major New Brunswick rivers continue to be short of expectations derived from historical MSW:1SW relationships.

Additional assessments based on counts obtained at fishways, counting fences, or by divers in 1989 suggest that target egg depositions were met on Western Arm Brook (Geographic Area 4), Grand and Middle rivers, Cape Breton (Geographic Area 8), and Big Salmon and Alma rivers (Geograhic Area 9). Seventy-five per cent of the target was estimated to have been achieved on the Godbout and de la Trinité (Geographic Area 5; 80% in some other rivers), and a number of rivers in Gaspé (Geographic Area 6). The Liscomb River (Geographic Area 8), a development project hindered by low pH, met only 50% of the target.

Counts of 1SW salmon obtained at fishways and counting fences (Anon., 1990a) in Insular Newfoundland (Geographic Areas 2, 3, and 4) were down from those of 1988 and mean counts, 1984-1988 in 11 out of 15 cases, many by as much as 50%. Counts of 1SW fish at 11 facilities in the Maritime Provinces (Geographic Areas 7, 8, and 9) were down from those of 1988 and the 1984-1988 means in 7 of 10 cases. Two of 4 fishways in Quebec (Geographic Areas 5 and 6) had counts lower than those of 1988 or 1984-1988. Counts of MSW salmon in Newfoundland were similar to those of 1988 although they were low in both years. Those of the Maritime Provinces were below 1988 and the 1984-1988 means in 6 of 10 cases. MSW counts at 4 fishways in Quebec were greater than those of 1988 or the 1984-1988 means.

6.1.4 Exploitation rates on the Canadian stocks

The exploitation rate was estimated in the recreational fisheries on nine 1SW stocks in Newfoundland and in the commercial fisheries for two 1SW stocks in Newfoundland.

Exploitation rates for the Saint John River salmon stock were calculated for MSW salmon in homewater fisheries and non-maturing 1SW salmon in Newfoundland fisheries, and West Greenland fisheries.

Counts of 1SW fish were available for nine salmon populations at fishways or fish counting fences in Newfoundland (1983-1989). Angling catches were also available for areas above and below these facilities. Exploitation rates were calculated using the formula:

$$u = \frac{A_a + A_b}{A_b + T}$$

where:

A_a = angling catch above fence or fishway,
A_b = angling catch below fence or fishway,
T = count from fence or fishway trap.

Analysis of variance was used to test the hypotheses that there were no differences in the exploitation rates among rivers and among years. The exploitation rates were arcsine transformed as recommended by Sokal and Rolhf (1969) for data such as percentages and proportions.

The results indicate a range in exploitation rates from a low of 0.076 on Exploits River in 1989 to a high of 0.530 on Middle Brook in 1988 (Table 51). Overall, mean exploitation rate was 0.229 on all rivers and for all years, and river means ranged from 0.131 on Grand Bank Brook to 0.426 on Middle Brook (Anon., 1990a). Analysis of variance revealed that mean exploitation rates were significantly different among river systems and among years. Although effort increased, there was no apparent trend in exploitation rates. Exploitation rates may be overestimated because a few salmon may have spawned in tributaries and in the main stems below the various counting facilities. Modelling of the exploitation patterns of Newfoundland salmon stocks may require annual estimates of exploitation.

Exploitation rates for commercial fisheries were calculated from Carlin tagging studies on salmon stocks of Conne River (SFA 11) in 1989 and Exploits River (SFA 4) in 1988-1989.

The estimate of commercial exploitation on the Conne River salmon stock, using a tag reporting rate of 0.7, is 0.03. The low commercial exploitation rate on this stock in comparison to exploitation rates on other Newfoundland stocks is related to the early run timing of this stock. If commercial exploitation is as low as this in other years, then the smolt to 1SW return rate to Conne River might provide estimates of natural mortality.

For the Exploits River salmon stock, the commercial exploitation rate was calculated, using a tag reporting rate of 0.70 in the commercial and recreational fisheries. The estimated commercial exploitation rate was 0.61 in 1988 and 0.57 in 1989. The Working Group noted that some tagged salmon may have passed upstream through the fishway undetected which would bias the exploitation rate upwards. However, there is some evidence that the reporting rate for tags from the commercial fisheries may be too high (Section 6.1.6), which would tend to offset the positive bias referred to above.

The total tag return rate was 0.12% in 1988 and 0.16% in 1989. The difference in tag return rates appears to be attributable to increased marine natural mortality because commercial exploitation was similar in both years, i.e., about 60%.

A more detailed description of the analysis of the exploitation rates for the above Newfoundland stocks is provided in Anon. (1990a).

The Working Group reviewed a time series of Carlin tag returns, harvest estimates, and exploitation rates of Saint John River origin non-maturing 1SW salmon in Newfoundland and Labrador and West Greenland (1974-1988) and their 2SW counterparts in home-waters 1975-1989.

Estimation of harvest in distant fisheries followed the procedure of Anon. (1986b) to estimate the harvest of USA-origin salmon in Canadian and West Greenland fisheries, i.e., H = t x L/[Rx(1-NC) x Ratio], and was for only that portion of the stock which originated at or above Mactaquac Dam. In accordance with harvest estimates for USA salmon (Anon., 1987, 1988a), reporting rates used were as shown below:

Fishery	Years	Tag reporting rate, R
Labrador	all	0.9
Newfoundland	all	0.7
Greenland	1975-1985	Annually variable (Anon., 1987)
	1986 on	0.8

Parameter values for NC and L were set at 0.1 and 0.9, respectively (Anon., 1987), except NC = 0.2 in West Greenland (Anon., 1988b). All tags returned from 1SW salmon captured in Newfoundland and Labrador were assumed to be those of potential 2SW maiden salmon.

Estimation of the RATIO parameter varied slightly from the approach outlined in Anon. (1987) because, i) tags in homewaters were returned from more than the recreational fishery (e.g., a by-catch in non-salmon gear, commercial fishery and native fishery each, in all probability, with an annually variable tag reporting rate) and ii) independent estimates of total homewater MSW salmon returns destined for Mactaquac were available. Hence, RATIO values (Table 52) were the number of tagged 2SW salmon counted at Mactaquac divided between the total hatchery and wild 2SW salmon counted (MSW salmon less an estimate of previous spawners) at Mactaquac.

Exploitation rates in the distant fisheries were based on home-water returns of 2SW salmon and the estimated harvests in Newfoundland and Labrador and West Greenland (see Section 4.1.5).

Basic assumptions were:

1) 2SW salmon returning to Mactaquac are the survivors of either the West Greenland fishery or the Newfoundland and Labrador fishery but not both.

2) Natural mortality is 0.12 per year.

3) Natural mortality is negligible during the period of the fishery.

4) The harvests in the fisheries were assumed to occur in the week in which the median number of tagged fish were captured, i.e., week 27 (July 02-08) year i, in Newfoundland and Labrador and week 33 (Aug. 20-26) year i in West Greeland; homewater returns and removals were assumed to occur in week 27, year i+1.

There were 365 tag returns from NAFO Divisions of Greenland in 1974-1988 (Table 53) and 327 from Salmon Fishing Areas of Newfoundland and Labrador (Table 54). Distant harvest accounted for 42% of the potential 2SW salmon, 58% were accounted for in homewater returns (Table 55). Distribution of the total 1974-1989 estimated harvest was 37% in Greenland, 36% in homewaters, 23% in insular Newfoundland, and 4% in Labrador.

Estimates of exploitation rates in homewater and distant fisheries for P = 0.3, 0.5, and 0.7 are in Table 56. Estimation of exploitation rates averaged 0.33 for Newfoundland and Labrador and 0.41 for West Greenland, 1974-1988, using P = 0.5. The average annual exploitation rate in homewaters over the same period was 0.406.

Ratios of Greenland harvest to homewater returns were positively correlated with ratios for Maine rivers (Anon., 1989a) (r^2 = 0.704; P <0.01, n = 13) while the ratios for estimates of harvest in Newfoundland and Labrador were not correlated. Estimated exploitation rates for Maine stocks in West Greenland 1974-1986 (1979 excluded) were also positively correlated with those of the Saint John (r^2 = 0.794; P <0.01).

6.1.5 Harvest estimates of USA-Origin salmon in Canada, 1967-1988

6.1.5.1 Comparison of Carlin tag and CWT harvest estimates of 1SW salmon in 1988

The Working Group considered harvest estimates of Maine-origin stocks in Newfoundland and Labrador derived from CWT and Carlin tagged salmon for areas sampled during CWT sampling. Estimates based on Carlin tags for the 1988 fishery were calculated, using the method described described in Anon. (1987), and as modified in this report. CWT harvest estimates were computed as in Anon. (1989b) except for the inclusion of the fishway passage efficiency factor of 85%. This factor was used in the calculation of the CWT tagged to untagged ratio for 2SW salmon in homewaters and the total number of CWTs in the trap in the Penobscot River. To compute the tag-raising factor for the 1988 CWT recovery date, the following 1989 inputs were used:

Run Estimate	2,941 2SW salmon
Total CWT	634
CWT at the trap	471
CWT by angling	80
Untagged/trap	1,715
Untagged/angled	233

From these data, the CWT to run ratio was 0.21561 and the raising factor for tags was 4.638. Estimated numbers of tags for a sample stratum in the fishery were raised for non-catch fishing mortality (Anon., 1989b) and raised to total harvest for the stratum.

Comparative harvest estimates based on CWT and Carlin tag recoveries for the communities and Statistical Sections sampled are presented in Table 57. As observed in Anon. (1989b), the ratio between the two estimates varied among locations, but the CWT estimate was usually higher. Additionally, when the harvest for communities was subtracted from the respective Statistical Sections, higher CWT to Carlin estimate ratios resulted. As observed with the 1987 fishery and sampling, Carlin tag recovery by port samplers may have increased the local reporting rate for Carlin tags.

The inclusion or exclusion of Carlin tags of unknown recovery date in the Carlin method were found to have a large effect on the ratio between the CWT and Carlin harvest estimates. It was noted by the Working Group that the time period of the CWT sampling in those locations with Carlin returns of unknown recovery date are weeks of high probability of encountering USA stocks as determined by the analysis of historical Carlin tag returns.

The Working Group reviewed the list of concerns developed for similar calculations from data for the 1987 fishery (Anon., 1989b). Considering the expanded program for CWT scanning (new sampling locations), the Working Group re-emphasized its concern over sample stratification in respect to timing, location, and size composition of the catch, in communities sampled. New information on run timing of tagged fish returning to the Veazie Dam on the Penobscot River suggests that CWT and Carlin tagged fish may have similar migrations. Other concerns about sampling and the statistical robustness of the comparison remain unresolved. Although it is unlikely that the two harvest estimates could be shown to be different by parametric statistical methods (see Table 57 and Anon., 1989b), the Working Group noted that this was the second year the CWT harvest estimates were found to be higher than the comparable Carlin tag harvest estimates. Since the CWT estimates do not require an assumed reporting rate, they potentially offer a means of estimating reporting rates for Carlin tags. These data indicate that the reporting rate in Newfoundland and Labrador is lower than the 70 and 90% rates used in the harvest model.

6.1.5.2 Historical harvest of 1SW and 2SW salmon

The Working Group expanded the assessment of USA-origin salmon harvest in Canada to include 2SW salmon catches occurring in Newfoundland and Labrador, and both 1SW and 2SW salmon catches occurring in regions outside of Newfoundland and Labrador. In addition, recent findings on the reporting rate of Carlin tags in Maine and the fish passage efficiency of fishways on Maine rivers were incorporated in the calculation of the ratio of tagged to untagged 2SW salmon in the homewater run (RATIO) (See Section 4.1.4 for details of changes in RATIO calculation).

Tag returns, with the exception of returns from North Shore Quebec, are summarized by Salmon Fishing Areas, whereas in previous assessments, these summaries were presented by Statistical Area. Harvest estimates by standard week are updated for both sea ages in Anon. (1990a).

The Working Group updated the time series of tag returns and harvest estimates of USA-origin 1SW salmon in Newfoundland and Labrador. Tag returns for Maine-origin 1SW salmon can be found in Table 58. Estimated harvest of 1SW salmon in Newfoundland and Labrador are summarized by year for 85% fish passage efficiency in Table 59. Estimates based on 85% efficiency are approximately 5% lower than the 100% efficiency estimates; the percent difference varies among years (Anon., 1990a). The harvest estimates for the 1988 fishery totalled 393 salmon at 85% passage efficiency and are distributed primarily in SFAs 1-3.

Tag returns from 1SW salmon of Maine-origin harvested in Quebec, Nova Scotia and New Brunswick are summarized in Table 60. In addition to tag returns from SFAs 19-23, four tags were recovered in Zones Q5-9 of North Shore Quebec. Most tag returns (approximately 84%) were recovered in SFAs 21-23, which comprise the Bay of Fundy and the Southwest Shore of Nova Scotia. The Working Group assumed that all of these returns were maturing salmon with the exception of the recaptures from Quebec. Similar to the summaries for Newfoundland and Labrador 1SW returns, harvest estimates are presented by year for fish passage efficiency 85% in Table 61.

Tag returns from 2SW salmon of Maine-origin harvested in Newfoundland and Labrador are summarized in Table 62. For the purposes of harvest estimation and run reconstruction modelling, the MSW components are reported separately. Tag returns are distributed among SFAs and have averaged four per year. Harvest estimates are presented by year for fish passage efficiency of 85% in Table 63.

Tag returns from 2SW salmon of Maine-origin intercepted in Quebec, Nova Scotia, and New Brunswick are summarized in Table 64. Almost all the returns were from the Bay of Fundy area and more than half were from recoveries made in 1968. Harvest estimates are presented by year and at fish passage efficiency 85% in Table 65. The Working Group assumed all of these returns were maturing salmon except the single tag recovery in North Shore Quebec.

6.1.6 Effectiveness of new or proposed management measures

No new or proposed management measures were introduced in Canada. However, the Working Group assessed the combined effects of all measures taken by Canada to reduce the harvest of USA-origin salmon by comparing only the harvest of 1SW salmon of Maine-origin in Newfoundland and Labrador fishery with the run size of 2SW fish the following year in Maine (Table 66). The harvest to run ratio of 0.134 for the year 1988 was the second lowest for the period 1967-1988.

6.2 USA

6.2.1 The fisheries in 1989

The unadjusted angling harvest (in numbers) by sea age for Maine rivers in 1989 is presented below:

River	Number of Atlantic Salmon				
	1 SW	2 SW	3 SW	P.S.	Total 1989
St Croix	7	(grilse only)			7
Dennys	1	11	0	0	12
E. Machias	14	16	0	1	31
Machias	7	9	0	0	16
Pleasant		Closed in 1989			
Narraguagus	4	35	0	0	39
Union	0	3	1	0	4
Penobscot	121	244	1	2	368
Ducktrap	0	0	0	0	0
Sheepscot	3	2	0	0	5
Kennebec	0	2	0	0	2
Saco	0	3	0	0	3
Total	157	325	2	3	487

The sport catch of salmon in Maine during 1989 was considerably higher than either 1988 (89%) or 1987 (73%). The sport catch in eastern Maine rivers was 28% 1SW salmon in 1989.

The licence sales in 1989 were the same for residents (2,375) as in 1988 and 20% less (268) for non-residents. The number of salmon caught and released exceeded the number caught and killed.

6.2.2 Composition and origin of the catch

The catches in USA rivers in 1989 are believed to have been of USA origin.

6.2.3 Status of the USA stocks

Catches in 1989 in Maine rivers with salmon runs that are primarily of wild origin, although higher than in the previous two years, were 52% below the long-term average (1967-1988). The increased catches in 1989 were primarily due to increases in 1SW salmon of both wild and hatchery origin (Anon., 1990a).

The Working Group reviewed the age structure of the angling catch for three Maine rivers for the period prior to the Greenland fishery (to 1961) and during the Greenland fishery (1962-1989).

For all three rivers the age distributions of the catch was different (P <0.001) for the two time periods. The differences in the distributions are in part due to significant increases in the catches of 1SW salmon (P = 0.05). However, the major influence on the age distributions was the highly significant (P = < 0.001) decrease in the numbers of salmon in the 3SW/PS category.

In addition to a decline in the numbers of 3SW/PS in the sport fishery since 1962, numbers of 2SW salmon, which comprise the major portion of the angling catch in both time periods, appear also to have declined in two of the three rivers (Figure 21).

Survival of hathcery-reared smolts of the Penobscot River for the period 1968-1989 are reported in Anon. (1990a). The total return rates for the 1985-1987 smolt classes were among the lowest observed during the past 19 years. The low rates of return are due to a decrease in the rate of return of MSW salmon (Figure 22) although the 1SW salmon return rates increased.

During the period 1966-1987, more than 1.2 million Carlin-tagged hatchery-reared Atlantic salmon smolts were released in Maine rivers. A total of 3,755 homewater tag returns were obtained from a variety of sources and only 2% of the total returns came from rivers other than the one where the smolts were originally stocked (Table 67).

Salmon ratios 1SW:MSW (by smolt class) for the Penobscot River salmon for the period 1969-1989 are shown in Figure 23. Although returns from the 1985-1987 smolt classes have yielded the highest 1SW:MSW ratios in the history of the Penobscot River restoration programme, smolt to 1SW salmon return rates are independent (r^2 = 0.086) of smolt to MSW salmon return rates.

The number of MSW female spawners required for full habitat utilisation (2.4 eggs/m^2) was estimated for three New England rivers. Spawning escapement of MSW female salmon, as counted at fishway traps (incuding hatchery broodstock), were:

River (Target; MSW females)	Year	Total run (both sexes)	No. MSW females
Penobscot River (Target=3,000)	1985	3,365	1,400
	1986	4,529	1,750
	1987	2,510	858
	1988	2,855	1,002
	1989	3,087	972
Merrimack River (Target=1,537)	1985	214	105
	1986	103	53
	1987	139	62
	1988	65	33
	1989	84	41
Connecticut River (Target= 4,076)	1985	310	152
	1986	318	170
	1987	353	193
	1988	95	59
	1989	109	57

The estimated total run of 2SW salmon to Maine rivers in 1989 was 2,941 salmon, based upon a fish passage efficiency of 85%

(Section 6.1.5). Although the total was similar to 1988, it was 25% below the mean run size (3,917) for the period 1979-1988.

6.2.4 Exploitation rates

In the development of the Carlin tag harvest model for Maine stocks, it was necessary to estimate reporting rates for untagged and tagged salmon returning to Maine rivers. The estimates of these rates adopted by the Working Group are 80 and 90%, respectively (Anon., 1987). If these reporting rates are accurate, estimates of uncorrected angler exploitation from the returns of tagged fish should be higher than those from the returns of untagged fish. An examination of the historical time series of exploitation estimates for the two groups showed that the estimates for untagged fish was generally higher than for tagged salmon (Anon., 1989a). A re-analysis of the data and information on run timing indicated that the rate for tagged salmon is not higher than the rate for untagged salmon (Anon., 1990a). Consequently, the Working Group set the reporting rates for both tagged and untagged fish at 80%.

The preliminary results of an ongoing fish passage efficiency evaluation (1987-1989) of the Penobscot River counting facility were reviewed. Based upon this, the Working Group decided to apply a fish passage efficiency of 0.85 to all fishway trapping facilities. The revised exploitation rates for the Penobscot River, based upon a fish passage efficiency of 0.85, are reported in Anon.(1990a). The exploitation rate in 1989 was 12.6%, which is 91% higher than in 1988.

6.2.5 Effectiveness of management measures

No new management measures were instituted in 1989, although measures instituted late in 1988 became fully operative. The effectiveness of management measures instituted in 1988 in Maine were not reported on, since most measures are virtually impossible to evaluate.

6.3 France (Islands of St. Pierre and Miquelon)

Information collected by NASCO, concerning the salmon fisheries of St. Pierre and Miquelon, was reviewed. In 1989, the licensed salmon fishery consisted of 13 professional fishermen using 125 mm mesh gill nets up to 1,080 m long and 37 recreational fishermen using nets up to 180 m long. The minimum landing size is 48 cm. The salmon fishing season is 1 May to 31 July (extracted from a copy of the fishing regulations for St. Pierre and Miquelon).

NASCO reported the numbers and total weight of salmon landed in 1987 to 1989. The numbers of small and large salmon caught were estimated from the average weight of small and large salmon, each year, caught in Statistical Section 33, Newfoundland. The Working Group was unsure if the catch reported by NASCO included catches by recreational fishermen.

Year	No. of fish reported	Weight (tonnes)	Mean wt Sect.33 small	large	No. of small	No. of large
1987	442	0.984	2.0	4.8	406	36
1988	813	2.084	1.9	4.3	597	216
1989	971	2.590	1.8	4.1	604	367

Other information supplied to the Working Group indicated that catches by professional fishermen were as follows:

	Year					
	1983	1984	1985	1986	1987	1988
Catch (t)	3	3	3	2.5	0.2	2

St. Pierre and Miquelon have no native salmon populations. The Working Group requests that information on biological characteristics of the catch be provided for its next meeting. Also, the differences between the report by NASCO of the catch and the official catch should be resolved. The Working Group requested that a longer time series of catches be provided including the distribution of catches by week.

7 HOMEWATER FISHERIES

7.1 Canada

The total salmon landings in Canada in 1989 were 1,166 t, consisting of 550 t and 616 t in the small and large categories, respectively. The commercial fisheries harvested 78.4% (914 t), the recreational fisheries 18.2% (212 t), and the native fisheries 3.4% (40 t). Further information is available in Section 6.1.

USA

There is no commercial harvesting of salmon allowed in the USA, and Maine is the only State that allows angling. The total catch in 1989 was 487 salmon, of which 32% were 1SW and 68% MSW salmon. The total catch was 89% higher than in 1988. More detailed information related to USA homewater fisheries is given in Section 6.2.

7.2 North East Atlantic

7.2.1 The Fishery in 1989

The total nominal catch in homewater fisheries in the North East Atlantic in 1989 was 3,907 t (excluding catch at Faroes). Most countries reported a decrease in catch, relative to 1988, with France, Iceland, Ireland, Norway, and Sweden having particularly poor catches (Table 2). Only two countries reported increased catches, Finland, where the fishing season opened earlier than normal and there was a large increase in numbers of recreational fishermen, and N. Ireland, where a very dry summer delayed migration into rivers until after the peak of the coastal fishery.

In almost all countries, a contributing factor to the decreases in catches was a reduction in angling catches, attributable to low river flows. This was particularly evident in England and Wales, where angling catches were 44% lower than in 1988.

Probably the single most important factor affecting the Norwegian fishery in 1989 was the ban on drift netting in Norwegian homewaters. Poor catches of 1SW salmon in Swedish waters were attributed to increased mortality on the migrating 1988 smolts, where toxic algal blooms occurred in coastal waters. Returns of 2SW salmon in 1989 were not affected by this and the numbers caught were close to the long-term average.

Iceland and the USSR reported increases in the proportion of 1SW salmon in the runs, but in the former case, the 2SW component of the run was only half of that expected. In the USSR, the unusually high proportion of 1SW salmon compared to other sea age groups was attributed to anomalously high sea temperatures in parts of the Barents Sea.

7.2.2 <u>Exploitation rates and the status of stocks in homewaters</u>

Data available for 1989 indicate a decrease in exploitation rates in several countries, though this was not uniform across all sea ages of fish. Stock levels were thought to be variable, within as well as among countries, though overall stock levels in freshwater are thought to be down relative to recent years.

Exploitation rates in France (R. Elorn) were higher on spring salmon (62%) than on 1SW fish (6%), with 1SW fish forming the largest stock component (80-90%) in small rivers where there are traps. Runs size increased in some and decreased in others.

Exploitation rates for the North Esk in 1989 indicated an exploitation over the year of 35% and 36% on 1SW and MSW salmon, respectively, in this Scottish river, while the adult escapements (80%, occurring outwith the netting season) was the second highest in recent years.

Effort in the Irish drift net fisheries was lower in 1989 than in 1988 in most areas. This reduced effort was reflected in higher angling catches and is likely to have resulted in improved spawning escapements despite an overall reduction in marine survival of smolts, relative to the high 1988 values. However, on the stock where exploitation was measured it was similar to 1988, between 72% and 82%. In Northern Ireland, data from the River Bush suggested an increase in homewater exploitation in 1989 on microtagged 1SW fish (89%) and 2SW fish (60%). The adult run on the River Bush was much poorer than expected, but this is thought to reflect lower flow conditions which prevailed until well past the peak of the commercial fishery. Elsewhere, runs were very good (highest in the Foyle system for several years), suggesting exploitation rates were lower for these stocks.

In Norway in 1989, marine exploitation rates were estimated on the River Imsa and River Drammen stocks. For two levels of tag reporting, 50% and 70% the following estimates were produced:

Stock	Smolt type	50%		70%	
		1SW	2SW	1SW	2SW
R.Imsa	Wild	0.67	0.74	0.59	0.67
R.Imsa	1+	0.56	0.86	0.48	0.81
R.Imsa	2+	0.34	0.44	0.27	0.38
R.Drammen	1+	0.40	0.57	0.32	0.50
R.Drammen	2+	-	0.60	-	0.53

Compared with estimates from 1988, exploitation rates decreased for all categories of salmon of the River Imsa stock, except for 1SW wild fish. Exploitation rates on 1SW salmon of the River Drammen stock decreased, but increased on 2SW fish. The within-river exploitation rate on the River Drammen decreased from 0.53 in 1988 to 0.35 in 1989.

Norwegian stocks continued to suffer the effects of _Gyrodactylus salaris_, which is now present in 33 salmon rivers, while acidification continues to deplete salmon stocks.

In Sweden, restoration efforts using liming have reportedly increased the smolt production by 49,000-93,000 smolts in acidified west coast rivers, though high rainfall in the winter 1989-1990 counteracted liming efforts in several rivers.

In Iceland, homewater exploitation rates in the R. Ellidaár were 41% in 1989, compared to 52% in 1988. Exploitation rates for most rivers varied between 30% and 80%.

In Finland, juvenile stocks are reported to be low in several important rivers. General increases in the proportion of salmon weighing 2 - 4.9 kg in the catches were attributed to the new Norwegian fishery regulations and increased number of fish farm escapees (see Section 7.3).

In the USSR, exploitation rates in the rivers of the Barent Sea and the White Sea basins were 67.7% and 51.8%, respectively. The number of spawners in the rivers of the Murmansk region was satisfactory. But for the Arkhangelsk and River Pechora regions, poor utilisation of spawning areas was reported. Due to few tag returns, it is not possible to estimate the exploitation rates in the sea for salmon stocks from the USSR.

7.2.3 Effectiveness of management measures

In Iceland, new regulations were introduced in 1989, governing gear, mesh size, and location of sea-char and sea trout nets in the sea, in order to minimize the accidental catching of salmon. Regulations introduced in 1988 to control transport of stocks and releases in the wild appear to have reduced transfer of stocks between river systems.

Other measures introduced in 1989 to protect stocks included deployment of two new fishery inspection vessels by Ireland to patrol their offshore drift net fishery and buy-outs of a number of riverine or estuarine net fisheries in England and Wales and Northern Ireland. The effectiveness of these measures has probably allowed an increase in escapement to freshwater, but no direct relationship can be expected, given the numerous factors controlling catch and effort and the particularly unusual weather conditions in 1989.

In Scotland, several local fishery regulations were introduced during 1989, but it will not be possible to assess their effects until late 1990. In Finland, regulations will come into effect in 1990 in the River Teno, where gill netting in the tributaries will be prohibited and recreational fishing restricted.

In the USSR, commercial fishing for salmon in the R. Pechora was prohibited in 1989, to remain in effect for a seven-year period.

No other changes in fishery regulations were reported for 1989.

7.3 Effectiveness of Recent Management Measures in Norway

During 1989, the most significant management measures to be introduced in Norwegian waters was the total ban on drift netting. Further measures restricted effort in other Norwegian net fisheries, especially those using bend nets, while salmon fishing by all methods was banned in 74 of approximately 500 rivers.

These regulatory measures had an impact on the catch in Norwegian homewaters in 1989:

Nominal catches in Norwegian homewaters 1982-1989 (t round weight) broken down to drift net fishery, marine fishery excluding drift nets (other nets) and freshwater fishery and the proportion of the total catch taken in freshwater:

	1982	1983	1984	1985	1986	1987	1988	1989
Drift nets	590	826	866	667	795	552	527	0
Other nets	469	418	458	572	497	461	314	484
Freshwater	289	306	299	322	306	372	235	397
Proportion in freshwater	0.21	0.20	0.18	0.21	0.19	0.27	0.22	0.45
Total	1,348	1,550	1,623	1,561	1,598	1,385	1,076	881

In the period 1982-1988, the total nominal catch of salmon fluctuated between 1,076 and 1,623 t, but decreased to 881 t in 1989, most probably as a result of the new management measures. In 1989, the marine catch of salmon was 484 t, which is much lower than for 1982-1988, when this catch varied between 841 and 1,324 t. The catch in the marine salmon fisheries, excluding drift netting, was close to the average for this period. It is likely that the ban on drift netting in 1989 has resulted in a larger number of salmon being available to the other salmon fisheries. The regulation of these fisheries has probably resulted in a substantial increase in freshwater escapement suggested by increased catches in freshwater. In 1989, freshwater catch accounted for 45% of the total nominal catch compared to between 18 and 27% over the years 1982-1988. Increased freshwater escapement is also suggested by the reduction in marine exploitation rates on most components of the River Imsa salmon stock. This was not the case for salmon of the River Drammen stock. However, drift nets have only exploited this stock to a small extent. The management measures introduced in freshwater have most probably resulted in increased spawning escapement as demonstrated for the River Drammen stock (Anon., 1990b).

8 THE RATIO OF MICROTAGGED TO ADIPOSE FIN-CLIPPED SALMON

The Working Group was asked by ACFM to review and provide explanation for the difference between the ratios of microtagged to adipose fin-clipped salmon at release and at recapture in fisheries and sampling traps.

The Working Group have compiled tagging and fin-clip data since the 1987 release year. These data are presented as separate annual reports in a prescribed format. It should be noted that the columns marked fin-clips in the compilation includes clips on any fin and not merely adipose fin-clips. The data also include many juvenile age classes which will migrate to sea in different years, and some of these age classes will have a mortality before migration.

The Working Group examined the possibility that the difference in the ratios at release and recapture sites could be related to tag loss. Tag loss rates for microtagging have been estimated by most tagging agencies and have generally been less than 5% and frequently less than 1%.

In the Faroes fishery, the number of microtagged fish per thousand fish caught has increased in line with the increase in numbers of salmon being microtagged. The percentage of adipose fin-clipped fish in the catch has also risen. The number of microtagged fish as a percentage of the number of clips has also increased although the percentage has been variable. A number of countries are releasing adipose fin-clipped fish which have not been recorded in the compilation of tagging and fin-clipping data. Ireland released 100,000 annually up to 1989. Scotland released in excess of 50,000 clipped fish in 1988. It is suspected that a considerable number of adipose clipped fish are released in Norway. The USSR releases large numbers of fin-clipped parr annually.

Tagging data suggest that there is little contribution from Ireland or Scotland, but the numbers of untagged fin-clipped fish in the Faroes fishery could easily be accounted for by the numbers of fish being released in Sweden, Norway, and the USSR.

The percentage of untagged fin-clipped fish in the homewater fisheries of countries using microtags in the North East Atlantic Commission Area was considered to be the same as would be predicted from the known (or estimated) numbers of fin-clipped and microtagged fish released in the area. This ratio will, of course, be different from the ratio of bulked tag to adipose clips releases.

In the fisheries in Newfoundland, Labrador, and West Greenland, and in homewaters, similar proportions for microtagged to adipose fin-clipped comparisons cannot be expected. Reasons for the disparity include: the presence of both European and North American stocks at West Greenland, different stock survival rates, different rates of maturity, different sea-age composition in stocks and different stock migration patterns and distribution. Home-water returns were measured only on the Penobscot River, where all fish released have adipose fin-clips and are all microtagged, and there were few adipose fin-clipped fish caught without tags.

There does not seem to be any great difference in ratios between adipose fin-clipped and microtagged fish in release and sampling sites, other than can be accounted for by tag loss. Differences in the ratio in high seas fisheries can be expected and can be explained by the factors mentioned above.

9 APPROPRIATENESS OF CONDUCTING FURTHER EXPERIMENTAL ACOUSTIC SURVEYS at SEA

The interest in an acoustic survey at the Faroes stemmed from the perception that acoustic estimates of abundance could be related to the data available on CPUE. For this purpose it is only necessary to relate CPUE data to point estimates of abundance of salmon in an area.

The possibility of a feasibility study done by an outside consultant was discussed; such a solution was recommended by the Working Group in 1987. However, the Anadromous and Catadromous Fish Committee decided to recommend that this study should be conducted at Faroes jointly by the Faroese Fisheries Laboratory, the Marine Laboratory, Aberdeen and the Institute of Marine Research, Bergen. The conclusion from that trial was that, given the equipment available and the apparent scattered distribution of salmon in the sea, it would not be appropriate to conduct further experimental acoustic surveys for assessing salmon populations at sea at this time.

The Working Group concluded that further work in this field would be very expensive because new techniques would have to be developed. A possible line of development might be to utilize two side scanning 38 kHz transducers in a towed body.

The Working Group recommended that before any further expensive surveys are planned, a desk study should be carried out to analyze the data on CPUE in more detail in order to get a better understanding of the distribution of salmon in time and space. Surveys already carried out on the West Coast of Canada and elsewhere should be assessed in detail.

10 METHODS TO OBTAIN DATA ON MOVEMENTS OF SALMON IN THE NORTH ATLANTIC, PARTICULARLY IN RELATION TO FISHERIES

The Working Group was requested by ACFM to review methods to obtain data on movements of salmon in the North Atlantic, particularly in relation to fisheries.

The Working Group is conscious that this question has wide implications, but decided to limit the discussions to movements of fish on the high seas. It discussed the many types of marks and tags available for investigating fish movements. Tracking experiments, and their role in studies of fish migrations, were also considered. As these methods are well described in the literature, it was not necessary to list them in this report.

The Working Group considered that salmon run reconstruction models are essential to providing management advice and to develop sound assessments of salmon stocks. One of the key problems in the development of run reconstruction models is the estimation of migratory routes and the fraction of the stock available to distant fisheries. Existing information on movements can be used to strengthen the run reconstruction model (see Section 3). More detailed information including smolt run timing, smolt size, and swimming speed of different sized fish, water currents and current speed along the migration routes, and arrival time in the different fisheries, should be examined.

The use of large-scale marine tagging experiments to estimate the proportions of the population available to the different fisheries was evaluated. Several problems complicate estimates from these experiments and necessitate a high number of tagged fish. Experiences from earlier large-scale marine tagging experiments make the feasibility of tagging a sufficient number of salmon questionable.

There are some data on the movements of salmon in the immediate post-smolt phase and further effort is needed in this area.

Most current tagging programmes utilize externally or internally tagged smolts. Tag recaptures in various fisheries are used to infer migration routes and/or timing and the composition of the fishery. Such programmes are best linked to index rivers, where quantification of the level and timing of adult return will be possible. If index rivers can be used as indicators of stock complexes, then valuable data on national contributions to fisheries can be derived. Numbers of fish tagged and recaptured are critical to such programmes, and it is essential that good tag recovery programmes are in place (in the case of microtags) or that reporting rates are known (in the case of external tags).

Further research should be carried out to determine whether natural features such as body form, scales, gene frequencies, etc., could yield information on the extent of movement and mixing of stocks in high seas fisheries.

11 COMPILATION OF TAG RELEASES AND FIN-CLIP DATA FOR 1989

Data were provided by Working Group members on the prescribed form and have been compiled as a separate report (Anon., 1990c). In excess of 1.6 million microtags (CWTs) and 0.26 million external tags were applied to Atlantic salmon released in 1989 (Table 10a in Anon., 1990c). In addition, 2.07 million salmon were finclipped. Thus, more than 3.93 million marked fish were released.

12 RESEARCH

12.1 Progress on Data Requirements and Research Needs

The Working Group reviewed the list of data requirements and research needs (Section 10; Anon., 1989a). The progress made to date is summarized below:

Research requirements and recommendations	Progress
Data requirements and research needs	
1. The data base of known-origin scale samples to discriminate wild, reared, and farmed salmon using scale characters should be expanded.	Little progress with respect to salmon of the North American and West Greenland Commission areas; additional scale samples have been collected in Norway and work on methods using these scales has been carried out.
2. In order to derive the number of salmon caught for the West Greenland fishery by origin and sea age, a method of allocation using the catches separated into weeks, divisions, and size categories is required.	A method has been developed.
3. The sampling programme at West Greenland for scales and CWTs should be modified in the 1989 fishing season to account for the new management regime.	Management regime reverted to its former system of allocations for small and large boats; given limited resources, sampling of salmon was done in the most efficient manner.
4. The tagging data base for the Newfoundland-Labrador and Greenland areas should be examined for evidence of the hypothesized migration patterns.	Results of adult salmon tagging in Newfoundland and Labrador 1967-1972 and West Greenland 1972 were examined in Anon. (1990a).
5. More research is required to refine the methods to estimate the number of salmon lost due to acid precipitation.	Although the topic was not posed to the Working Group a method and estimates were provided for western Sweden.
6. The Working Group requires further work on biochemical techniques, incorporating additional samples, and suggests that this methodology merits further investigations for country of origin.	No information was tabled, however, research is continuing at the same university and government laboratories.

12.2 Progress on Recommendations from 1989

Research requirements and recommendations	Progress
1. The Working Group considers that salmon run reconstruction models are essential to providing management advice and to develop sound assessment of salmon stocks. To this end, the Working Group makes the following recommendations for research on index rivers:	
a) information on spawning stock numbers should be collected for areas and rivers where this information does not currently exist;	Collections begun but not reported.
b) research should be conducted on stock composition of fisheries including origin of stocks, migration routes, and migration times;	Initiatives continued in most member countries.
c) exploitation rates should be obtained for stocks in areas where they are currently unavailable;	New attempts to estimate exploitation rates on same stocks in Canada, West Greenland, and Norway.
d) reliable estimates should be obtained for non-reported catches.	Non-reported catches provided by all countries but reliability was not evaluated.
2. The Working Group recommends that countries engage in tagging and tag recovery programs, including estimation of tag reporting rates, non-reported catches, and obtain reliable estimates of returning adults. Work of this nature should be carried out on representative stocks, i.e. indicator stocks.	New indicator stocks include the River Corrib (Ireland), River Drammen and River Halselu (Norway), and Conne River (Newfoundland).
3. The Working Group recommends that a Workshop should be held on techniques to distinguish fish farmed escapees from wild salmon.	The Workshop was approved by the Anadromous and Catadromous Fish Committee and plans are underway. However, this Workshop will not report to the Working Group.

4. The Working Group recommends that Canada immediately begin smolt tagging and tag recovery programmes, including the provision of reliable estimates of spawning stock biomass. This research should be done on major rivers providing MSW salmon that contribute to the West Greenland fishery.

A microtagging programme on Saint John River hatchery smolts commenced.

5. The Working Group endorses the recommendations of the Study Group on the North American Salmon Fisheries, the Study Group on the the Norwegian Sea and Faroes Salmon Fishery, and the Study Group on Toxicological Mechanisms Involved in the Impact of Acid Rain and its Effects on Salmon.

12.3 Requirements for Future Meetings

1. The identification of North American and European fish in West Greenland in 1989 was hindered by the lack of a suitable test sample of fish of known origin and the high misclassification rates associated with the historical database used to form the discriminant function. The Working Group recommends that as in earlier years, scale samples should be collected from 2SW salmon in homewaters and forwarded to D. Reddin, Canada, in case the collections of tissue from West Greenland in 1989 cannot be successfully separated to continent of origin on the basis of nuclear DNA patterns.

2. The Working Group noted that no effort data were available from the West Greenland fishery in 1989 and recommends that in future years estimates of effort be provided for the 'small' and 'large' boat components, and for individual fishermen who might cooperate in the daily completion of catch/effort logbooks.

3. The possibility of obtaining the data on weight categories recorded by the factories at West Greenland should be investigated.

4. The Working Group readressed the appropriateness of conducting acoustic surveys for salmon in the Faroes area and recommends that i) a feasibility study be conducted to determine if assumed densities and equipment capabilities would be adequate to provide precise estimates of salmon density, ii) a more detailed analysis of CPUE data be undertaken to extract abundance indices and iii) results of acoustic surveys of salmon in North America be reviewed.

5. The Working Group recommends that at future meetings countries should present data on the production of farmed salmon, the number of salmon that have escaped from specific localities, the size and age of the fish, and the time of escape. Furthermore, all countries should present estimates of the proportion of farmed salmon in fisheries and spawning populations in their home waters.

6. The Working Group requests that information on biological characteristics of the catch at St. Pierre and Miquelon be provided for its next meeting. Also, the differences between the report by NASCO of the catch and the offical catch should be resolved. The Working Group requested that a longer time series of catches be provided including the distribution of catches by week.

7. The Working Group noted that the sea surface temperatures presented with the annual estimates of the proportion (P) of Maine and Saint John River stocks that were estimated to have been in West Greenland were confined to a small area of the North Atlantic and recommends that data from a wider area be used to develop a rational basis for explanation of the variation of P values.

8. The Working Group recommends that for 1990-1991, countries should develop run reconstruction models of their stocks for discussion at Study Groups and input to a North Atlantic model at the Working Group. Data useful to the modelling should be brought to the Working Group in the format specified in Appendix 5.

13 RECOMMENDATIONS

Further progress in developing and applying models to answer questions on interactions between fisheries will depend on estimating exploitation rates and determining the origin of stocks.

The Working Group, therefore, recommends that:

Research effort should be increased on methods of stock discrimination such as body form and scale analysis, gene frequencies, and other biochemical methods.

Research effort should be increased on methods to distinguish maturing and non-maturing components of fisheries.

The Working Group endorsed the recommendations of the Study Group (Appendix 2) and the Study Groups should meet in 1991 to prepare data for the Working Group. An extra day should be allocated to the Study Group on the Norwegian Sea and Faroes Salmon Fishery and both Study Groups should provide text suitable to answer the questions of interest to the North American and North East Atlantic Commission's areas.

It was recommended that the Workshop on Techniques to Distinguish Fish Farm Escapees from Wild Salmon should report to the Working Group on North Atlantic Salmon.

Table 1 Nominal catch of SALMON by country (in tonnes round fresh weight), 1960-1989.

Year	France	Engl.+ Wales	Scotland	Ireland[2]	Northern Ireland[2,3]	Norway[4]	Sweden (west coast)	Finland	USSR	Iceland	Canada[5]	USA	Faroes	West Green-land	East Green-land	Others[6]	Total[1]
1960	75	283	1,436	743	139	1,659	40	-	1,100	100	1,636	1	-	60	-	-	7,272
1961	75	232	1,196	707	132	1,533	27	-	790	127	1,583	1	-	127	-	-	6,530
1962	75	318	1,740	1,459	356	1,935	45	-	710	125	1,719	1	-	244	-	-	8,727
1963	75	325	1,698	1,458	306	1,786	23	-	480	145	1,861	1	-	466	-	-	8,624
1964	75	307	1,914	1,617	377	2,147	36	-	590	135	2,069	1	-	1,539	-	-	10,807
1965	75	320	1,563	1,457	281	2,000	40	-	590	133	2,116	1	-	861	-	-	9,437
1966	75	387	1,624	1,238	287	1,791	36	-	570	106	2,369	1	-	1,370	-	-	9,854
1967	75	420	2,133	1,463	449	1,980	25	-	883	146	2,863	1	-	1,601	-	-	12,039
1968	75	282	1,563	1,413	312	1,514	20	-	827	162	2,111	1	5	1,127	-	403	9,815
1969	75	377	1,947	1,730	267	1,383	22	-	360	133	2,202	1	7	2,210	-	893	11,607
1970	75	527	1,329	1,787	297	1,171	20	-	448	195	2,323	1	12	2,146	-	922	11,253
1971	75	426	1,419	1,639	234	1,207	18	-	417	204	1,992	1	-	2,689	-	471	10,792
1972	34	442	1,693	1,804	210	1,568	18	32	462	250	1,759	1	9	2,113	-	486	10,891
1973	12	450	1,964	1,930	182	1,726	23	50	772	256	2,434	2.7	28	2,341	-	533	12,704
1974	13	383	1,641	2,128	184	1,633	32	76	709	225	2,539	0.9	20	1,917	-	373	11,874
1975	25	447	1,561	2,216	164	1,537	26	76	811	266	2,485	1.7	28	2,030	-	475	12,149
1976	9	208	1,010	1,561	113	1,530	20	66	772	225	2,506	0.8	40	1,175	<1	289	9,526
1977	19	345	1,131	1,372	110	1,488	10	59	497	230	2,545	2.4	40	1,420	6	192	9,466
1978	20	349	1,323	1,230	148	1,050	10	37	476	291	1,545	4.1	37	984	8	138	7,650
1979	10	261	1,075	1,097	99	1,831	12	26	455	225	1,287	2.5	119	1,395	<1	193	8,089
1980	30	360	1,134	947	122	1,830	17	34	664	249	2,680	5.5	536	1,194	<1	277	10,081
1981	20	493	1,233	685	101	1,656	26	44	463	163	2,437	6.0	1,025	1,264	<1	313	9,930
1982	20	286	1,092	993	132	1,348	25	54	364	147	1,798	6.4	865	1,077	<1	437	8,645
1983	16	429	1,221	1,656	187	1,550	28	57	507	198	1,424	1.3	678	310	<1	466	8,729
1984	25	345	1,013	829	78	1,623	40	44	593	159	1,112	2.2	628	297	<1	101	6,890
1985	22	361	913	1,595	98	1,561	45	49	659	217	1,133	2.1	566	864	7	-	8,092
1986	28	430	1,271	1,730	109	1,598	54	38	608	310	1,559	1.9	530	960	19	-	9,246
1987	27	302	922	1,239	56	1,385	47	49	564	222	1,784	1.2	576	966	<1	-	8,141
1988	32	395	882	1,874	114	1,076	40	34	419	396	1,311	0.9	243	893	4	-	7,714
1989[1]	14	296	780	1,079	142	881	29	52	359	275	1,166	1.7	364	337	<1	-	5,777

[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] Includes catches on Norwegian Sea by vessels from Denmark, Sweden, Federal Republic of Germany, Norway, and Finland.

Table 2 Nominal catch of SALMON in homewaters by country (in tonnes round fresh weight), 1960-1989.

Year	France	Engl.+ Wales	Scotland[2]			Ireland[3]			N.Ireland[3,4]	Norway[5]			Sweden (west coast)	Finland			USSR	Iceland	Canada[6]			USA	Total all countr.
	T	T	S	G	T	S	G	T	T	S	G	T	T	S	G	T	T	T	S	G	T	T	T
1960	75	283	927	509	1,436	-	-	743	139	-	-	1,659	40	-	-	-	1,100	100	-	-	1,636	1	7,212
1961	75	232	772	424	1,196	-	-	707	132	-	-	1,533	27	-	-	-	790	127	-	-	1,583	1	6,403
1962	75	318	808	932	1,740	-	-	1,459	356	-	-	1,935	45	-	-	-	710	125	-	-	1,719	1	8,483
1963	75	325	1,168	530	1,698	-	-	1,458	306	-	-	1,786	23	-	-	-	480	145	-	-	1,861	1	8,158
1964	75	307	913	1,001	1,914	-	-	1,617	377	-	-	2,147	36	-	-	-	590	135	-	-	2,069	1	9,268
1965	75	320	835	728	1,563	-	-	1,457	281	-	-	2,000	40	-	-	-	590	133	-	-	2,116	1	8,576
1966	75	387	788	836	1,624	-	-	1,238	287	-	-	1,791	36	-	-	-	570	106	-	-	2,369	1	8,484
1967	75	420	857	1,276	2,133	-	-	1,463	449	-	-	1,980	25	-	-	-	883	146	-	-	2,863	1	10,438
1968	75	282	783	780	1,563	-	-	1,413	312	-	-	1,514	20	-	-	-	827	162	-	-	2,111	1	8,280
1969	75	377	539	1,408	1,947	-	-	1,730	267	801	582	1,383	22	-	-	-	360	133	-	-	2,202	1	8,497
1970	75	527	503	826	1,329	-	-	1,787	297	815	356	1,171	20	-	-	-	448	195	1,562	761	2,323	1	8,173
1971	75	426	496	923	1,419	-	-	1,639	234	771	436	1,207	18	-	-	-	417	204	1,482	510	1,992	1	7,632
1972	34	442	588	1,105	1,693	200	1,604	1,804	210	1,064	514	1,578	18	-	-	32	462	250	1,201	558	1,759	1	8,283
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	1,641	170	1,958	2,128	184	1,149	484	1,633	32	-	-	76	709	225	1,589	950	2,539	0.9	9,564
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	772	225	1,721	785	2,506	0.8	8,021
1977	19	345	369	762	1,131	145	1,227	1,372	110	1,018	470	1,488	10	-	-	59	497	230	1,883	662	2,545	2.4	7,808
1978	20	349	781	542	1,323	147	1,082	1,230	148	668	382	1,050	10	-	-	37	476	291	1,225	320	1,545	4.1	6,483
1979	10	261	598	478	1,075	105	922	1,097	99	1,150	681	1,831	12	-	-	26	455	225	705	582	1,287	2.5	6,383
1980	30	360	851	283	1,134	202	745	947	122	1,352	478	1,830	17	-	-	34	664	249	1,763	917	2,680	5.5	8,073
1981	20	493	843	389	1,233	164	521	685	101	1,189	467	1,656	26	-	-	44	463	163	1,619	818	2,437	6.0	7,327
1982	20	286	596	496	1,092	63	930	993	132	985	363	1,348	25	-	-	54	364	147	1,082	716	1,798	6.4	6,265
1983	16	429	672	549	1,221	150	1,506	1,656	187	957	593	1,550	28	-	-	57	507	198	911	513	1,424	1.3	7,274
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	659	217	540	593	1,133	2.1	6,655
1986	28	430	745	526	1,271	136	1,594	1,730	109	1,042	556	1,598	54	28	10	38	608	310	779	780	1,559	1.9	7,737
1987	27	302	503	419	922	127	1,112	1,239	56	894	491	1,385	47	35	14	49	564	222	951	833	1,784	1.2	6,598[7]
1988	32	395	501	381	882	141	1,733	1,874	114	656	420	1,076	40	26	8	34	419	396	633	677	1,311	0.9	6,574
1989[1]	14	296	412	368	780	132	947	1,079	142	479	402	881	29	17	35	52	359	275	616	550	1,166	1.7	5,075

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] 0.08 t reported by Portugal not included.

Table 3 Report[illegible] catch of SALMON in numbers and weight in tonnes (round f[illegible] weight). Catches reported for 1989 [illegible] provisional. Some countries divide 1SW from MSW salmon [illegible] on weight.

Country	Year	1SW No.	1SW Wt	2SW No.	2SW Wt	3SW No.	3SW Wt	4SW No.	4SW Wt	5SW No.	5SW Wt	MSW[1] No.	MSW[1] Wt	PS No.	PS Wt	Total No.	Total Wt
France	1985	1,074	-	-	-	-	-	-	-	-	-	3,278	-	-	-	4,352	22
	1986	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6,801	28
	1987	6,013	18	-	-	-	-	-	-	-	-	1,806	9	-	-	7,819	27
	1988	2,063	7	-	-	-	-	-	-	-	-	4,964	25	-	-	7,027	32
	1989	1,351	4	-	-	-	-	-	-	-	-	1,296	6	-	-	2,647	10
Scotland	1982	208,061	416	-	-	-	-	-	-	-	-	128,242	596	-	-	336,303	1,092
	1983	209,617	549	-	-	-	-	-	-	-	-	145,961	672	-	-	320,578	1,221
	1984	213,079	509	-	-	-	-	-	-	-	-	107,213	504	-	-	230,292	1,013
	1985	158,012	399	-	-	-	-	-	-	-	-	114,648	514	-	-	272,660	913
	1986	202,861	526	-	-	-	-	-	-	-	-	148,398	745	-	-	351,259	1,271
	1987	164,785	419	-	-	-	-	-	-	-	-	103,994	503	-	-	268,779	922
	1988	149,098	381	-	-	-	-	-	-	-	-	112,162	501	-	-	261,260	882
	1989	150,466	368	-	-	-	-	-	-	-	-	91,659	412	-	-	242,125	780
Ireland	1980	248,333	745	-	-	-	-	-	-	-	-	39,608	202	-	-	287,941	947
	1981	173,667	521	-	-	-	-	-	-	-	-	32,159	164	-	-	205,826	685
	1982	310,000	930	-	-	-	-	-	-	-	-	12,353	63	-	-	322,353	993
	1983	502,000	1,506	-	-	-	-	-	-	-	-	29,411	150	-	-	531,411	1,656
	1984	242,666	728	-	-	-	-	-	-	-	-	19,804	101	-	-	262,470	829
	1985	498,333	1,495	-	-	-	-	-	-	-	-	19,608	100	-	-	517,941	1,595
	1986	498,125	1,594	-	-	-	-	-	-	-	-	28,335	136	-	-	526,450	1,730
	1987	358,842	1,112	-	-	-	-	-	-	-	-	27,609	127	-	-	386,451	1,239
	1988	559,297	1,733	-	-	-	-	-	-	-	-	30,599	141	-	-	589,896	1,874
	1989	331,544	947	-	-	-	-	-	-	-	-	32,875	132	-	-	354,419	1,079
Norway	1981	221,566	467	-	-	-	-	-	-	-	-	213,943	1,189	-	-	435,509	1,656
	1982	163,120	363	-	-	-	-	-	-	-	-	174,229	985	-	-	337,349	1,348
	1983	278,061	593	-	-	-	-	-	-	-	-	171,361	957	-	-	449,442	1,550
	1984	294,365	628	-	-	-	-	-	-	-	-	176,716	995	-	-	471,081	1,623
	1985	299,037	638	-	-	-	-	-	-	-	-	162,403	923	-	-	461,440	1,561
	1986	264,849	556	-	-	-	-	-	-	-	-	191,524	1,042	-	-	456,373	1,598
	1987	235,703	491	-	-	-	-	-	-	-	-	153,554	894	-	-	389,257	1,385
	1988	217,617	420	-	-	-	-	-	-	-	-	120,367	656	-	-	337,984	1,076
	1989	208,290	402	-	-	-	-	-	-	-	-	87,890	479	-	-	296,180	881
Iceland	1982	23,026	58	-	-	-	-	-	-	-	-	18,119	89	-	-	41,145	147
	1983	33,769	85	-	-	-	-	-	-	-	-	24,454	113	-	-	58,223	198
	1984	18,901	47	-	-	-	-	-	-	-	-	22,188	112	-	-	41,089	159
	1985	50,000	125	-	-	-	-	-	-	-	-	16,300	94	-	-	66,300	217
	1986	67,300	174	-	-	-	-	-	-	-	-	22,300	136	-	-	89,600	310
	1987	42,550	114	-	-	-	-	-	-	-	-	18,840	108	-	-	61,390	222
	1988	112,000	288	-	-	-	-	-	-	-	-	19,000	108	-	-	133,500	396
	1989	72,382	161	-	-	-	-	-	-	-	-	18,253	115	-	-	90,635	276

(cont'd)

Table 3 (cont'd)

Country	Year	1SW No.	1SW Wt	2SW No.	2SW Wt	3SW No.	3SW Wt	4SW No.	4SW Wt	5SW No.	5SW Wt	MSW[1] No.	MSW[1] Wt	PS No.	PS Wt	Total No.	Total Wt
Canada	1982	358,000	716	-	-	-	-	-	-	-	-	240,000	1,082	-	-	598,000	1,798
	1983	265,000	513	-	-	-	-	-	-	-	-	201,000	911	-	-	466,000	1,424
	1984	234,000	467	-	-	-	-	-	-	-	-	143,000	645	-	-	377,000	1,112
	1985	333,084	593	-	-	-	-	-	-	-	-	122,621	540	-	-	455,705	1,133
	1986	417,269	780	-	-	-	-	-	-	-	-	162,305	779	-	-	579,574	1,731
	1987	435,799	833	-	-	-	-	-	-	-	-	203,731	951	-	-	639,530	1,784
	1988	372,178	677	-	-	-	-	-	-	-	-	137,637	633	-	-	509,815	1,311
	1989	304,654	550	-	-	-	-	-	-	-	-	141,183	616	-	-	445,837	1,166
USA	1982	33	-	1,206	-	5	-	-	-	-	-	-	-	21	-	1,265	6.4
	1983	26	-	314	1.2	2	-	-	-	-	-	-	-	6	-	348	1.3
	1984	50	-	545	2.1	2	-	-	-	-	-	-	-	12	-	609	2.2
	1985	23	-	528	2.0	2	-	-	-	-	-	-	-	13	-	557	2.1
	1986	76	-	482	1.8	2	-	-	-	-	-	-	-	3	-	541	1.9
	1987	33	-	229	1.0	10	-	-	-	-	-	-	-	10	-	282	1.2
	1988	49	-	203	0.8	3	-	-	-	-	-	-	-	4	-	259	0.9
	1989	157	0.3	325	1.3	2	-	-	-	-	-	-	-	3	-	487	1.7
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	539
	1987/1988	5,833	-	55,728	-	3,450	-	0	-	-	-	-	-	-	-	65,011	208
	1988/1989	1,351	-	86,417	-	5,728	-	0	-	-	-	-	-	-	-	93,496	309
West Greenland	1982	315,532	-	17,810	-	-	-	-	-	-	-	-	-	2,688	-	336,030	1,077
	1983	90,500	-	8,100	-	-	-	-	-	-	-	-	-	1,400	-	100,000	310
	1984	78,942	-	10,442	-	-	-	-	-	-	-	-	-	630	-	90,014	297
	1985	292,181	-	18,378	-	-	-	-	-	-	-	-	-	934	-	311,493	864
	1986	307,800	-	9,700	-	-	-	-	-	-	-	-	-	2,600	-	320,100	960
	1987	297,128	-	6,287	-	-	-	-	-	-	-	-	-	2,898	-	306,313	966
	1988	281,356	-	4,602	-	-	-	-	-	-	-	-	-	2,296	-	288,233	893
	1989	110,359	-	5,379	-	-	-	-	-		-	-	-	1,875	-	117,613	337
England & Wales	1985	-	-	-	-	-	-	-	-	-	-	-	-	-	-	95,531	361
	1986	-	-	-	-	-	-	-	-	-	-	-	-	-	-	110,794	430
	1987	66,371	-	-	-	-	-	-	-	-	-	17,063	-	-	-	83,434	302
	1988	76,521	-	-	-	-	-	-	-	-	-	33,642	-	-	-	110,163	395
	1989	65,450	-	-	-	-	-	-	-	-	-	19,550	-	-	-	85,000	296

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

Table 4 Nominal catches at West Greenland, 1960-1989 (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	966	935
1988	-	-	-	-	893	893	-
1989	-	-	-	-	337	337[2]	900

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

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

Table 5 Distribution of nominal catches (tonnes) taken by Greenland vessels in 1976-1989 by NAFO divisions according to place where landed.

Div.	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989[1]
1A	171	201	81	120	52	105	111	14	33	85	46	48	24	9
1B	299	393	349	343	275	403	330	77	116	124	73	114	100	28
1C	262	336	245	524	404	348	239	93	64	198	128	229	213	81
1D	218	207	186	213	231	203	136	41	4	207	203	205	191	73
1E	182	237	113	164	158	153	167	55	43	147	233	261	198	75
1F	43	46	10	31	74	32	76	30	32	103	277	109	167	71
1NK	-	-	-	-	-	20	18	-	5	-	-	-	-	-
Total	1,175	1,420	984	1,395	1,194	1,264	1,077	310	297	864	960	966	893	337
East Greenl.	+	6	8	+	+	+	+	+	+	7	19	+	4	-
Total	1,175	1,426	992	1,395	1,194	1,264	1,077	310	297	871	979	966	897	337

[1] Provisional figures.

Table 6 Percentage (by number) of North American and European salmon in research vessel catches at West Greenland (1969-82) and from commercial samples (1978-89).

Source	Year	Sample size		Continent of origin (%)			
		Length	Scales	NA	(95% CI)[1]	E	(95% CI)
Research	1969	212	212	51	(57,44)	49	(56,43)
	1970	127	127	35	(43,26)	65	(74,57)
	1971	247	247	34	(40,28)	66	(72,50)
	1972	3,488	3,488	36	(37,34)	64	(66,63)
	1973	102	102	49	(59,39)	51	(61,41)
	1974	834	834	43	(46,39)	57	(61,54)
	1975	528	528	44	(48,40)	56	(60,52)
	1976	420	420	43	(48,38)	57	(62,52)
	1977	-	-	-	(-)	-	(-)
	1978[2]	606	606	38	(41,34)	62	(66,59)
	1978[3]	49	49	55	(69,41)	45	(59,31)
	1979	328	328	47	(52,41)	53	(59,48)
	1980	617	617	58	(62,54)	42	(46,38)
	1981	-	-	-	(-)	-	(-)
	1982	443	443	47	(52,43)	53	(58,48)
Commercial	1978	392	392	52	(57,47)	48	(53,43)
	1979	1,653	1,653	50	(52,48)	50	(52,48)
	1980	978	978	48	(51,45)	52	(55,49)
	1981	4,570	1,930	59	(61,58)	41	(42,39)
	1982	1,949	414	62	(64,60)	38	(40,36)
	1983	4,896	1,815	40	(41,38)	60	(62,59)
	1984	7,282	2,720	50	(53,47)	50	(53,47)
	1985	13,272	2,917	50	(53,46)	50	(54,47)
	1986	20,394	3,509	57	(66,48)	43	(52,34)
	1987	13,425	2,960	59	(63,54)	41	(46,37)
	1988	11,047	2,562	43	(49,38)	57	(62,51)
	1989	9,366	2,227	56	(60,52)	44	(48,40)

[1]CI - confidence interval calculated by method of Pella and Robertson (1979) for 1984-86 and by binomial distribution for the others.

[2]During fishery.

[3]Research samples after fishery closed.

Table 7 The number of fin-clipped and microtagged Atlantic salmon observed during the sampling programme at West Greenland in 1989. The percentages of the fish examined that were fin-clipped and microtagged are given in parentheses.

Sampling Site	NAFO Div	No of salmon weight category				No of fin clips weight category				No of CWT's weight category				% of AFC fish with microtags	No untagged AFC fish (%)
		<3kg	3-5kg	>5kg	Total	<3kg	3-5kg	>5kg	Total	<3kg	3-5kg	>5kg	Total		
Sisimiut	1B	3228	313	113	3654	112	12	2	126 (3.45)	36	6	0	42 (1.15)	33.3	84 (2.30)
Nuuk	1D	7004	493	94	7591	149	12	0	161 (2.12)	38	6	0	44 (0.58)	27.3	117 (1.54)
Paamiut	1E	3714	564	64	4343	36	6	2	44 (1.01)	14	0	0	14 (0.32)	31.8	30 (0.69)
TOTAL		13946	1370	272	15588	297	30	4	331 (2.12)	88	12	0	100 (0.64)	30.2	231 (1.48)
%		89.5	8.8	1.7		89.7	9.1	1.2		88.0	12.0	0			

Table 8 Mean lengths and weights and distributions of recaptures at West Greenland of microtagged salmon from different release areas. Recovery rates per 1000 fish examined are given in parentheses.

Country	Release site	Stage at Release	Total No. of recoveries	No. of recoveries by NAFO divisions 1B	1D	1E	Mean fork length (mm)	Mean gutted weight (kg)
USA	Connecticut R.	*	14	5	8	1	644	2.60
	Penobscot R.	*	39	19	17	3	641	2.56
	Merrimack R.	*	17	7	8	2	627	2.41
	Total		70	31	33	6	638	2.53
				(8.5)	(4.3)	(1.4)		
Canada	Miramichi R.	*	2	0	1	1	610	2.32
					(0.1)	(0.2)		
Ireland	R.Castleconnell	*	3	1	2	0	687	3.20
	R.Corrib	1988 W.S.	4	2	2	0	648	2.59
	Shannon Est.	*	1	1	0	0	700	3.41
	L.Furnace	*	1	0	1	0	640	2.44
	R.Lee	*	3	2	0	1	663	2.84
	Total		12	6	5	1	665	2.86
				(1.6)	(0.7)	(0.2)		
England and Wales	R.Coquet	1988 W.S.	1	0	0	1	650	2.67
	R.Tyne	1987 H.P.	1	0	1	0	640	2.28
	R.Wear	1988 W.S.	5	0	1	4	666	2.63
	R.Wye	1988 W.S.	1	0	1	0	670	2.78
	R.Usk	*	2	1	1	0	655	2.50
	R.Tawe	1987 H.P.	1	1	0	0	720	3.22
	R.Hodder	1987 H.P.	1	0	0	1	700	2.71
	Total		12	2	4	6	668	2.65
				(0.5)	(0.5)	(1.4)		
Scotland	R.Lussa	*	1	0	1	0	660	2.86
	R.Tay	1987 W.P.	1	1	0	0	640	2.41
	Total		2	1	1	0	650	2.64
				(0.3)	(0.1)			
N Ireland	R.Bush	1988 W.S.	1	1	0	0	630	2.17
				(0.3)				

Key:
* = 1988 hatchery smolts
1988 W.S. = 1988 wild smolts
1987 H.P. = 1987 hatchery parr, migrated in 1988
1987 W.P. = 1987 wild parr, migrated in 1988

Table 9 Summary of input data for harvest calculations: Releases by smolt age for USA and Canada.

Year	Maine Rivers		Ratio	Canada
	1-yr (U1)	2-yr (U2)	Tot: 1-yr	1-yr (C1)
1975	15,758	153,577	1,074,597	28,700
1976	6,0229	242,468	5,025,768	92,636
1977	128,885	245,608	2,905,637	138,000
1978	168,033	135,014	1,803,497	132,900
1979	98,693	272,585	3,761,949	59,800
1980	399,903	282,001	1,705,173	126,300
1981	24,695	232,348	1,040,871	97,800
1982	135,007	259,674	2,923,411	123,700
1983	367,605	170,277	1,463,206	219,200
1984	657,722	137,203	1,208,603	254,800
1985	612,548	108,598	1,177,289	247,400
1986	723,400	55,000	107,603	452,800
1987	637,536	82,759	1,129,811	449,300
1988	850,900	87,100	1,102,362	472,500

Table 10 Summary of input data for harvest calculations: Mean weights, landings, proportion American stock and the fraction of river age 1 harvest.

Year	Greenland catch (t)	Mean weight (kg)	Total Harvest	North American Harvest	(NA1) 1-yr North America
1976	1,175	3.04	386,513	170,066	1,237
1977	1,420	3.21	442,023	190,070	3,820
1978	984	3.35	293,731	132,546	3,542
1979	1,395	3.34	417,665	187,949	7,889
1980	1,194	3.22	370,807	194,674	11,390
1981	1,264	3.17	398,738	189,401	6,661
1982	1,077	3.11	346,302	197,392	2,656
1983	310	3.10	100,000	40,000	1,232
1984	297	3.11	95,498	51,569	2,488
1985	864	2.87	301,045	141,491	7,225
1986	960	3.03	316,832	186,931	3,768
1987	966	3.16	305,696	180,361	7,261
1988	893	3.18	280,818	112,327	5,808
1989	337	2.87	117,422	65,756	5,132

Table 11 Harvest estimates in numbers of fish for Maine salmon in West Greenland fishery using the proportional harvest model. Estimates include a non-catch fishing mortality rate = 0.2.

Year	Total N. American river age 1	Total Maine river age 1+2	Std Err
1976	1,237	5,889	3,130
1977	3,820	9,456	1,345
1978	3,542	6,213	861
1979	7,889	9,930	430
1980	11,390	33,351	1,305
1981	6,661	10,789	618
1982	2,656	6,965	1,623
1983	1,232	2,350	194
1984	2,488	2,851	111
1985	7,225	7,867	286
1986	3,768	3,950	240
1987	7,261	6,006	224
1988	5,808	4,812	219
1989	5,132	4,547	153

Table 12 Estimation of the harvest of 1SW, river age 1 salmon of USA and Canadian origin in West Greenland in 1989 using image processing techniques.

NAFO Division	Identification							Harvest	
	USA	Canada	Non-Alloc.[1]	USG[2]	CANC[2]	SS[3]	TS[4]	USA	Canada
1A							1,776	180	98
1B	24	13	2	25.2	13.8	311	5,984	606	331
1C							15,746	831	777
1D	14	13	2	15.0	14.0	355	18,869	995	931
1E	3	9	1	3.2	9.8	245	8,767	145	438
1F							13,815	228	690
Total	41	35	5	43.4	37.6	911	64,957	2,985	3,265

[1] Sample that could not be allocated due to regenerated scale samples.
[2] Identification of USA and Canadian origin salmon is corrected for discriminant function bias and non-allocated samples.
[3] Sample size of scale sample from the Greenland sampling program.
[4] Total North American salmon is the number of 1SW salmon of North American origin caught in West Greenland in 1989.

Table 13 Annual mean fork lengths and whole weights of Atlantic salmon caught at West Greenland, 1969–89. 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	E	NA	E	NA	E	NA	E	Total	NA	E	NA	E	NA	E
1969	3.12	3.76	5.48	5.80	-	5.13	3.25	3.86	3.58	65.0	68.7	77.0	80.3	-	75.3
1970	2.85	3.46	5.65	5.50	4.85	3.80	3.06	3.53	3.28	64.7	68.6	81.5	82.0	78.0	75.0
1971	2.65	3.38	4.30	-	-	-	2.68	3.38	3.14	62.8	67.7	72.0	-	-	-
1972	2.96	3.46	5.85	6.13	2.65	4.00	3.25	3.55	3.44	64.2	67.9	80.7	82.4	61.5	69.0
1973	3.28	4.54	9.47	10.00	-	-	3.83	4.66	4.18	64.5	70.4	88.0	96.0	61.5	-
1974	3.12	3.81	7.06	8.06	3.42	-	3.22	3.86	3.58	64.1	68.1	82.8	87.4	66.0	-
1975	2.58	3.42	6.12	6.23	2.60	4.80	2.65	3.48	3.12	61.7	67.5	80.6	82.2	66.0	75.0
1976	2.55	3.21	6.16	7.20	3.55	3.57	2.75	3.24	3.04	61.3	65.9	80.7	87.5	72.0	70.7
1977	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1978	2.96	3.50	7.00	7.90	2.45	6.60	3.04	3.53	3.35	63.7	67.3	83.6	-	60.8	85.0
1979	2.98	3.50	7.06	7.60	3.92	6.33	3.12	3.56	3.34	63.4	66.7	81.6	85.3	61.9	82.0
1980	2.98	3.33	6.82	6.73	3.55	3.90	3.07	3.38	3.22	64.0	66.3	82.9	83.0	67.0	70.9
1981	2.77	3.48	6.93	7.42	4.12	3.65	2.89	3.58	3.17	62.3	66.7	82.8	84.5	72.5	-
1982	2.79	3.21	5.59	5.59	3.96	5.66	2.92	3.43	3.11	62.7	66.2	78.4	77.8	71.4	80.9
1983	2.54	3.01	5.79	5.86	3.37	3.55	3.02	3.14	3.10	61.5	65.4	81.1	81.5	68.2	70.5
1984	2.64	2.84	5.84	5.77	3.62	5.78	3.20	3.03	3.11	62.3	63.9	80.7	80.0	69.8	79.5
1985	2.50	2.89	5.42	5.45	5.20	4.97	2.72	3.01	2.87	61.2	64.3	78.9	78.6	79.1	77.0
1986	2.75	3.13	6.44	6.08	3.32	4.37	2.89	3.19	3.03	62.8	65.1	80.7	79.8	66.5	73.4
1987	3.00	3.20	6.36	5.96	4.69	4.70	3.10	3.26	3.16	64.2	65.6	81.2	79.6	74.8	74.8
1988	2.83	3.36	6.77	6.78	4.75	4.64	2.93	3.41	3.18	63.0	66.6	82.1	82.4	74.7	73.8
1989	2.56	2.86	5.87	5.77	4.23	5.83	2.77	2.99	2.87	62.3	64.5	80.8	81.0	73.8	82.2

Table 14a Sea age composition (%) from research vessel and commercial catch samples of ATLANTIC SALMON at West Greenland, 1969-1989.

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

Table 14b The sea age composition of samples from commercial catches at West Greenland, 1985-1989.

Year	Sea age composition (%)					
	North American			European		
	1SW	2SW	Previous spawners	1SW	2SW	Previous spawners
1985	92.5	7.2	0.3	95.0	4.7	0.4
1986	95.1	3.9	1.0	97.5	1.9	0.6
1987	96.3	2.3	1.4	98.0	1.7	0.3
1988	96.7	2.0	1.2	98.1	1.3	0.5
1989	92.3	5.2	2.4	95.5	3.8	0.6

Table 15 **River age distribution (%) for all North American and European origin salmon** sampled at West Greenland, 1968-1989.

Year	1	2	3	4	5	6	7	8
				North American				
1968	0.3	19.6	40.4	21.3	16.2	2.2	0.0	0.0
1969	0.0	27.1	45.8	19.6	6.5	0.9	0.0	0.0
1970	0.0	58.1	25.6	11.6	2.3	2.3	0.0	0.0
1971	1.2	32.9	36.5	16.5	9.4	3.5	0.0	0.0
1972	0.8	31.9	51.4	10.6	3.9	1.2	0.4	0.0
1973	2.0	40.8	34.7	18.4	2.0	2.0	0.0	0.0
1974	0.9	36.0	36.6	12.0	11.7	2.6	0.3	0.0
1975	0.4	17.3	47.6	24.4	6.2	4.0	0.0	0.0
1976	0.7	42.6	30.6	14.6	10.9	0.4	0.4	0.0
1977	-	-	-	-	-	-	-	-
1978	2.7	31.9	43.0	13.6	6.0	2.0	0.9	0.0
1979	4.2	39.9	40.6	11.3	2.8	1.1	0.1	0.0
1980	5.9	36.3	32.9	16.3	7.9	0.7	0.1	0.0
1981	3.5	31.6	37.5	19.0	6.6	1.6	0.2	0.0
1982	1.4	37.7	38.3	15.9	5.8	0.7	0.0	0.2
1983	3.1	47.0	32.6	12.7	3.7	0.8	0.1	0.0
1984	4.8	51.7	28.9	9.0	4.6	0.9	0.2	0.0
1985	5.1	41.0	35.7	12.1	4.9	1.1	0.1	0.0
1986	2.0	39.9	33.4	20.0	4.0	0.7	0.0	0.0
1987	3.9	41.4	31.8	16.7	5.8	0.4	0.0	0.0
1988	5.2	31.3	30.8	20.9	10.7	1.0	0.1	0.0
1989	7.9	39.0	30.1	15.9	5.9	1.3	0.0	0.0
Total	3.8	38.5	34.9	15.5	6.1	1.1	0.1	0.0
				European				
1968	21.6	60.3	15.2	2.7	0.3	0.0	0.0	0.0
1969	0.0	83.8	16.2	0.0	0.0	0.0	0.0	0.0
1970	0.0	90.4	9.6	0.0	0.0	0.0	0.0	0.0
1971	9.3	66.5	19.9	3.1	1.2	0.0	0.0	0.0
1972	11.0	71.2	16.7	1.0	0.1	0.0	0.0	0.0
1973	26.0	58.0	14.0	2.0	0.0	0.0	0.0	0.0
1974	22.9	68.2	8.5	0.4	0.0	0.0	0.0	0.0
1975	26.0	53.4	18.2	2.5	0.0	0.0	0.0	0.0
1976	23.5	67.2	8.4	0.6	0.3	0.0	0.0	0.0
1977	-	-	-	-	-	-	-	-
1978	26.2	65.4	8.2	0.2	0.0	0.0	0.0	0.0
1979	23.6	64.8	11.0	0.6	0.0	0.0	0.0	0.0
1980	25.8	56.9	14.7	2.5	0.2	0.0	0.0	0.0
1981	15.4	67.3	15.7	1.6	0.0	0.0	0.0	0.0
1982	15.6	56.1	23.5	4.2	0.7	0.0	0.0	0.0
1983	34.7	50.2	12.3	2.4	0.3	0.1	0.1	0.0
1984	22.7	56.9	15.2	4.2	0.9	0.2	0.0	0.0
1985	20.2	61.6	14.9	2.7	0.6	0.0	0.0	0.0
1986	19.5	62.5	15.1	2.7	0.2	0.0	0.0	0.0
1987	19.2	62.5	14.8	3.3	0.3	0.0	0.0	0.0
1988	18.4	61.6	17.3	2.3	0.5	0.0	0.0	0.0
1989	18.0	61.7	17.4	2.7	0.3	0.0	0.0	0.0
Total	20.8	61.9	14.7	2.3	0.3	0.0	0.0	0.0

Table 16 List of input parameters by river and year (i+1) used to estimate run size and tag returns to Maine rivers. Data for years prior to 1988 are the same as those given in Anon. (1989a), except those listed below. Ta = number of tagged salmon recovered by anglers, Ua = number of untagged salmon recovered by anglers, Tt = number of tagged salmon recovered at the trap, and Ut = number of untagged salmon recovered at the trap.

1987

River	Ta	Ua	Tt	Ut
Penobscot	5	138	95	1401
Union	0	5	0	38
Narraguagus	0	35	0	0
Pleasant	0	0	0	9
Machias	0	4	0	0
East Machias	0	13	0	0
Dennys	0	1	0	0
Kennebec	0	4	0	0
Androscoggin	0	0	0	21
Sheepscot	0	12	0	0
Ducktrap	0	0	0	0
Saco	1	11	0	23

1988

River	Ta	Ua	Tt	Ut
Penobscot	6	127	258	1666
Union	0	2	0	45
Narraguagus	0	34	0	0
Pleasant	0	0	0	0
Machias	0	6	0	0
East Machias	0	13	0	0
Dennys	0	9	0	0
Kennebec	0	2	3	10
Androscoggin	0	0	3	8
Sheepscot	0	0	0	0
Ducktrap	0	0	0	0
Saco	0	3	1	33

1989

River	Ta	Ua	Tt	Ut
Penobscot	11	233	149	1715
Union	0	3	0	22
Narraguagus	0	35	0	0
Pleasant	0	0	0	0
Machias	0	9	0	0
East Machias	0	16	0	0
Dennys	0	11	0	0
Kennebec	0	2	1	13
Androscoggin	0	0	0	17
Sheepscot	0	0	0	0
Ducktrap	0	0	0	0
Saco	0	3	0	13

Table 17 Estimated Carlin tags and run size in Maine rivers. RATIO=tags to run for 2SW salmon used in the estimation of distant water harvest the preceding year. Parenthetical number (either 100 or 85) is the fishway passage efficiency used in the calculations.

Year	Tags (100)	Run (100)	RATIO (100)	Tags (85)	Run (85)	RATIO (85)
1967	0.0	946.0	0.00000	0.0	1018.5	0.00000
1968	152.0	670.3	0.22678	168.2	729.2	0.23072
1969	6.5	633.8	0.01026	7.2	690.2	0.01044
1970	12.0	787.8	0.01523	13.2	855.5	0.01547
1971	59.3	638.5	0.09280	67.7	687.2	0.09855
1972	274.8	1330.8	0.20646	318.2	1448.5	0.21966
1973	176.3	1378.5	0.12786	206.3	1447.5	0.14249
1974	183.3	1306.5	0.14026	214.5	1411.3	0.15198
1975	387.5	2185.3	0.17733	450.1	2344.8	0.19198
1976	158.8	1221.3	0.12999	184.3	1341.3	0.13744
1977	86.3	1922.5	0.04486	96.8	2024.9	0.04783
1978	85.3	3855.0	0.02211	96.5	4110.0	0.02349
1979	31.3	1773.8	0.01762	35.7	1877.9	0.01899
1980	0.0	5225.0	0.00000	0.0	5582.4	0.00000
1981	413.0	4734.5	0.08723	470.0	5107.2	0.09203
1982	252.0	5447.5	0.04626	284.1	6002.5	0.04733
1983	121.8	1776.5	0.06853	138.2	1914.9	0.07215
1984	52.8	2793.0	0.01889	61.4	3024.7	0.02030
1985	161.0	4321.8	0.03725	185.0	4829.6	0.03831
1986	265.0	4893.5	0.05415	309.1	5563.4	0.05556
1987	102.5	2117.0	0.04842	119.3	2397.1	0.04976
1988	272.5	2512.0	0.10848	319.3	2869.7	0.11125
1989	163.8	2600.0	0.06298	190.2	2940.6	0.06469

Table 18 Tag returns from 1SW salmon of Maine origin in West Greenland by year and NAFO division.

Year	1A	1B	1C	1D	1E	1F	Unk	Total
1967	1	10	10	8	3	2	3	37
1969	0	1	3	0	1	0	1	6
1970	10	14	6	7	12	2	7	58
1971	29	34	50	57	58	60	94	382
1972	5	4	35	6	15	5	12	82
1973	5	28	25	16	13	12	32	131
1974	8	75	95	79	32	20	48	357
1975	10	22	16	5	1	3	70	127
1976	13	11	9	3	0	0	3	39
1977	0	1	6	0	1	2	1	11
1978	0	5	2	0	0	0	2	9
1980	0	37	20	9	0	0	6	72
1981	0	17	5	0	0	0	18	40
1982	1	42	1	1	0	2	2	49
1983	0	1	6	0	0	0	0	7
1984	1	9	9	0	1	3	0	23
1985	4	25	7	8	0	5	9	58
1986	1	10	15	17	11	18	0	72
1987	2	29	52	43	29	10	0	165
1988	1	29	24	27	19	4	0	104
1989	4	14	43	22	14	8	0	105
Unk	1	7	10	6	5	2	3	34
Total	96	425	449	314	215	158	311	1,968

Table 19 Estimated harvest (with 100% passage efficiency for fishways in Maine rivers) of 1SW salmon of Maine origin in West Greenland by year and NAFO division.

Year	1A	1B	1C	1D	1E	1F	Unk	Total
1967	6	62	62	50	19	12	19	229
1969	0	92	277	0	92	0	92	554
1970	152	212	91	106	182	30	106	879
1971	198	232	341	388	395	409	640	2,602
1972	55	44	385	66	165	55	132	902
1973	50	281	251	160	130	120	321	1,313
1974	63	595	753	626	254	159	381	2,831
1975	108	238	173	54	11	32	757	1,374
1976	543	460	376	125	0	0	125	1,630
1977	0	85	509	0	85	170	85	933
1978	0	639	255	0	0	0	255	1,149
1980	0	1,193	645	290	0	0	193	2,321
1981	0	827	243	0	0	0	875	1,946
1982	27	1,149	27	27	0	55	55	1,341
1983	0	74	447	0	0	0	0	521
1984	38	340	340	0	38	113	0	868
1985	104	649	182	208	0	130	234	1,506
1986	29	290	436	494	319	523	0	2,091
1987	26	376	674	557	376	130	0	2,139
1988	22	648	536	603	424	89	0	2,322
Total	1,422	8,485	7,002	3,756	2,490	2,027	4,271	29,451

Table 20 Estimated harvest (with 85% passage efficiency for fishways in Maine rivers) of 1SW salmon of Maine origin in West Greenland by year and NAFO division.

Year	1A	1B	1C	1D	1E	1F	Unk	Total
1967	6	61	61	49	18	12	18	226
1969	0	91	273	0	91	0	91	545
1970	143	200	86	100	171	29	100	828
1971	186	218	320	365	371	384	602	2,446
1972	49	39	345	59	148	49	118	809
1973	46	259	231	148	120	111	296	1,212
1974	59	549	696	579	234	147	352	2,615
1975	102	225	164	51	10	31	716	1,299
1976	510	431	353	118	0	0	118	1,529
1977	0	80	479	0	80	160	80	878
1978	0	592	237	0	0	0	237	1,066
1980	0	1,131	611	275	0	0	183	2,200
1981	0	808	238	0	0	0	856	1,901
1982	26	1,091	26	26	0	52	52	1,273
1983	0	69	416	0	0	0	0	485
1984	37	330	330	0	37	110	0	844
1985	101	633	177	202	0	127	228	1,468
1986	28	283	424	480	311	509	0	2,035
1987	25	367	657	544	367	126	0	2,086
1988	22	630	522	587	413	87	0	2,261
Total	1,340	8,088	6,646	3,583	2,372	1,933	4,046	28,007

Table 21 Tag returns from 2SW salmon of Maine origin in West Greenland by year and NAFO division.

Year	1A	1B	1C	1D	1E	1F	Unk	Total
1968	0	1	0	1	0	0	1	3
1969	0	0	0	0	0	0	1	1
1971	3	0	1	0	1	1	1	7
1972	1	3	3	1	0	0	4	12
1973	1	5	1	1	1	1	2	12
1974	0	1	1	1	0	0	4	7
1975	0	8	1	0	1	0	0	10
1978	0	1	0	0	0	0	0	1
1981	0	0	1	0	0	0	1	2
1982	0	3	0	0	0	0	0	3
1983	0	2	2	0	0	0	0	4
1984	0	1	0	0	0	0	0	1
1986	0	1	0	0	1	0	0	2
1988	0	0	1	1	1	0	0	3
1989	0	0	1	0	0	0	0	1
Total	5	26	12	5	5	2	14	69

Table 22 Estimated harvest (with 100% passage efficiency for fishways in Maine rivers) of 2SW salmon of Maine origin in West Greenland by year and NAFO division.

Year	1A	1B	1C	1D	1E	1F	Unk	Total
1968	0	6	0	6	0	0	6	19
1969	0	0	0	0	0	0	137	137
1971	45	0	15	0	15	15	15	106
1972	7	20	20	7	0	0	27	82
1973	11	55	11	11	11	11	22	132
1974	0	10	10	10	0	0	40	70
1975	0	63	8	0	8	0	0	79
1978	0	85	0	0	0	0	0	85
1981	0	0	32	0	0	0	32	64
1982	0	146	0	0	0	0	0	146
1983	0	55	55	0	0	0	0	109
1984	0	74	0	0	0	0	0	74
1986	0	26	0	0	26	0	0	52
1988	0	0	13	13	13	0	0	39
1989	0	0	22	0	0	0	0	22
Total	63	541	187	47	73	26	280	1,217

Table 23 Estimated harvest (with 85% passage efficiency for fishways in Maine rivers) of 2SW salmon of Maine origin in West Greenland by year and NAFO division.

Year	1A	1B	1C	1D	1E	1F	Unk	Total
1968	0	6	0	6	0	0	6	18
1969	0	0	0	0	0	0	135	135
1971	43	0	14	0	14	14	14	100
1972	6	19	19	6	0	0	26	77
1973	10	49	10	10	10	10	20	118
1974	0	9	9	9	0	0	37	65
1975	0	59	7	0	7	0	0	73
1978	0	80	0	0	0	0	0	80
1981	0	0	31	0	0	0	31	61
1982	0	143	0	0	0	0	0	143
1983	0	52	52	0	0	0	0	104
1984	0	69	0	0	0	0	0	69
1986	0	25	0	0	25	0	0	51
1988	0	0	13	13	13	0	0	38
1989	0	0	22	0	0	0	0	22
Total	59	511	177	44	69	24	268	1,153

Table 24 Tag returns from previous spawners of Maine origin in West Greenland by year and NAFO division.

Year	1A	1B	1C	1D	1E	1F	Unk	Total
1963	0	1	0	0	0	0	0	1
1964	0	1	0	0	0	0	0	1
1966	0	0	1	0	0	1	0	2
1967	0	1	2	0	1	0	0	4
1968	0	4	0	0	0	1	0	5
1969	0	0	1	0	0	0	0	1
1970	0	0	0	0	0	0	1	1
1971	0	1	0	0	0	0	0	1
1972	1	2	0	0	0	0	0	3
1973	1	4	1	2	1	2	0	11
1974	0	0	0	1	0	0	0	1
1975	0	1	0	0	0	0	0	1
1986	0	1	0	0	0	0	0	1
1987	0	0	0	1	0	0	0	1
Total	2	16	5	4	2	4	1	34

Table 25 Tag returns from and estimated harvest of 1SW salmon of Maine origin in East Greenland (NAFO division 14b). Parenthetical number (either 100 or 85) is the fishway passage efficiency used in the calculations.

Year	Tags	Harvest	
		(100)	(85)
1971	7	48	45
1974	4	32	29
1985	6	156	152
1986	2	58	57
1988	9	201	196
Total	28	495	479

Table 26 Input data for exploitation rate calculations for 1SW salmon.

Year i	RUN2 i+1	RUN3 i+2	GH2 i+1	CH2 i+1	USAC i+1	NN2 i+1	GH1 i	CH1 i
1967	729	19	18	50	0	161	226	242
1968	690	18	135	274	0	274	0	411
1969	856	17	0	92	0	92	545	277
1970	687	49	100	135	14	14	828	398
1971	1,449	13	77	12	7	52	2,446	295
1972	1,448	59	118	66	30	20	809	105
1973	1,411	28	65	9	28	38	1,212	220
1974	2,345	5	73	65	30	7	2,615	755
1975	1,341	16	0	8	0	0	1,299	1,014
1976	2,025	32	0	90	30	60	1,529	2,230
1977	4,110	4	80	61	0	0	878	933
1978	1,878	10	0	59	0	0	1,066	309
1980	5,107	41	61	135	0	0	2,200	4,607
1981	6,003	15	143	144	30	60	1,901	1,137
1982	1,915	16	104	31	0	20	1,273	1,586
1983	3,025	8	69	0	0	0	485	1,689
1984	4,830	24	0	95	0	0	844	1,322
1985	5,563	52	51	66	0	0	1,468	2,274
1986	2,397	7	0	0	0	0	2,035	533
1987	2,870	7	38	49	13	0	2,086	584
1988	2,941		22	61	44	0	2,261	393

RUN2 = Run to homewaters of 2SW salmon.

RUN3 = Run to homewaters of 3SW salmon.

GH2 = Greenland harvest of 2SW salmon

CH2 = Canada harvest of 2SW salmon.

USAC = USA Coastal harvest of 2SW salmon.
NN2 = Non-Newfoundland commercial fishery harvest of 2SW salmon.

GH1 = Greenland harvest of 1SW salmon.

CH1 = Canada harvest of 1SW salmon.

Table 27 Input data for exploitation rate calculations for 2SW salmon.

Year i	RUN3 i+1	GH2 i	CH2 i
1968	19	18	50
1969	18	135	274
1970	17	0	92
1971	49	100	135
1972	13	77	12
1973	59	118	66
1974	28	65	9
1975	5	73	65
1976	16	0	8
1977	32	0	90
1978	4	80	61
1980	33	0	59
1981	41	61	135
1982	15	143	144
1983	16	104	31
1984	8	69	0
1985	24	0	95
1986	52	51	66
1987	7	0	0
1988	7	38	49

RUN3 = Run to homewaters of 3SW salmon.

GH2 = Greenland harvest of 2SW salmon.

CH2 = Canada harvest of 2SW salmon.

<u>Table 28</u> Estimated exploitation rate of 1SW salmon for the extant population of Maine origin stocks.

Natural Mortality Per cent Unaccounted Adjusted Carlin	0.12 0.00 1	0.12 0.00 2	0.12 0.10 1	0.12 0.10 2	0.24 0.00 1	0.24 0.00 2	0.24 0.10 1	0.24 0.10 2
1967	0.30	0.41	0.32	0.43	0.28	0.38	0.30	0.41
1968	0.21	0.26	0.23	0.28	0.19	0.24	0.21	0.26
1969	0.41	0.54	0.44	0.57	0.38	0.51	0.41	0.54
1970	0.52	0.63	0.55	0.66	0.49	0.60	0.52	0.63
1971	0.60	0.74	0.63	0.76	0.58	0.71	0.60	0.73
1972	0.32	0.45	0.34	0.48	0.29	0.42	0.32	0.45
1973	0.45	0.60	0.47	0.62	0.42	0.57	0.45	0.60
1974	0.54	0.69	0.57	0.71	0.52	0.67	0.54	0.69
1975	0.60	0.75	0.63	0.77	0.58	0.73	0.60	0.75
1976	0.60	0.74	0.63	0.76	0.57	0.71	0.60	0.73
1977	0.28	0.42	0.30	0.45	0.25	0.40	0.28	0.42
1978	0.39	0.55	0.41	0.58	0.36	0.52	0.39	0.55
1980	0.53	0.69	0.56	0.71	0.51	0.66	0.53	0.69
1981	0.30	0.45	0.32	0.47	0.28	0.42	0.30	0.44
1982	0.55	0.70	0.58	0.72	0.52	0.67	0.55	0.69
1983	0.39	0.55	0.41	0.58	0.36	0.52	0.38	0.55
1984	0.28	0.43	0.30	0.46	0.26	0.41	0.28	0.43
1985	0.37	0.53	0.39	0.56	0.34	0.51	0.37	0.53
1986	0.49	0.66	0.52	0.68	0.46	0.63	0.49	0.66
1987	0.45	0.61	0.47	0.63	0.42	0.58	0.44	0.61
1988	0.44	0.60	0.46	0.62	0.41	0.57	0.44	0.60
Average (Time Series)	0.43	0.57	0.45	0.60	0.40	0.55	0.43	0.57
Average (Last Ten)	0.42	0.58	0.44	0.60	0.39	0.55	0.42	0.58

Table 29 Estimated exploitation rate of 2SW salmon for the extant population of Maine origin stocks.

Natural Mortality	0.12	0.12	0.12	0.12	0.24	0.24	0.24	0.24
Per cent Unaccounted	0.00	0.00	0.10	0.10	0.00	0.00	0.10	0.10
Adjusted Carlin	1	2	1	2	1	2	1	2
1968	0.76	0.86	0.78	0.88	0.74	0.85	0.76	0.86
1969	0.95	0.98	0.96	0.98	0.95	0.97	0.95	0.98
1970	0.83	0.91	0.85	0.92	0.82	0.90	0.83	0.91
1971	0.81	0.90	0.83	0.90	0.79	0.88	0.81	0.90
1972	0.86	0.92	0.87	0.93	0.84	0.91	0.86	0.92
1973	0.74	0.85	0.76	0.86	0.71	0.83	0.74	0.85
1974	0.70	0.83	0.73	0.84	0.68	0.81	0.70	0.83
1975	0.96	0.98	0.97	0.98	0.96	0.98	0.96	0.98
1976	0.31	0.48	0.34	0.50	0.29	0.45	0.31	0.48
1977	0.72	0.84	0.74	0.85	0.69	0.82	0.72	0.83
1978	0.97	0.99	0.97	0.99	0.97	0.98	0.97	0.99
1980	0.62	0.76	0.64	0.78	0.59	0.74	0.62	0.76
1981	0.81	0.90	0.83	0.90	0.79	0.88	0.81	0.89
1982	0.95	0.97	0.95	0.98	0.94	0.97	0.95	0.97
1983	0.89	0.94	0.90	0.94	0.87	0.93	0.88	0.94
1984	0.88	0.94	0.89	0.94	0.87	0.93	0.88	0.94
1985	0.78	0.88	0.80	0.89	0.76	0.87	0.78	0.88
1986	0.67	0.80	0.69	0.82	0.65	0.78	0.67	0.80
1987	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1988	0.92	0.96	0.92	0.96	0.91	0.95	0.91	0.96
Average (Time Series)	0.76	0.83	0.77	0.84	0.74	0.82	0.76	0.83
Average (Last Ten)	0.75	0.81	0.76	0.82	0.74	0.80	0.75	0.81

Table 30 Estimates of Exploitation Rates for the Reduced Model (Figure 1C) in the fisheries of Newfoundland-Labrador and West Greenland for varying levels of P, the fraction of the stock migrating from each fishery and for two levels of adjustment for reporting rate of Carlin tags.

	Carlin Adjustment = 1.0 Evaluation of P-fraction						Carlin Adjustment = 2.0 Evaluation of P-fraction					
Year (i)	Can. 0.1	Grld 0.9	Can. 0.5	Grld 0.5	Can. 0.9	Grld 0.1	Can 0.1	Grld 0.9	Can. 0.5	Grld 0.5	Can. 0.9	Grld 0.1
1967	0.75	0.24	0.37	0.36	0.25	0.73	0.85	0.38	0.54	0.53	0.40	0.85
1968	0.84	0.00	0.52	0.00	0.37	0.00	0.91	0.00	0.68	0.00	0.54	0.00
1969	0.74	0.39	0.37	0.53	0.24	0.85	0.85	0.56	0.54	0.69	0.39	0.92
1970	0.84	0.54	0.51	0.68	0.37	0.91	0.91	0.71	0.68	0.81	0.54	0.96
1971	0.65	0.63	0.27	0.75	0.17	0.94	0.78	0.77	0.42	0.86	0.29	0.97
1972	0.40	0.36	0.12	0.50	0.07	0.83	0.56	0.53	0.21	0.67	0.13	0.91
1973	0.58	0.46	0.22	0.61	0.14	0.88	0.73	0.63	0.36	0.75	0.24	0.94
1974	0.74	0.53	0.37	0.67	0.24	0.91	0.85	0.69	0.54	0.80	0.39	0.95
1975	0.87	0.49	0.58	0.63	0.43	0.90	0.93	0.66	0.73	0.78	0.60	0.95
1976	0.91	0.43	0.67	0.57	0.52	0.87	0.95	0.60	0.80	0.73	0.69	0.93
1977	0.67	0.17	0.29	0.28	0.19	0.66	0.80	0.30	0.45	0.43	0.31	0.79
1978	0.60	0.36	0.23	0.50	0.14	0.84	0.74	0.53	0.37	0.67	0.25	0.91
1980	0.89	0.30	0.62	0.43	0.47	0.79	0.94	0.46	0.76	0.61	0.64	0.88
1981	0.63	0.24	0.25	0.36	0.16	0.74	0.77	0.39	0.41	0.53	0.28	0.85
1982	0.88	0.40	0.60	0.54	0.45	0.86	0.93	0.57	0.75	0.70	0.62	0.92
1983	0.83	0.14	0.50	0.22	0.36	0.59	0.90	0.24	0.67	0.36	0.53	0.74
1984	0.71	0.15	0.33	0.24	0.22	0.61	0.83	0.26	0.50	0.38	0.35	0.76
1985	0.79	0.21	0.42	0.32	0.29	0.70	0.88	0.34	0.60	0.49	0.45	0.82
1986	0.67	0.46	0.29	0.60	0.18	0.88	0.80	0.63	0.44	0.75	0.31	0.94
1987	0.65	0.42	0.27	0.56	0.17	0.87	0.78	0.59	0.42	0.72	0.29	0.93
1988	0.55	0.43	0.19	0.58	0.12	0.87	0.70	0.60	0.33	0.73	0.21	0.93
Average	0.72	0.35	0.38	0.47	0.26	0.77	0.83	0.50	0.53	0.62	0.40	0.85
Average last 10 years	0.72	0.31	0.37	0.44	0.26	0.77	0.83	0.46	0.52	0.60	0.39	0.87

Table 31 Summary of input variables for Maine stocks for model calibration approach. Variable names are defined in the text.

Year	2SW RUN RU	S to river SU	S to river SPU	1X Harvests HGU	1X Harvests HCU	2X Harvests HGU2	2X Harvests HCU2
1974	2344.8	0.893	0.901	2615	755	5230	1510
1975	1341.3	0.893	0.901	1299	1014	2598	2028
1976	2024.9	0.893	0.901	1529	2230	3058	4460
1977	4110	0.893	0.901	878	933	1756	1866
1978	1877.9	0.893	0.901	1066	309	2132	618
1980	5107.2	0.893	0.901	2200	4607	4400	9214
1981	6002.5	0.893	0.901	1901	1137	3802	2274
1982	1914.9	0.893	0.901	1273	1586	2546	3172
1983	3024.7	0.893	0.901	485	1689	970	3378
1984	4829.6	0.893	0.901	844	1322	1688	2644
1985	5563.4	0.893	0.901	1468	2274	2936	4548
1986	2397.1	0.893	0.901	2035	533	4070	1066
1987	2869.7	0.893	0.901	2086	584	4172	1168
1988	2940.6	0.893	0.901	2261	393	4522	786
Average	3310.6			1567.1	1383.3	3134.3	2766.6

Input parameters for Maine stocks

Table 32 Summary of input variables for St. John River stock for model calibration approach. Variable names are defined in the text.

Input parameters for St. John River

Year	2SW RUN RC	S to river SC	S to river SPC	1X Harvests HGC	1X Harvests HCC	2X Harvests HGC2	2X Harvests HCC2
1974	8995	0.893	0.901	7672	3089	15344	6178
1975	9871	0.893	0.901	4258	6044	8516	12088
1976	10522	0.893	0.901	5504	2887	11008	5774
1977	6050	0.893	0.901	957	4897	1914	9794
1978	3126	0.893	0.901	1402	1339	2804	2678
1980	7846	0.893	0.901	1986	3204	3972	6408
1981	5689	0.893	0.901	1871	845	3742	1690
1982	3843	0.893	0.901	3011	1940	6022	3880
1983	10578	0.893	0.901	234	2555	468	5110
1984	10915	0.893	0.901	991	2237	1982	4474
1985	6357	0.893	0.901	1943	2714	3886	5428
1986	4436	0.893	0.901	2289	661	4578	1322
1987	3420	0.893	0.901	2335	3191	4670	6382
1988	4318	0.893	0.901	3451	0	6902	0
Average	6854.7			2707.4	2543.1	5414.9	5086.1

Table 33 The numbers of European, Canadian, and Maine fish caught at West Greenland and the numbers caught in homewaters the following year. Numbers of salmon are in thousands.

Year	Number of salmon caught at West Greenland			Number of salmon caught in homewaters, year n+1		
	European	Canadian	Maine	European	Canadian	Maine[1]
1987	125.5	176.4	4.1	320.6	132.6	2.9
1988	164.2	119.2	4.5	251.5	141.1	2.9

[1] Run size.
Non-catch fishing mortality not included in Greenland or homewater fisheries

Table 34 The estimated return from West Greenland to homewaters, using different exploitation rates at West Greenland, and 10% natural mortality between West Greenland and homewaters.

Year	Expl. rate	Stock present at West Greenland before the fishery, year n			Return to homewater year n + 1		
		Europe	Canada	Maine	Europe	Canada	Maine
1987	0.59	212.7	299.0	6.9	78.5	110.3	2.6
	0.72	174.3	245.0	5.7	43.9	61.7	1.4
	0.93	134.9	189.7	4.4	8.5	12.0	0.27
1988	0.59	278.3	202.2	7.6	102.7	74.6	2.8
	0.72	228.1	165.7	6.3	57.5	41.8	1.6
	0.93	176.6	128.3	4.8	11.1	8.1	0.27

Table 35 Estimated fractions (1-P) of 2SW homewater returns coming from Greenland and exploitation rates for St John River and Maine Rivers stocks in the fisheries of Newfoundland-Labrador and West Greenland. Carlin tag-based estimates of harvest not adjusted for un-reporting, i.e., Carlin adjustment = 1.0. Results based on calibration method described in text.

Year	(1-P) values		Exploitation rates			
			St. John		Maine rivers	
	St.John PC	Maine PU	Nfl-Lab ECC	W.Grld EGC	Nfl-Lab ECU	W.Grld EGU
1974	0.792	0.808	0.598	0.49	0.602	0.552
1975	0.554	0.605	0.553	0.41	0.633	0.588
1976	0.762	0.701	0.509	0.38	0.768	0.490
1977	0.725	0.822	0.726	0.163	0.535	0.188
1978	0.805	0.886	0.664	0.332	0.565	0.364
1980	0.675	0.655	0.531	0.251	0.702	0.370
1981	0.908	0.890	0.593	0.244	0.608	0.241
1982	0.638	0.599	0.557	0.523	0.650	0.498
1983	0.827	0.770	0.557	0.023	0.686	0.157
1984	0.869	0.849	0.585	0.085	0.620	0.155
1985	0.750	0.749	0.606	0.267	0.595	0.239
1986	0.902	0.882	0.578	0.338	0.629	0.462
1987	0.733	0.837	0.759	0.454	0.529	0.437
1988	0.922	0.920	0	0.436	0.601	0.427
Average	0.7759	0.7838	0.5583	0.3140	0.6231	0.3691

Table 36 Estimated fractions (1-P) of 2SW homewater returns coming from Greenland and exploitation rates for St John River and Maine Rivers stocks in the fisheries of Newfoundland-Labrador and West Greenland. Carlin tag-based estimates of harvest increased 2X for un-reporting, i.e., Carlin adjustment factor = 2.0. Results based on calibration method described in text.

Year	(1-P) values		Exploitation rates			
			St. John		Maine rivers	
	St.John PC2	Maine PU2	Nfl-Lab ECC2	W.Grld EGC2	Nfl-Lab ECU2	W.Grld EGU2
1974	0.589	0.606	0.601	0.721	0.596	0.767
1975	0.058	0.075	0.539	0.93	0.596	0.958
1976	0.441	0.424	0.469	0.679	0.775	0.761
1977	0.519	0.594	0.752	0.352	0.502	0.391
1978	0.667	0.741	0.699	0.546	0.534	0.578
1980	0.143	0.174	0.462	0.76	0.663	0.816
1981	0.81	0.789	0.585	0.42	0.618	0.418
1982	0.246	0.224	0.547	0.85	0.658	0.841
1983	0.668	0.663	0.567	0.056	0.749	0.302
1984	0.724	0.724	0.572	0.183	0.641	0.301
1985	0.503	0.491	0.608	0.52	0.591	0.49
1986	0.788	0.779	0.559	0.539	0.645	0.661
1987	0.556	0.623	0.791	0.687	0.493	0.676
1988	0.842	0.839	0	0.629	0.599	0.621
Average	0.5396	0.5533	0.5536	0.5623	0.6186	0.6129

Table 37 Nominal landings of Atlantic salmon by Faroese vessels in years 1982-1989 and the seasons 1981/1982 - 1988/1989.

Year	Catch (tonnes)	Season	Catch (tonnes)
1982	606	1981/1982	796
1983	678	1982/1983	625
1984	628	1983/1984	651
1985	566	1984/1985	598
1986	530	1985/1986	545
1987	576	1986/1987	539
1988	243	1987/1988	208
1989[1]	364	1988/1989[1]	309

[1] Preliminary catch.

Table 38 Catch in number of salmon by month in the Faroes fishery for the seasons 1983/1984 to 1988/1989.

Season	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total
1983/84	8,680	24,882	12,504	26,396	32,712	12,486	6,849	0	124,508
1984/85	5,884	20,419	14,493	24,380	26,035	25,471	19,095	0	135,776
1985/86	1,571	27,611	13,992	50,146	25,968	21,209	14,057	0	154,554
1986/87	1,881	19,693	5,905	15,113	35,241	21,953	39,153	1,365	140,304
1987/88	4,259	27,125	5,803	9,387	9,592	4,203	4,642	0	65,011
1988/89	17,019	24,743	2,916	4,663	12,457	31,698	-	-	93,496

Table 39 Catch in number per unit effort (1,000 hooks) by month in the Faroes long-line fishery for salmon in the seasons 1982/1983 to 1988/1989.

CPUE for whole fishery:

Season	Nov	Dec	Jan	Feb	Mar	Apr	May	Total
1982/83	83	134	73	49	46	39	34	47
1983/84	75	81	79	53	39	23	32	51
1984/85	42	35	31	35	37	42	37	36
1985/86	55	57	65	45	63	73	96	58
1986/87	37	44	33	62	84	101	74	64
1987/88	53	61	48	35	34	33	0	48
1988/89	78	77	54	32	75	71	0	72

CPUE within EEZ (not calculated for seasons prior to 1986/1987):

Season	Nov	Dec	Jan	Feb	Mar	Apr	May	Total
1986/87	38	44	34	62	86	101	92	62
1987/88	44	57	46	34	34	32	0	43
1988/89	78	77	54	32	75	71	0	72

Table 40 CPUE by degree latitude by month in the Faroes fishery in 1988/1989 (Catch in number per 1,000 hooks).

Latitude		Nov	Dec	Jan	Feb	Mar	Apr	Total
Outside								
EEZ	68	0	0	0	0	0	0	0
	67	0	0	0	0	0	0	0
	66	0	0	0	0	0	0	0
Inside								
EEZ	65	0	0	0	23	68	70	59
	64	32	36	42	0	69	81	71
	63	71	75	51	0	86	64	71
	62	92	79	58	39	74	0	78
	61	5	0	34	0	0	0	16
Totals:								
Outside EEZ		0	0	0	0	0	0	0
Inside EEZ		78	77	54	32	75	71	72
All areas		78	77	54	32	75	71	72

Table 41 Number of microtags recovered at Faroes by country.

Season of recovery	Country of origin	Numbers recovered			
		Discards	1SW	2SW	Total
1981/1982	Ireland	-	-	2	2
	Scotland	-	-	2	2
1982/1983	Ireland	-	8	1	9
	Scotland	-	-	1	1
1983/1984	Scotland	-	-	1	1
1984/1985	Ireland	14	1	3	18
	Scotland	2	1	-	3
	Raising factors	(21.0)	(4.0)	(4.0)	
1985/1986	Ireland	8	1	4	13
	Faroe Islands	-	-	2	2
	Raising factors	(12.6)	(3.3)	(3.3)	
1986/1987	Faroe Islands	-	-	30	30
	Ireland	7	-	2	9
	England/Wales	3	-	3	6
	N. Ireland	3	-	1	4
	Scotland	-	2	1	3
	Raising factors	(2.9)	(2.3)	(2.3)	
1987/1988	Faroe Islands	-	-	20	20
	Ireland	2	1	5	8
	England/Wales	1	-	3	4
	Iceland	-	-	1	1
	Raising factors	(52.0)	(2.8)	(2.8)	
1988/1989	Ireland	12	5	2	19
	England/Wales	2	-	14	16
	Iceland	-	-	15	15
	Scotland	1	-	3	4
	Faroe Islands	2	-	-	2
	N. Ireland	-	1	-	1
	Canada	1	-	-	1
	USA	-	-	1	1
	Raising factors	(6.1)	(1.7)	(1.7)	

Table 42 Estimated numbers of 1SW and 2SW microtagged salmon caught in the Faroese fishery for smolt releases between 1984 and 1988.

Year of migration	Country of origin	No. released	No. in catch			Rec./Rel. x 10^{-3}
			1SW	2SW	Total	
1984	Ireland	260,816	298	16	331	1.27
	Scotland	30,040	63	-	63	2.10[1]
	England/Wales	39,780	-	4	4	0.10
	Faroes	19,602	-	-	8	0.41
1985	Ireland	220,000	113	7	120	0.55
	Faroes	-	-	99	99	-
	Scotland	13,497	-	3	3	0.22
	N. Ireland	-	-	3	3	-
	England/Wales	53,347	-	10	10	0.19
1986	Faroes	43,000	-	46	46	1.07
	Ireland	143,866	20	12	32	0.22
	N. Ireland	26,320	9	-	9	0.33
	England/Wales	177,071	9	7	16	0.09
	Iceland	-	-	2	2	-
1987	Iceland	800,000	-	42	42	0.05
	England/Wales	195,373	-	39	39	0.20
	Scotland	20,876	-	8	8	0.40
	Ireland	162,189	156	-	156	0.96
	N. Ireland	20,245	-	3	3	0.15
	USA	640,400	-	3	3	<0.01
1988[2]	Ireland	165,841	82	N/A	82	0.49
	England/Wales	189,913	12	N/A	12	0.06
	Scotland	31,331	6	N/A	6	0.19
	Faroes	43,481	12	N/A	12	0.28
	Canada	13,322	2	N/A	2	0.15

[1] Group of experimentally sterilized salmon.
[2] Recapture rates for 1SW fish only.

Table 43 Catch in number by sea age class by month in the Faroese salmon fishery in 1988/1989.

Month	Sea age 1	%	2	%	3	%	4	%	Total
Nov	300	2	16,138	95	581	3	0	0	17,019
Dec	272	1	23,503	95	968	4	0	0	24,743
Jan	75	3	2,731	94	110	4	0	0	2,916
Feb	102	2	4,301	92	260	6	0	0	4,663
Mar	247	2	10,858	87	1,352	11	0	0	12,457
Apr	355	1	28,886	91	2,457	8	0	0	31,698
May	0	0	0	0	0	0	0	0	0
Total	1,351	1	86,417	92	5,728	6	0	0	93,496

Table 44 Catch in number by sea age class by seasons in the Faroese salmon fishery.

Season	Sea age 1	%	2	%	3	%	4	%	Total number	Catch (t)	Mean weight
1983/1984	4,052	3	107,487	86	12,923	10	46	0	124,508	651	5.23
1984/1985	345	0	125,158	92	10,273	8	0	0	135,776	598	4.40
1985/1986	1,762	1	147,770	96	4,945	3	76	0	154,554	545	3.53
1986/1987	76	0	133,078	95	7,070	5	80	0	140,304	539	3.84
1987/1988	5,833	9	55,728	86	3,450	5	0	0	65,011	208	3.20
1988/1989	1,351	1	86,417	92	5,728	6	0	0	93,496	309	3.30

Table 45 Smolt age composition from samples taken in the Faroese fishery from 1984/1985 to 1988/1989.

Season	1	2	3	4	5	6	Unknown	Total
1984/85	1.5	37.9	46.9	12.3	1.5	0.1	0	2,194
1985/86	0.8	20.4	52.7	24.4	1.7	0	0	951
1986/87	0.2	16.2	48.5	31.8	3.1	0.2	0	575
1987/88	1.2	35.9	49.5	13.2	0.4	0	0	680
1988/89	3.5	47.0	40.5	7.0	0.3	0	1.8	798

Table 46 Estimated exploitation rate of 1SW and 2SW salmon in the Faroes fishery. Reporting rates for external tag recoveries assumed to be as follows: Faroese fishery 75%, North Esk area 100%, elsewhere in Scotland 75% and Norwegian coastal fisheries 50% (and 75% in paranthesis). W = wild. H = hatchery-reared.

Country	River or stock	Seasons		Exploitation rates (%) 1SW	2SW	3SW
England	NE England stocks	Combined data		approx.1	approx.1	
Ireland	Total Irish stock	Combined data		<1	<1	
N.Ireland	R. Bush	1986/1987		<1	0	
Norway	Drammen R.	1984/1985		5 (5)	-	
		1985/1986		0 (0)	30 (32)	
		1986/1987		0 (0)	3 (4)	
		1987/1988		0 (0)	6 (6)	
		1988/1989		0 (0)	36 (38)	
	Imsa R.	1981/1982	W	0 (0)	- -	
			H	1 (1)	- -	
		1982/1983	W	0 (0)	25 (32)	
			H	2 (2)	38 (46)	
		1983/1984	W	0 (0)	50 (56)	
			H	1 (2)	45 (52)	
		1984/1985	W	0 (0)	33 (41)	
			H	2 (3)	39 (53)	
		1985/1986	W	0 (0)	38 (44)	
			H	0 (0)	30 (36)	
		1986/1987	W	0 (0)	13 (17)	
			H	1 (1)	28 (36)	
		1987/1988	W	0 (0)	5 (6)	
			H	1 (1)	21 (27)	
		1988/1989	W	0 (0)	3 (4)	
			H	0 (1)	10 (12)	
Scotland	North Esk	1981/1982		<1	0	0
		1982/1983		0	6	0
		1983/1984		<1	13	7
		1984/1985		0	9	29
		1985/1986		0	0	9
		1986/1987		<1	4	0
		1987/1988		0	5	0
		1988/1989		0	0	0

Table 47 Reported accidents of escapement of farmed fish in Ireland June 1989 to January 1990.

Date	Site	Quantity	Average weight
01.06.89	Galway	40,000	1.5 kg
02.11.89	Galway	50,000-70,000	
18.12.89	Donegal	12,518	2.5 kg
08.01.90	Cork	38,000	900 g
09.01.90	Galway	1,000	

Table 48 Proportion of reared salmon in samples from five commercial fisheries in Scotland 1981-1989. (- = no sample.)

	Sampling Site				
Year	Moray Firth	Kyle of Sutherland	North Coast	Northwest Coast	Solway Firth
1981	0	0	1.0	0	0
1982	0	0	0.3	0	0
1983	0	0	0	1.1	0
1984	-	0	0	0	0
1985	-	0	0	0	0
1986	-	0	0	0.6	-
1987	-	0	0	1.3	0
1988	-	0	0.6	1.5	-
1989	-	0.7	6.1	6.6	-

Table 49 Nominal catch in tonnes of Atlantic salmon of all ages for Salmon Fishing Areas of Newfoundland and Labrador and Quebec commercial fisheries in 1986-89. Catches for 1989 are preliminary.

Salmon Fishing Areas	1986	1987	1988	1989
Newfoundland-Labrador				
1	89	75	65	43
2	309	407	292	223
3	192	369	192	152
4	200	180	104	130
5	61	60	39	36
6	54	48	25	27
7-11	167	137	82	104
12-14	159	212	174	118
Quebec Q7-Q9	85	97	89	79
Quebec Q11	15	11	9	1
Total	1,329	1,596	1,071	914

Table 50 Nominal catches (tonnes) in Newfoundland and Labrador commercial Atlantic salmon fishery, 1971-89.

Year	Small	Large	Total[2]
1971	-	-	1577
1972	-	-	1394
1973	-	-	2011
1974	-	-	2010
1975	750	1294	2043
1976	632	1380	2013
1977	533	1404	1938
1978	274	907	1180
1979	494	495	987
1980	809	1295	2103
1981	676	1233	1910
1982	578	743	1321
1983	417	611	1028
1984	332	465	797
1985	470	411	881
1986	608	622	1230
1987	705	780	1485
1988	511	461	972
1989	417	416	832[1]

[1]Preliminary.
[2]Differences between total and sum of small and large are due to rounding.

Table 51 A summary of mean exploitation rates of 1SW salmon angled in nine rivers in Newfoundland.

River	N	$\bar{X}$	SD	Range	95% Confidence Limit
		Exploitation Rate			
SFA 4					
Exploits River	6	0.160	0.050	0.076-0.205	0.108-0.212
Gander River (entire)	1	0.151	-	-	-
Salmon Brook (Gander R.)	4	0.147	0.053	0.081-0.193	0.063-0.231
SFA 5					
Middle Brook	4	0.426	0.130	0.245-0.530	0.219-0.633
Terra Nova River	6	0.331	0.051	0.248-0.389	0.277-0.385
SFA 9					
Biscay Bay River	5	0.154	0.033	0.114-0.194	0.112-0.196
SFA 10					
Northeast River, Placentia	4	0.261	0.077	0.153-0.333	0.138-0.384
SFA 11					
Grand Bank Brook	3	0.131	0.052	0.086-0.188	0.002-0.260
Conne River	4	0.224	0.039	0.181-0.275	0.162-0.286
All Rivers Combined	37	0.229	0.113	0.076-0.530	0.191-0.267

Table 52 Numbers of Carlin tagged smolts released, 1973-1987 and returning as 2SW fish to Mactaquac 1975-1989, count of hatchery and wild 2SW fish at Mactaquac and RATIO.

Year i	Number of smolts yr i	2SW Count yr i+2 Tags	Total	RATIO (tags/count)
1973	47,956	143	8,058	0.01775
1974	11,984	51	7,134	0.00715
1975	23,953	136	9,315	0.01460
1976	11,997	72	4,985	0.01444
1977	29,946	60	2,885	0.02080
1978	35,908	233	10,451	0.02229
1979	37,849	135	3,530	0.03824
1980	13,977	43	2,990	0.01438
1981	12,000	15	1,941	0.00773
1982	13,998	47	7,817	0.00601
1983	10,000	30	6,956	0.00431
1984	19,988	24	4,143	0.00579
1985	15,900	38	3,430	0.01108
1986	15,902	25	2,441	0.01024
1987	11,550	14	4,291	0.00326
Totals	312,908	1,066		

Table 53 1SW Carlin tag returns of Saint John River salmon from NAFO Divisions of West Greenland for the years 1974-1988.

Year	NAFO Divisions 1A	1B	1C	1D	1E	1F	Uk	Total
1974	5	13	20	15	3	3	33	92
1975	1	2	5	3	1	0	11	23
1976	11	8	11	2	0	1	7	40
1977	1	1	2	0	0	0	5	7
1978	0	11	1	0	0	0	12	14
1979	8	32	26	6	0	0	20	84
1980	0	3	4	0	0	0	5	27
1981	0	5	0	1	0	0	0	11
1982	0	10	2	0	0	0	0	12
1983	0	0	1	0	0	0	0	1
1984	0	2	1	0	0	0	0	3
1985	2	2	2	0	1	0	1	8
1986	0	3	2	8	4	1	0	18
1987	0	5	5	3	2	2	0	17
1988	0	1	3	2	1	1	0	8
Total	28	98	85	40	12	8	94	365

Table 54 1SW Carlin tag returns of Saint John River salmon from Salmon Fishing Areas of Newfoundland-Labrador for the years 1974-1988.

Year	Salmon Fishing Areas 3	4	5	6	1-2	7-14	Uk	Total
1974	2	3	1	5	4	19	1	35
1975	0	3	10	2	5	8	0	28
1976	5	3	6	1	8	4	1	28
1977	12	9	5	5	9	6	0	46
1978	11	0	1	0	3	2	1	18
1979	8	2	2	1	7	4	0	24
1980	43	20	4	1	8	2	0	78
1981	0	2	3	0	2	1	0	8
1982	0	2	0	1	3	4	0	10
1983	3	3	1	0	2	1	0	10
1984	3	0	0	2	0	1	0	6
1985	1	4	0	1	1	3	0	10
1986	1	0	0	1	2	1	0	5
1987	6	2	3	1	3	6	0	21
1988	0	0	0	0	0	0	0	0
Total	95	53	36	21	57	62	3	327

Table 55 Estimates of hatchery and wild 2SW salmon returning to Saint John River at or above Mactaquac, homewater harvest and estimates of harvests of the same smolt class in Newfoundland, Labrador and West Greenland, 1974-88.

Year i	Homewaters yr i+1 Total est. returns[1]	Total est. harvest[2]	Harvest (H) yr i Nfld	Labr	Nfld + Labr	Greenland
1974	8,995	2,065	2,495	250	2,745	7,672
1975	9,871	4,118	4,595	777	5,372	4,258
1976	10,522	3,989	1,957	609	2,566	5,504
1977	6,050	2,040	3,660	693	4,353	957
1978	3,126	1,090	1,030	160	1,190	1,402
1979	12,803	5,084	1,089	349	1,438	7,851
1980	7,846	5,474	2,616	232	2,848	1,986
1981	5,689	3,496	596	155	751	1,871
1982	3,843	2,392	1,294	431	1,725	3,011
1983	10,578	4,171	1,901	370	2,271	234
1984	10,915	4,447	1,989	0	1,989	991
1985	6,357	2,646	2,220	192	2,412	1,943
1986	4,436	1,346	386	201	587	2,289
1987	3,420	1,394	2,511	326	2,837	2,335
1988	4,318	540	0	0	0	3,451
Total	108,769	44,292	28,339	4,745	33,084	45,755

[1] Includes harvest
[2] Includes harvest in-river and out-flow areas

Table 56 Estimated exploitation rates of Saint John-origin salmon in homewaters and under assumptions of 0.3, 0.5 and 0.7 of the total population being available to Newfoundland and Labrador and West Greenland fisheries.

Year i	Nfld-Labr (yr i)			Grnlnd (yi i)			Homewaters
	.3	.5	.7	.7	.5	.3	(yr i+1)
1974	0.472	0.349	0.277	0.522	0.604	0.718	0.230
1975	0.615	0.489	0.406	0.356	0.436	0.563	0.417
1976	0.417	0.300	0.235	0.401	0.484	0.610	0.379
1977	0.678	0.559	0.475	0.168	0.221	0.321	0.337
1978	0.527	0.401	0.324	0.365	0.446	0.572	0.349
1979	0.248	0.165	0.124	0.440	0.524	0.647	0.394
1980	0.516	0.390	0.313	0.245	0.312	0.431	0.698
1981	0.279	0.189	0.142	0.296	0.371	0.495	0.615
1982	0.568	0.441	0.361	0.501	0.584	0.701	0.622
1983	0.386	0.274	0.213	0.028	0.038	0.062	0.394
1984	0.348	0.243	0.186	0.104	0.140	0.213	0.407
1985	0.527	0.400	0.323	0.281	0.354	0.477	0.416
1986	0.280	0.189	0.143	0.398	0.480	0.607	0.303
1987	0.709	0.594	0.511	0.466	0.550	0.671	0.408
1988	0.0	0.0	0.0	0.506	0.589	0.705	0.125
Mean	0.438	0.332	0.269	0.338	0.409	0.520	0.406

Table 57 Comparison of harvest estimates of 1SW Maine-origin Salmon, based on Carlin tags reported by fishermen and coded wire tags (CWT) recovered by sampling during 1988.

Location(1)	Carlin Included(2)	CWT Harvest	Carlin Harvest	Ratio	SD of Ratio for Assumed CV (%) of 10	30	50
Harbour Deep Sampling							
Sec	sum-unk	79	22	3.59	1.80	2.83	4.89
Comm	sum-unk	23	22	1.05			
Difference		56	0				
Sec	sum	79	66	1.20	0.20	0.31	0.54
Comm	sum	23	44	0.52			
Difference		56	22	2.55			
Nippers Harbour Sampling							
Sec	sum	50	0				
Comm	sum	10	0				
Difference		40	0				
Square Islands Sampling							
Sec	sum	85	0				
Comm	sum	8	0				
Difference		77	0				
Makkovik Sampling							
Sec	sum-unk	161	52	3.10	1.41	2.18	3.71
Comm	sum-unk	23	0				
Difference		138	52	2.65			
Sec	sum	161	103	1.56	0.36	0.55	0.95
Comm	sum	23	0				
Difference		138	103	1.34			
Totals for 1988 Sampling							
Sectot	sum-unk	375	74	5.07	1.50	3.55	7.66
Commtot	sum-unk	64	22	2.92			
Difference		311	52	5.98			
Sectot	sum	375	169	2.22	0.29	0.68	1.47
Commtot	sum	64	44	1.46			
Difference		311	125	2.49			

(1) Sec=Statistical section
Comm=Community
Sectot=Statistical section total
Commtot=Community total

(2) Sum=Carlin harvest estimates include tags with unknown recovery date.
Sum-unk=Carlin harvest estimates do not include tags with unknown recovery date.

Table 58 Carlin tag returns from 1SW salmon of Maine origin in Newfoundland and Labrador by year and Salmon Fishing Area.

Year	SFA 1	2	3	4	5	6	7-14	UNK	Total
1967	3	1	7	14	5	0	8	2	40
1968	0	0	0	2	1	0	0	0	3
1969	0	0	2	0	0	0	1	0	3
1970	5	2	13	5	1	1	2	0	29
1971	10	2	4	18	10	3	1	0	48
1972	6	1	0	0	4	0	1	0	12
1973	6	1	6	4	1	1	6	0	25
1974	0	5	19	38	13	10	18	0	103
1975	16	4	18	36	13	6	9	0	102
1976	18	6	26	14	5	5	6	0	80
1977	2	1	6	5	0	0	2	0	16
1978	4	0	1	0	0	0	0	0	5
1980	55	24	112	72	22	6	23	1	315
1981	14	0	2	10	7	5	3	0	41
1982	14	7	20	21	7	6	10	0	85
1983	8	1	11	6	0	0	0	0	26
1984	12	4	7	7	4	2	3	0	39
1985	20	3	15	36	11	1	7	1	94
1986	3	5	6	2	1	0	4	0	21
1987	14	2	16	4	6	2	4	1	49
1988	8	2	5	0	1	0	4	0	20
1989	21	4	10	4	2	1	3	0	45
UNK	1	0	1	1	0	0	2	0	5
Total	239	75	306	298	114	49	115	5	1201

Table 59 Estimated harvest (with 85% passage efficiency for fishways in Maine rivers) of 1SW salmon of Maine origin in Newfoundland and Labrador by year and Salmon Fishing Area.

Year	SFA 1	2	3	4	5	6	7-14	UNK	Total
1967	14	5	43	87	31	0	50	12	242
1968	0	0	0	274	137	0	0	0	411
1969	0	0	185	0	0	0	92	0	277
1970	56	23	188	72	14	14	29	0	398
1971	51	10	26	117	65	20	7	0	295
1972	47	8	0	0	40	0	10	0	105
1973	44	7	56	38	9	9	56	0	220
1974	0	29	141	283	97	74	131	0	755
1975	129	32	187	374	135	62	94	0	1014
1976	418	139	777	418	149	149	179	0	2230
1977	95	47	365	304	0	0	122	0	933
1978	234	0	75	0	0	0	0	0	309
1980	664	290	1739	1118	342	93	347	16	4607
1981	329	0	60	302	211	151	84	0	1137
1982	216	108	396	416	139	119	194	0	1586
1983	438	55	774	422	0	0	0	0	1689
1984	348	116	261	261	149	75	112	0	1322
1985	400	60	386	926	283	26	169	26	2274
1986	67	112	172	57	29	0	96	0	533
1987	140	20	205	51	77	26	51	13	584
1988	137	39	110	0	22	0	83	0	393
Total	3827	1100	6148	5520	1929	818	1904	66	21312

Table 60 Carlin tag returns from 1SW salmon of Maine origin in the provinces Quebec, Nova Scotia and New Brunswick by year.

Year	SFA 19	20	21	22	23	Q5-9	UNK	Total
1967	0	0	1	2	0	0	1	4
1968	0	1	0	4	0	0	0	5
1969	0	0	1	1	0	0	0	2
1970	0	0	1	1	0	0	0	2
1971	0	0	1	2	0	0	0	3
1973	0	0	0	0	1	0	0	1
1974	1	0	0	1	2	0	0	4
1975	0	0	0	1	1	0	0	2
1976	1	0	2	5	5	0	0	13
1977	0	0	0	1	0	0	0	1
1978	0	0	0	0	1	0	0	1
1980	0	0	5	2	1	3	0	11
1981	0	0	1	0	0	0	0	1
1982	0	1	0	0	3	0	0	4
1983	0	0	1	0	0	0	0	1
1984	0	0	1	0	0	0	0	1
1987	0	0	1	0	0	1	0	2
Total	2	2	15	20	14	4	1	58

Table 61 Estimated harvest (with 85% passage efficiency for fishways in Maine rivers) of 1SW salmon of Maine origin in the provinces Quebec, Nova Scotia and New Brunswick by year and Salmon Fishing Area.

Year	SFA 19	20	21	22	23	Q5-9	UNK	Total
1967	0	0	6	12	0	0	6	25
1968	0	137	0	547	0	0	0	684
1969	0	0	92	92	0	0	0	185
1970	0	0	14	14	0	0	0	29
1971	0	0	7	13	0	0	0	20
1973	0	0	0	0	9	0	0	9
1974	7	0	0	7	15	0	0	30
1975	0	0	0	10	10	0	0	21
1976	30	0	60	149	149	0	0	388
1977	0	0	0	61	0	0	0	61
1978	0	0	0	0	75	0	0	75
1980	0	0	78	31	16	47	0	171
1981	0	0	30	0	0	0	0	30
1982	0	20	0	0	59	0	0	79
1983	0	0	70	0	0	0	0	70
1984	0	0	37	0	0	0	0	37
1987	0	0	13	0	0	13	0	26
Total	37	157	408	939	334	59	6	1940

Table 62 Carlin tag returns from 2SW salmon of Maine origin in Newfoundland and Labrador by year and Salmon Fishing Area.

Year	SFA							Total
	1	2	3	4	5	6	7-14	
1968	0	0	2	2	2	0	2	8
1969	0	0	0	0	0	0	2	2
1970	0	0	0	0	0	0	1	1
1971	2	1	1	0	1	3	2	10
1972	0	0	0	1	0	0	1	2
1973	2	0	1	0	1	0	3	7
1974	0	0	0	0	0	0	1	1
1975	1	0	1	1	2	3	1	9
1976	1	0	0	0	0	0	0	1
1977	0	0	1	1	0	1	0	3
1978	0	0	1	0	0	0	0	1
1979	0	1	0	0	0	0	0	1
1981	4	2	2	2	0	0	0	10
1982	1	0	0	2	0	0	2	5
1983	2	0	0	0	0	0	0	2
1985	1	1	0	0	0	0	1	3
1986	0	1	0	1	0	0	1	3
1988	0	1	2	0	0	1	0	4
1989	0	1	0	2	0	0	0	3
Total	14	8	11	12	6	8	17	76

Table 63 Estimated harvest (with 85% passage efficiency for fishways in Maine rivers) of 2SW salmon of Maine origin in Newfoundland and Labrador by year and Salmon Fishing Area.

Year	SFA 1	2	3	4	5	6	7-14	Total
1968	0	0	12	12	12	0	12	50
1969	0	0	0	0	0	0	274	274
1970	0	0	0	0	0	0	92	92
1971	23	11	14	0	14	43	29	135
1972	0	0	0	7	0	0	5	12
1973	16	0	10	0	10	0	30	66
1974	0	0	0	0	0	0	9	9
1975	6	0	7	7	15	22	7	65
1976	8	0	0	0	0	0	0	8
1977	0	0	30	30	0	30	0	90
1978	0	0	61	0	0	0	0	61
1979	0	59	0	0	0	0	0	59
1981	48	24	31	31	0	0	0	135
1982	23	0	0	60	0	0	60	144
1983	31	0	0	0	0	0	0	31
1985	29	29	0	0	0	0	37	95
1986	0	20	0	26	0	0	20	66
1988	0	10	26	0	0	13	0	49
1989	0	17	0	44	0	0	0	61
Total	184	170	192	217	52	109	577	1500

Table 64 Carlin tag returns from 2SW salmon of Maine origin in the provinces Quebec, Nova Scotia and New Brunswick by year and Salmon Fishing Area.

Year	SFA 18	21	22	23	Q5-9	Total
1968	0	4	20	2	0	26
1969	1	0	1	0	0	2
1970	0	0	1	0	0	1
1971	0	0	1	0	0	1
1972	0	3	2	3	0	8
1973	0	0	0	1	1	2
1974	0	1	1	2	0	4
1975	0	0	1	0	0	1
1977	0	0	0	2	0	2
1982	0	0	0	2	0	2
1983	0	0	0	1	0	1
Total	1	8	27	13	1	50

Table 65 Estimated harvest (with 85% passage efficiency for fishways in Maine rivers) of 2SW salmon of Maine origin in the provinces Quebec, Nova Scotia and New Brunswick by year and Salmon Fishing Area.

Year	SFA 18	21	22	23	Q5-9	Total
1968	0	25	124	12	0	161
1969	137	0	137	0	0	274
1970	0	0	92	0	0	92
1971	0	0	14	0	0	14
1972	0	20	13	20	0	52
1973	0	0	0	10	10	20
1974	0	9	9	19	0	38
1975	0	0	7	0	0	7
1977	0	0	0	60	0	60
1982	0	0	0	60	0	60
1983	0	0	0	20	0	20
Total	137	54	397	201	10	799

Table 66 Estimated total run size of 1SW and 2SW salmon returning to Maine rivers and estimated harvests of 1SW salmon in Newfoundland and Labrador fisheries. All run size and harvest estimates are computed assuming 85 percent fish passage efficiency.

Year i	Run 1SW i	2SW i+1	1/2SW Ratio	Harvest i	Harvest /Run Ratio
1967	100	729	0.138	242	0.332
1968	24	690	0.035	411	0.595
1969	36	856	0.041	277	0.324
1970	14	687	0.021	398	0.579
1971	44	1449	0.030	295	0.204
1972	32	1448	0.022	105	0.073
1973	43	1411	0.030	220	0.156
1974	99	2345	0.042	755	0.322
1975	116	1341	0.086	1014	0.756
1976	231	2025	0.114	2230	1.101
1977	98	4110	0.024	933	0.227
1978	161	1878	0.086	309	0.165
1979	251	5582	0.045		
1980	847	5107	0.166	4607	0.902
1981	1148	6003	0.191	1137	0.189
1982	320	1915	0.167	1586	0.828
1983	276	3025	0.091	1689	0.558
1984	393	4830	0.081	1322	0.274
1985	337	5563	0.061	2274	0.409
1986	711	2397	0.297	533	0.222
1987	950	2870	0.331	584	0.204
1988	881	2941	0.300	393	0.134

Table 67 Summary of Carlin-tagged smolt releases in Maine rivers 1966-1987, homewater adult captures, and incidence of straying by year of release.

Year of release	No. fish released	Total homewater returns	No. returns to river of release	No. returns to other rivers	Rate of straying (%)
1966	82,251	172	160	12	6.98
1967	80,717	8	8	0	0.00
1968	73,772	19	18	1	5.26
1969	76,615	68	61	7	10.29
1970	48,212	278	265	13	4.68
1971	29,828	190	174	16	8.42
1972	52,522	189	188	1	0.53
1973	38,030	389	388	1	0.26
1974	41,750	166	166	0	0.00
1975	28,960	95	95	0	0.00
1976	24,980	83	83	0	0.00
1977	48,899	34	34	0	0.00
1979	59,743	476	466	10	2.10
1980	49,759	261	259	2	0.77
1981	49,950	162	158	4	2.47
1982	49,360	58	58	0	0.00
1983	49,615	164	164	0	0.00
1984	99,342	291	291	0	0.00
1985	99,400	129	128	1	0.78
1986	100,000	321	313	8	2.49
1987	100,000	202	201	1	0.50
Total	1,283,705	3,755	3,678	77	2.05

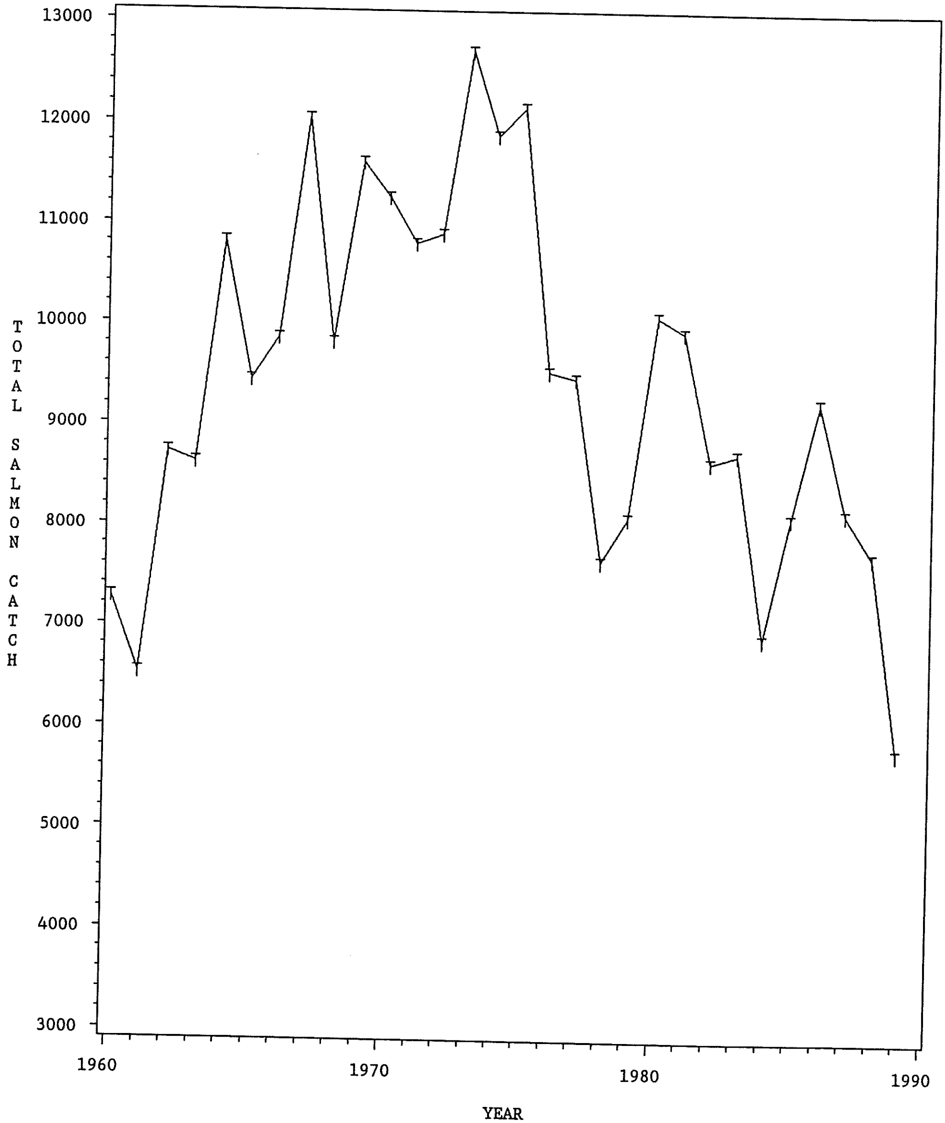
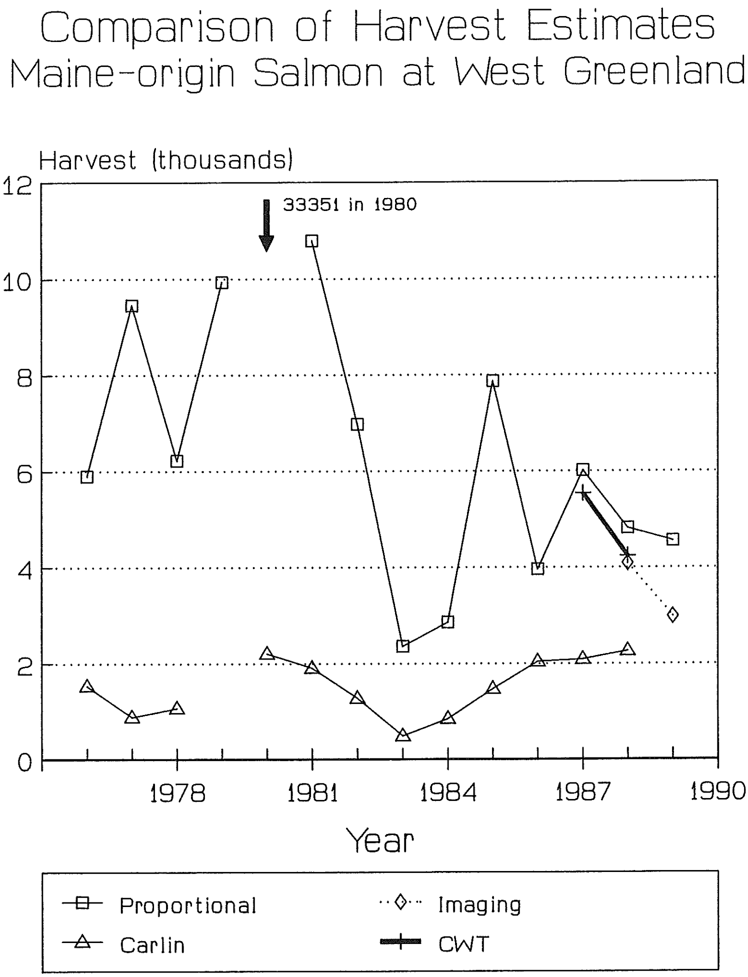
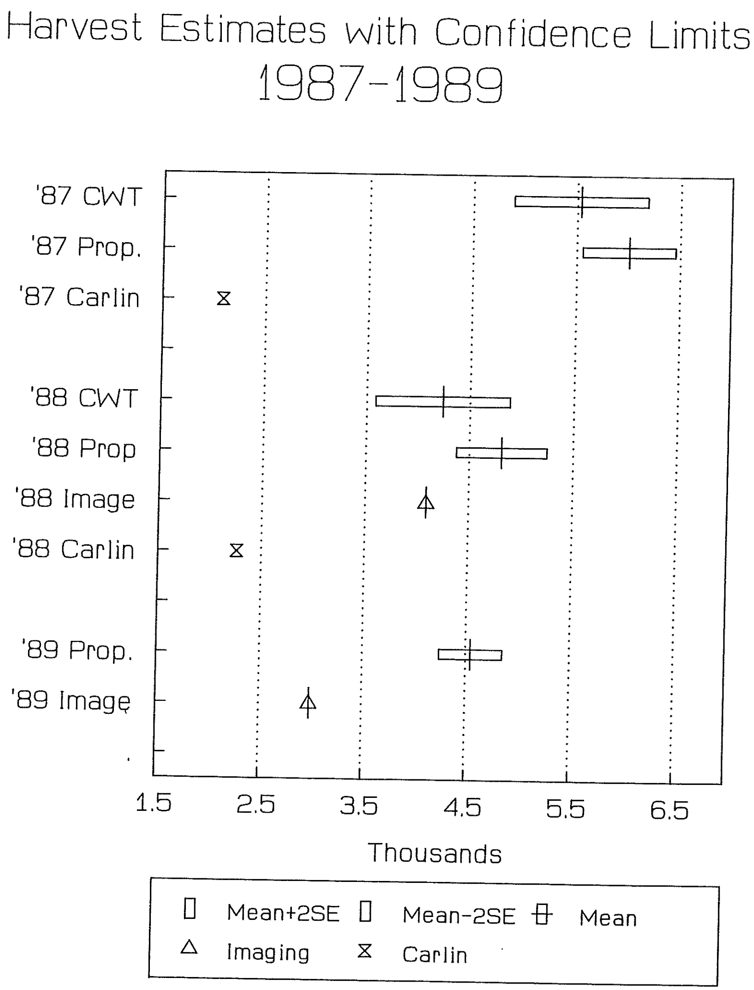


Figure 1. Nominal catches of Atlantic salmon, 1960-1989.



Note:No USA Carlin tags released in 1978

Figure 2



No variance estimate for imaging tech.

Figure 3

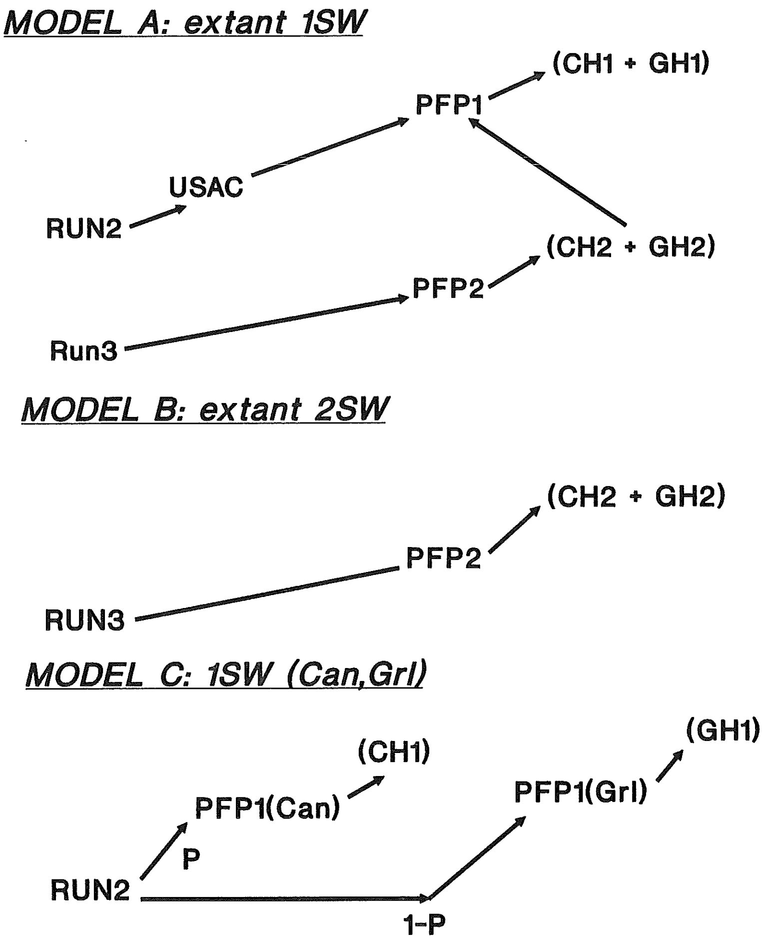
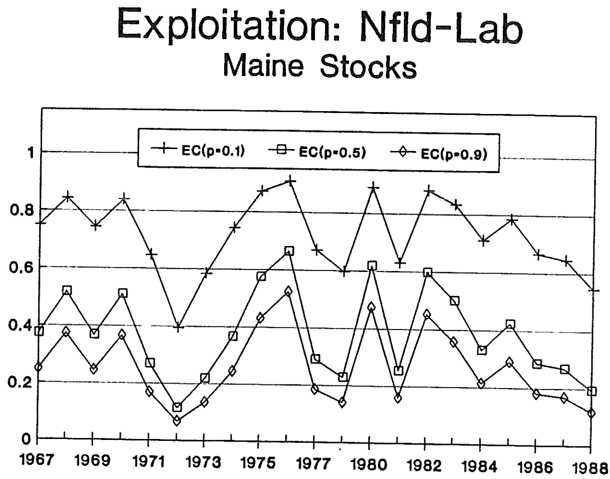


Figure 4 (A) Schematic diagram of model to estimate exploitation rates for extant stock of Maine-origin 1SW salmon. (B) Schematic diagram of model to estimate exploitation rates for extant stock of Maine-origin 2SW salmon. (C) Schematic diagram of the migration model used to estimate exploitation rates for 1SW salmon originating from the St. John River, N.B. and Maine rivers. The endpoint of the West Greenland fishery is assumed to occur 49 weeks prior to the midpoint of the salmon run in homewaters. The endpoint of the Newfoundland-Labrador fishery is assumed to occur 45 weeks prior to the midpoint of the salmon run in homewaters.



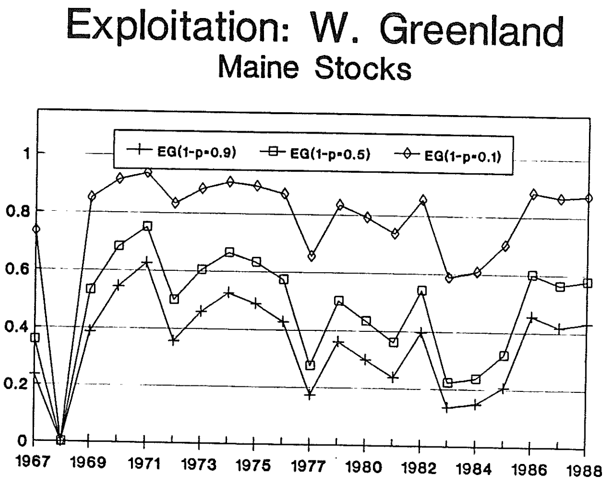
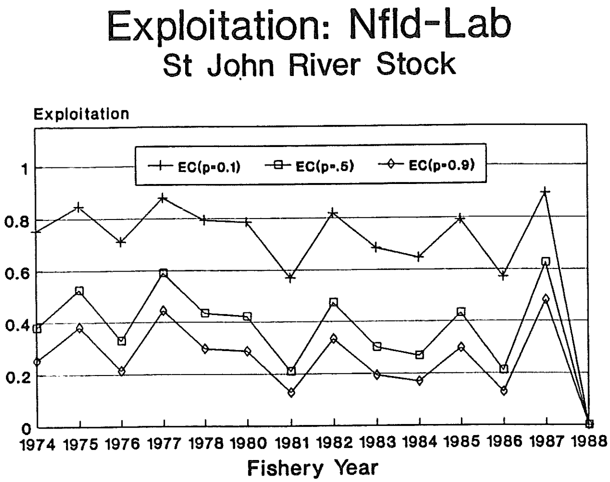


Figure 5 Estimated exploitation rates of the West Greenland and Newfoundland-Labrador fisheries for non-maturing 1SW salmon 1967-1988, originating from Maine rivers. P represents proportion of the stock returning from the Canadian fishery; the remainder of the stock (1-P) is assumed to have returned from the Greenland fishery. See model C in Figure 4.



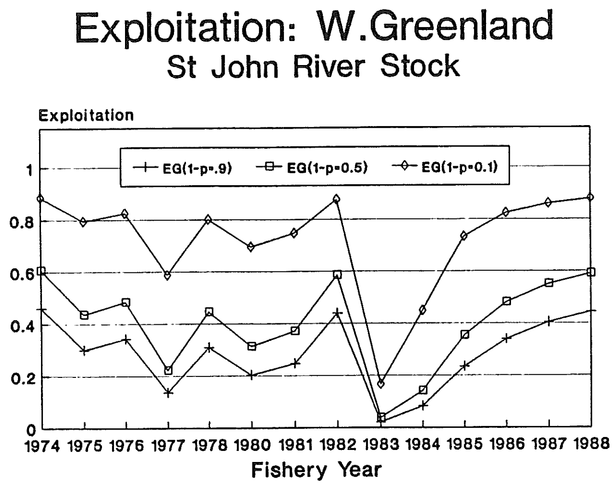


Figure 6 Estimated exploitation rates of the West Greenland and Newfoundland-Labrador fisheries for non-maturing 1SW salmon 1974-1988, originating from the St. John River, New Brunswick. P represents proportion of the stock returning from the Canadian fishery; the remainder of the stock (1-P) is assumed to have returned from the Greenland fishery. See model C in Figure 4.

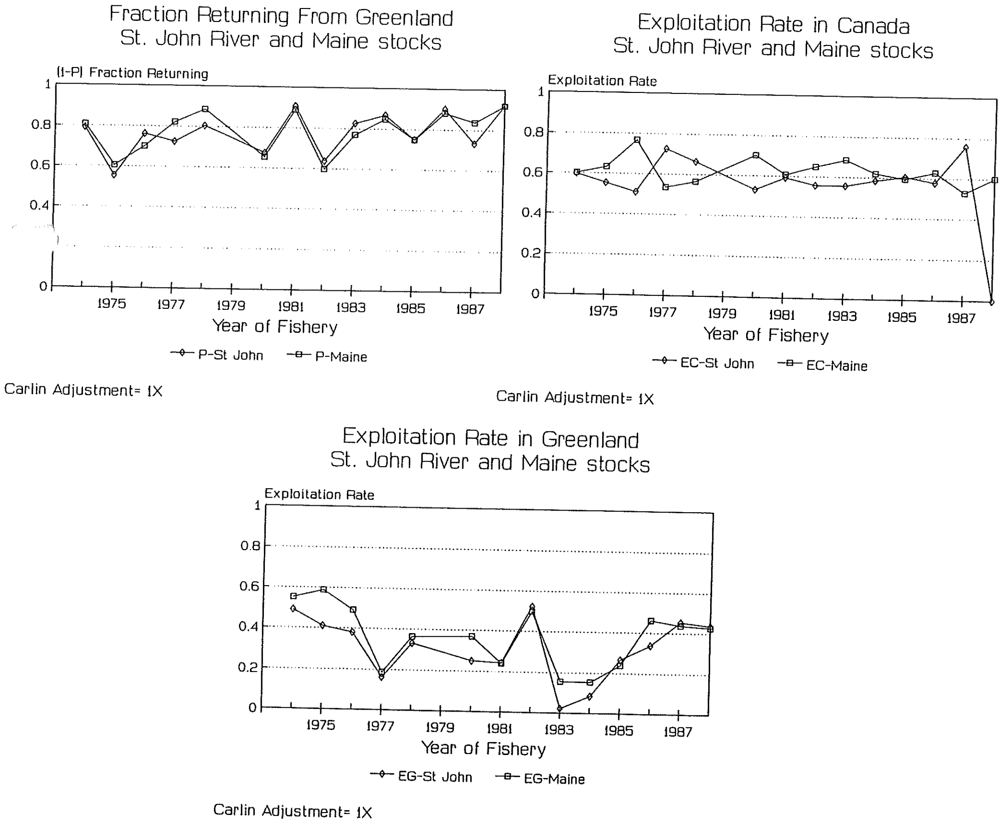
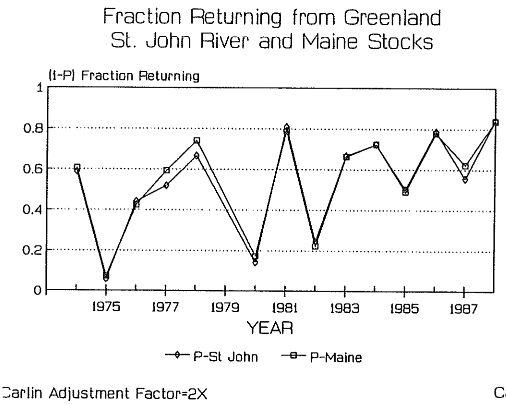
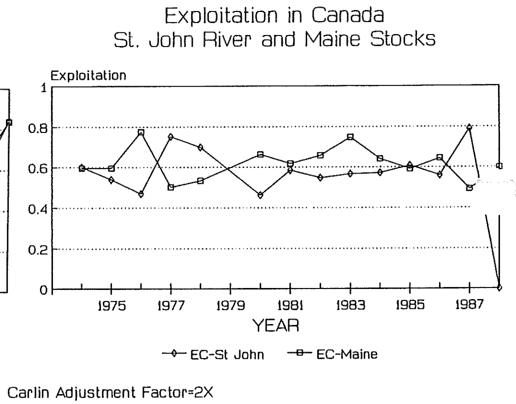


Figure 7 Estimated annual values of 1-P, exploitation rates in the Newfoundland-Labrador fishery and in the West Greenland fishery for the St. John (diamond) and Maine origin (square) stocks. The Carlin adjustment factor was 1.0 for these plots.





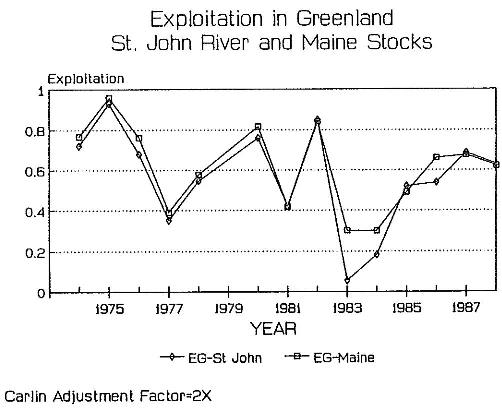


__Figure 8__ Estimated annual values of 1-P, exploitation rates in the Newfoundland-Labrador fishery and in the West Greenland fishery for the St. John (diamond) and Maine origin (square) stocks. The Carlin adjustment factor was 2.0 for these plots.

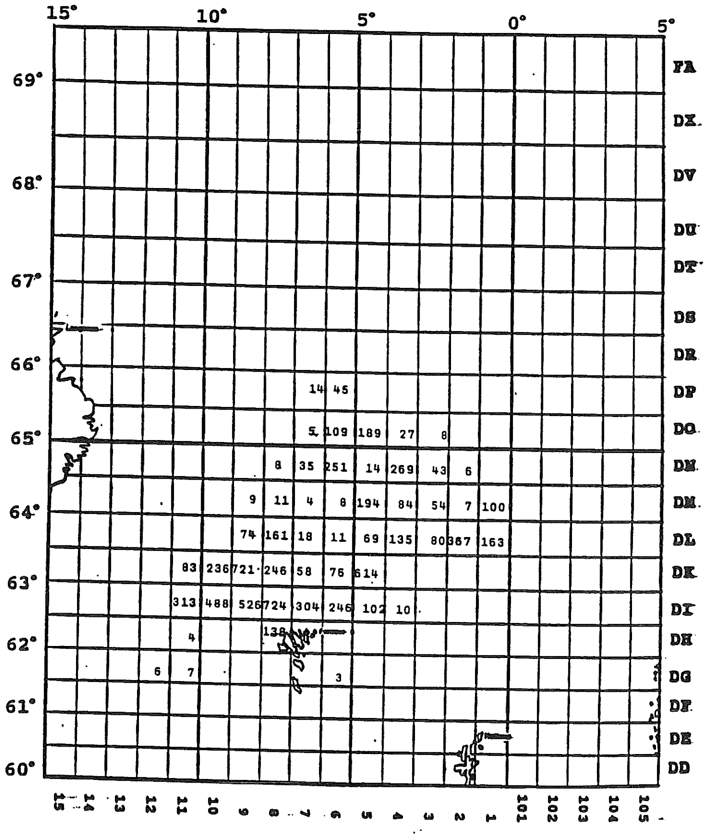


Figure 9 Catch in number*10^{-1} by statistical rectangle from logbooks, 1988/1989 season.

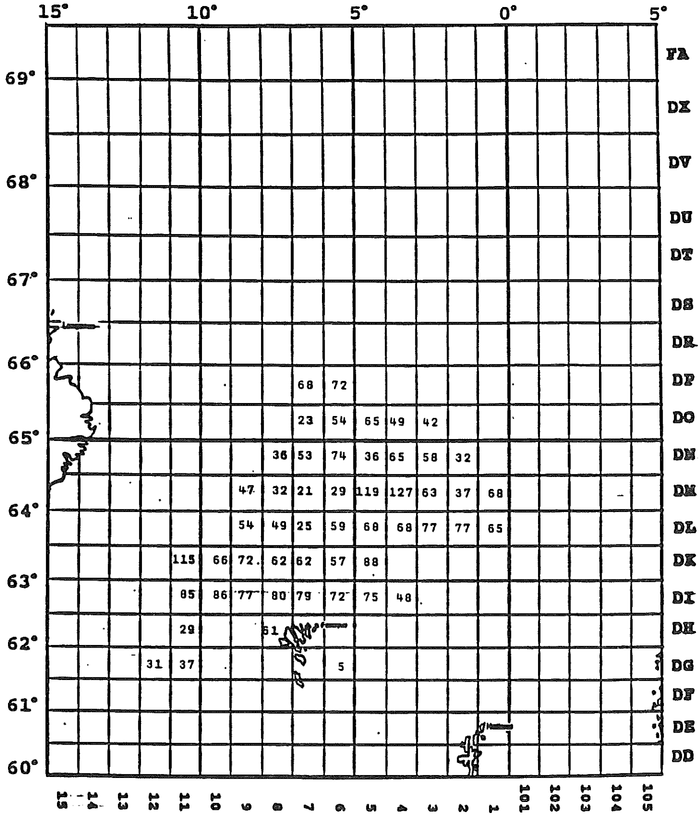
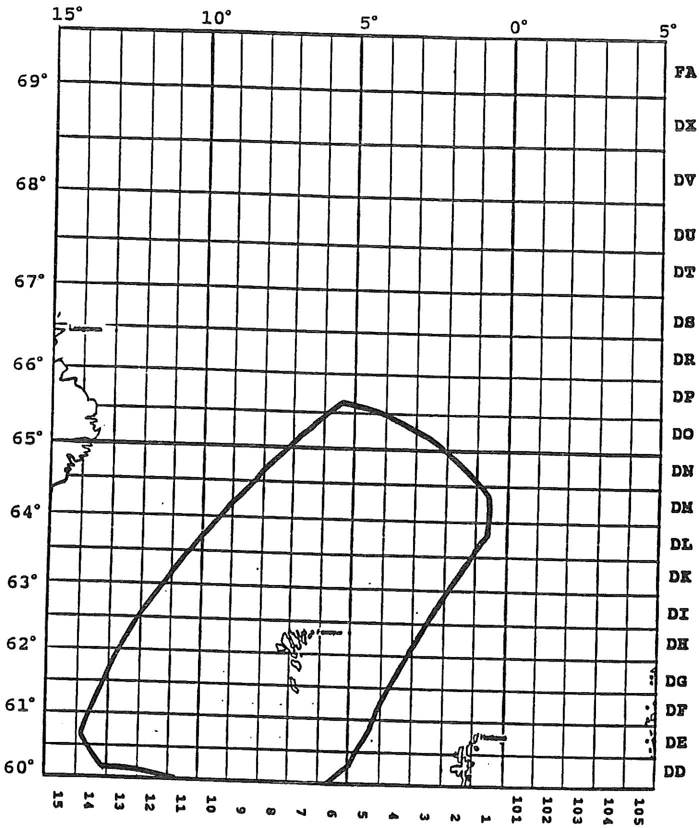


Figure 10 Catch per unit effort (1,000 hooks) by statistical rectangle from logbooks. 1988/1989 season.



<u>Figure 11</u> The Faroese Exclusive Economic Zone (EEZ).

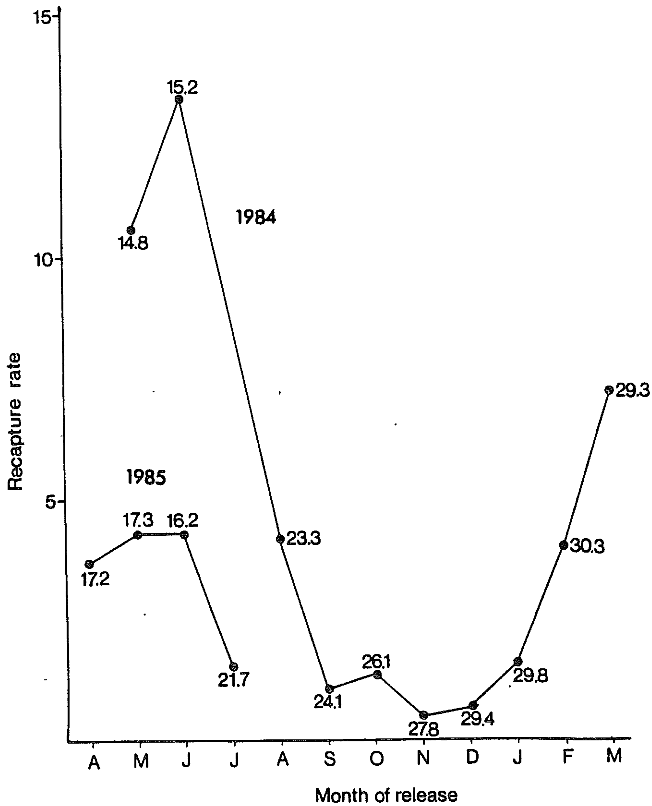


Figure 12 Recaptures (% of number released) of River Lone Atlantic salmon with sea age ⩾ 3 months. Fish were smolts in spring 1984 and retained in seawater (32 $^{o}/_{oo}$) from 21 May 1984 till the date of release. They were released at a sea locality 4 km outside the River Imsa. Mean lengths at tagging are given in cm.

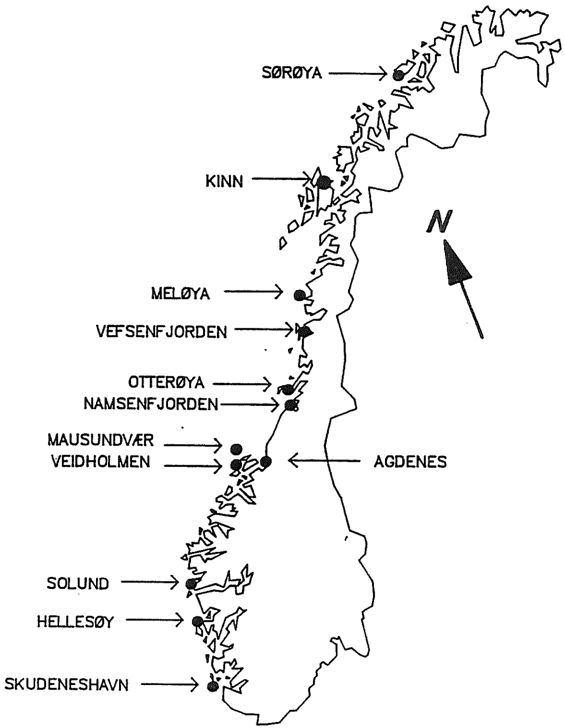


Figure 13 Geographical distribution of marine sampling sites 1986-1989.

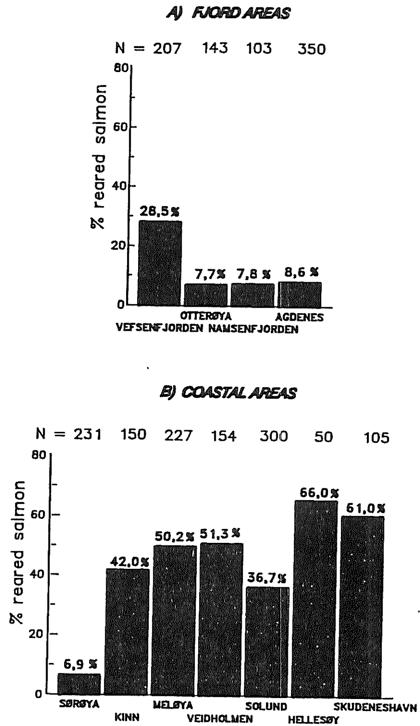


Figure 14 Proportion of reared Atlantic salmon in commercial marine salmon fisheries in Norway 1989. N = number of salmon examined.

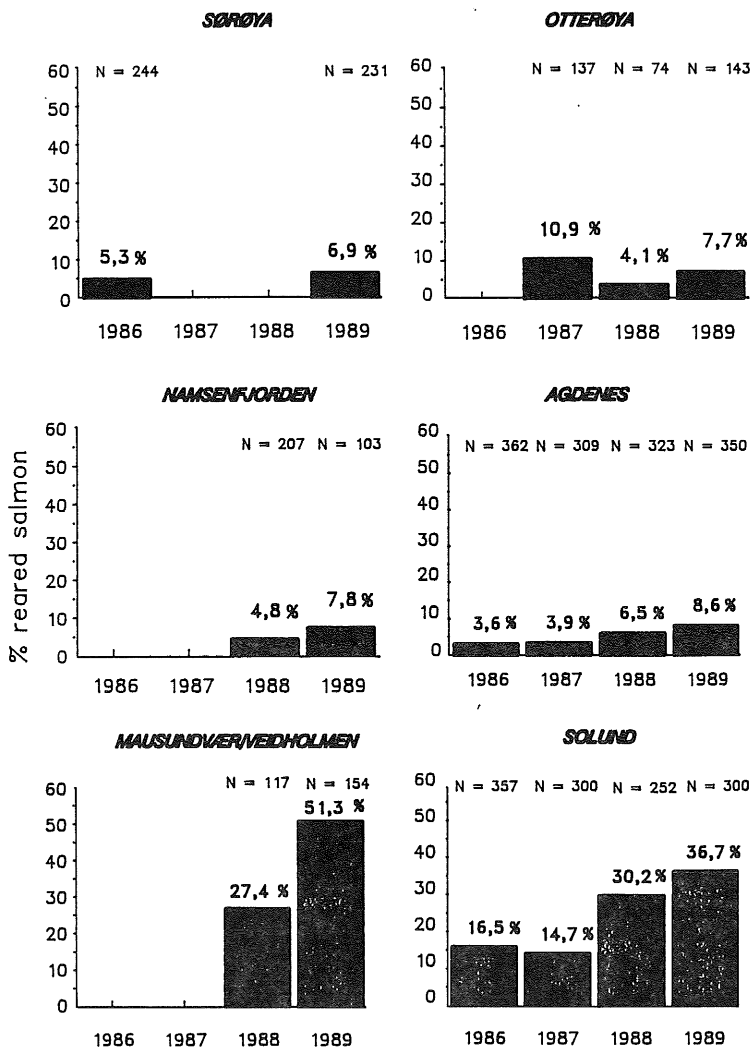
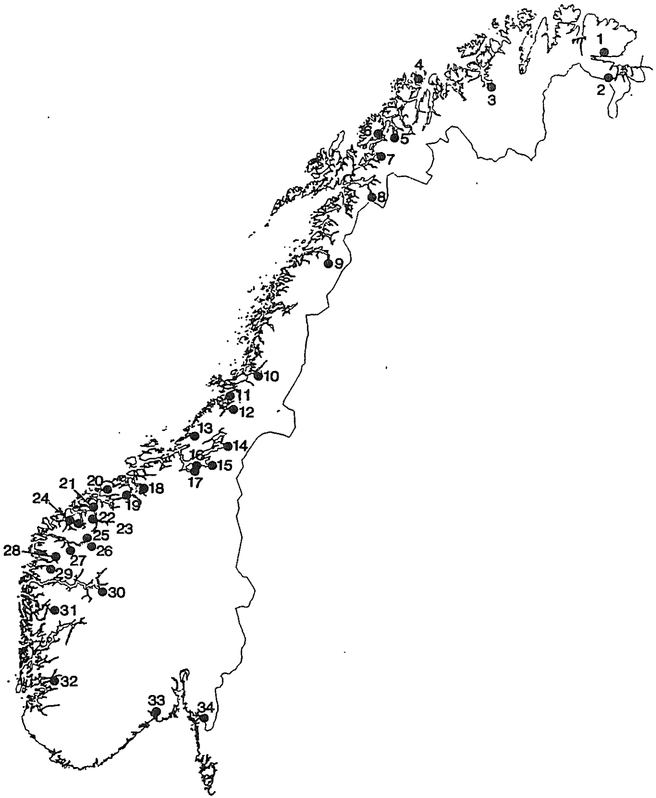


Figure 15 Proportion of reared Atlantic salmon in marine fisheries during the period 1986-1989. N = number of salmon examined.

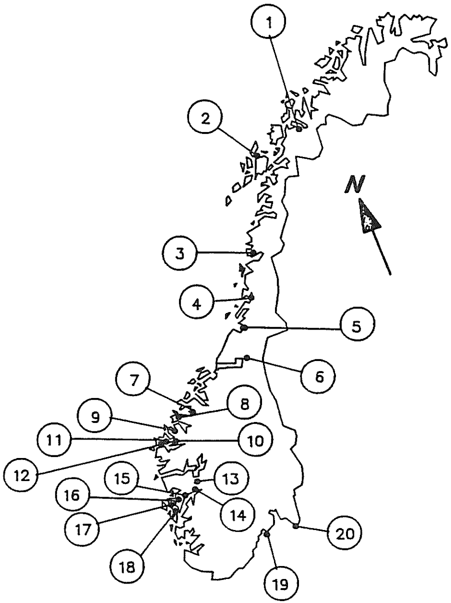
Figure 16 Geographical distribution of sampling sites in the freshwater fisheries.



Proportion of reared salmon in sport fisheries (angling) in different rivers 1988 and 1989. N = number of salmon examined. Part of the data from 1988 are from Moen & Gausen (1989)*.

No	River	County	1988 N	1988 % reared	1989 N	1989 % reared
1	Vestre Jakobselv	Finnmark	-	-	60	23.3
2	Neiden	Finnmark	110*	0	160	0
3	Altaelva	Finnmark	499	0.2	517	2.7
4	Skipsfjordvassdr.	Troms	-	-	156	0.6
5	Målselva	Troms	161*	3.1	111	1.8
6	Laukhellevassdr.	Troms	-	-	168	3.6
7	Salangselva	Troms	-	-	55	20.0
8	Skjomenelva	Nordland	-	-	106	1.9
9	Saltdalselva	Nordland	53	0	94	11.7
10	Åbjøra	Nordland	-	-	205	6.3
11	Salsvassdraget	Nord-Trøndelag	-	-	38	18.4
12	Namsen	Nord-Trøndelag	307	1.6	221	12.7
13	Stordalselva	Sør-Trøndelag	30	13.3	118	4.2
14	Verdalselva	Nord-Trøndelag	100	0	187	3.2
15	Stjørdalselva	Nord-Trøndelag	-	-	188	6.4
16	Nidelva	Sør-Trøndelag	-	-	78	3.8
17	Gaula	Sør-Trøndelag	146*	2.7	271	0.7
18	Søya	Møre & Romsdal	-	-	154	5.8
19	Oselva	Møre & Romsdal	-	-	172	4.7
20	Moaelva	Møre & Romsdal	-	-	151	3.3
21	Ørskogelva	Møre & Romsdal	-	-	51	15.7
22	Strandaelva	Møre & Romsdal	-	-	47	4.3
23	Bondalselva	Møre & Romsdal	-	-	296	2.7
24	Ørstaelva	Møre & Romsdal	-	-	94	12.8
25	Stryneelva	Sogn & Fjordane	47	0	57	8.8
26	Loenelva	Sogn & Fjordane	-	-	28	39.3
27	Gloppenelva	Sogn & Fjordane	211*	0	47	23.4
28	Nausta	Sogn & Fjordane	-	-	101	6.9
29	Gaula	Sogn & Fjordane	-	-	281	19.2
30	Lærdalselva	Sogn & Fjordane	127*	0	225	0.4
31	Vosso	Hordaland	-	-	76	6.6
32	Suldalslågen	Rogaland	-	-	151	16.6
33	Skienselva	Telemark	-	-	195	9.7
34	Enningdalselva	Østfold	50*	0	32	0

Figure 17 Geographical distribution of sampling sites in brood stock fisheries in 1988-1989.



Proportion of reared Atlantic salmon from brood stock fisheries 1988 and 1989. N = number of salmon examined. Most data from 1988 are from Moen & Gausen (1989)*.

			1988		1989		
No	River	County	N	% reared	N	% reared	Gear
1	Målselva	Troms	48*	0	26	0	Rod
2	Gårdselva	Nordland	-	-	34	23.5	Net
3	Sila#	Nordland	-	-	28	42.9	Fish trap
4	Åbjøra	Nordland	-	-	21	33.3	Rod
5	Namsen	Nord-Trøndelag	27	29.6	108	72.2	Net
6	Verdalselva	Nord-Trøndelag	-	-	36	2.8	Rod
7	Oselva	Møre & Romsdal	-	-	78	53.8	Rod
8	Moaelva	Møre & Romsdal	-	-	46	30.4	Rod and dip-netting
9	Ørskogelva	Møre & Romsdal	-	-	23	78.3	Rod
10	Strandaelva	Møre & Romsdal	-	-	40	2.5	Rod
11	Bondalselva	Møre & Romsdal	-	-	111	14.3	Dip-netting
12	Ørstaelva	Møre & Romsdal	-	-	25	40.0	Rod
13	Lærdalselva	Sogn & Fj.	59*	1.7	56	1.8	Rod
14	Granvinvassdraget	Hordaland	-	-	41	26.8	Rod and net
15	Øysteseelva	Hordaland	-	-	39	23.1	Rod
16	Daleelva	Hordaland	-	-	39	56.4	Rod and seine
17	Loneelva	Hordaland	-	-	85	20.0	Rod
18	Oselva	Hordaland	177*	76.8	85	76.7	Rod and electrofish.
19	Skiensvassdraget	Telemark	-	-	103	20.4	Rod
20	Enningdalselva	Østfold	-	-	19	10.5	Rod

The entire spawning population controlled by fish trapping.

366

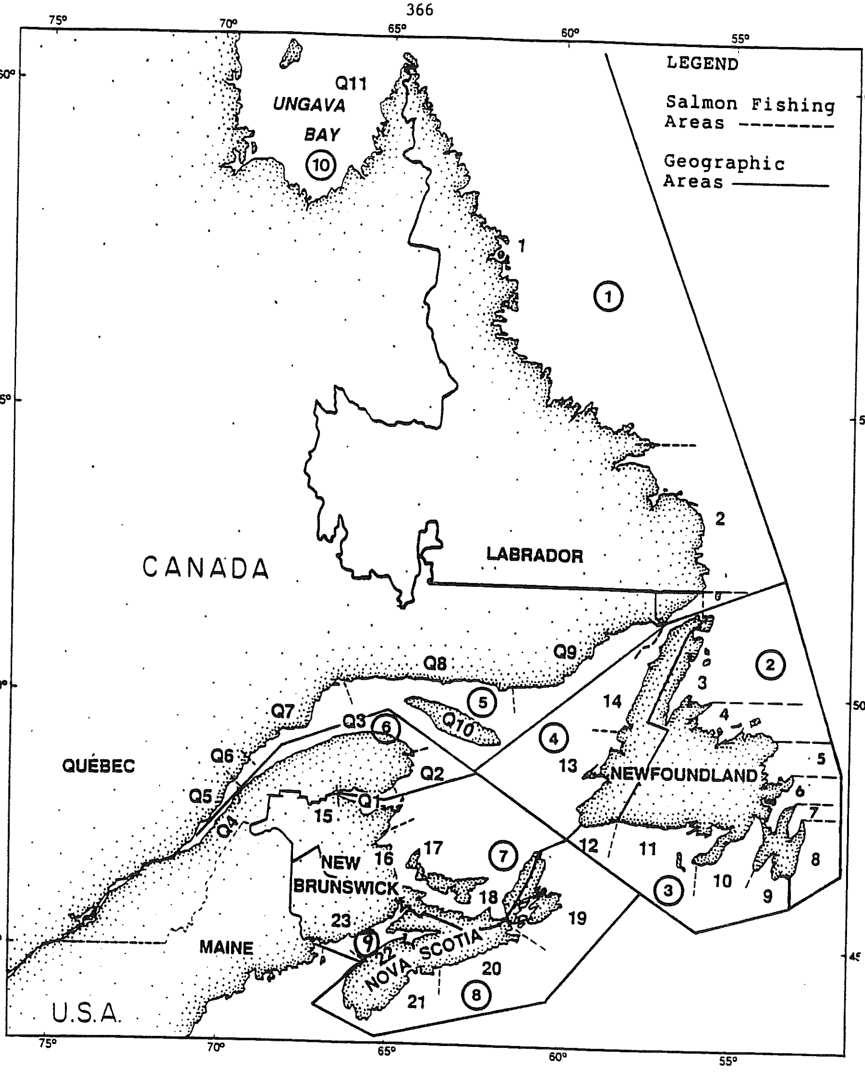


Figure 18 Map of Atlantic Provinces showing Salmon Fishing Areas 1-23, Salmon Management Zones of Quebec (Qs) 1-11, and Geographic Areas ①–⑩.

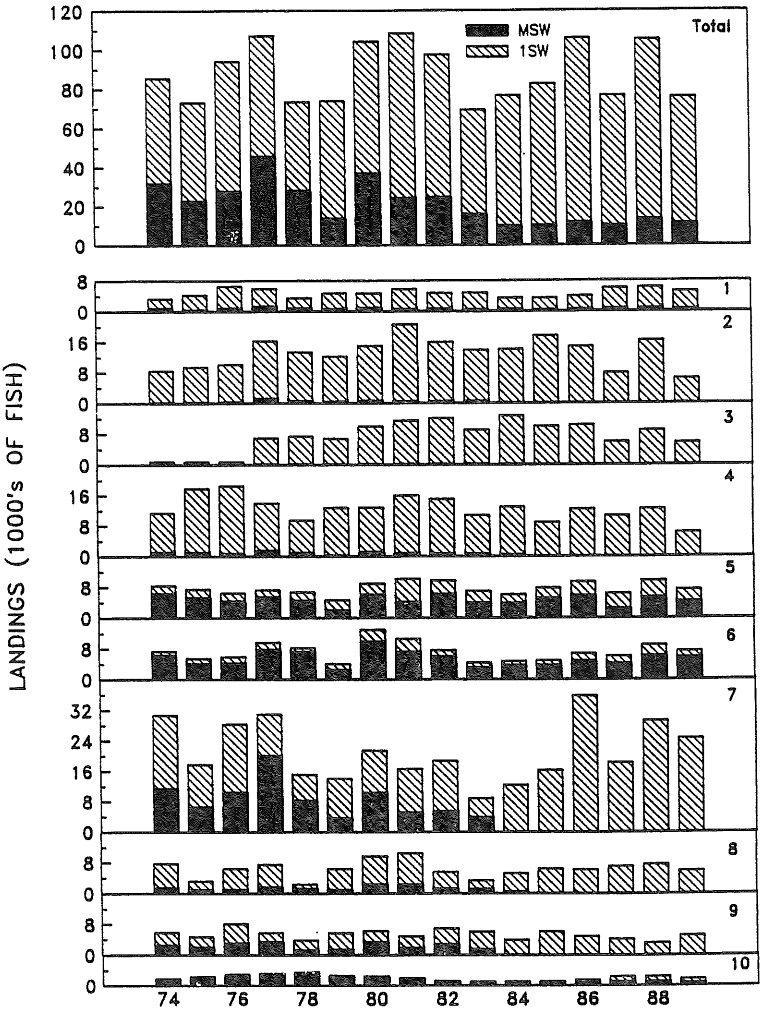


Figure 19 Recreational landings (numbers of 1SW & MSW salmon) of Atlantic salmon, 1974–1989, Canada – Total and; 1–Labrador; 2–East coast Newfoundland; 3–South coast Newfoundland; 4–West coast Newfoundland; 5–North shore & Anticosti Island, Québec; 6–South shore Québec; 7–Gulf New Brunswick & Nova Scotia; 8–Atlantic coast Nova Scotia; 9–Bay of Fundy N.S. and N.B., and 10–Ungava Bay, Québec.

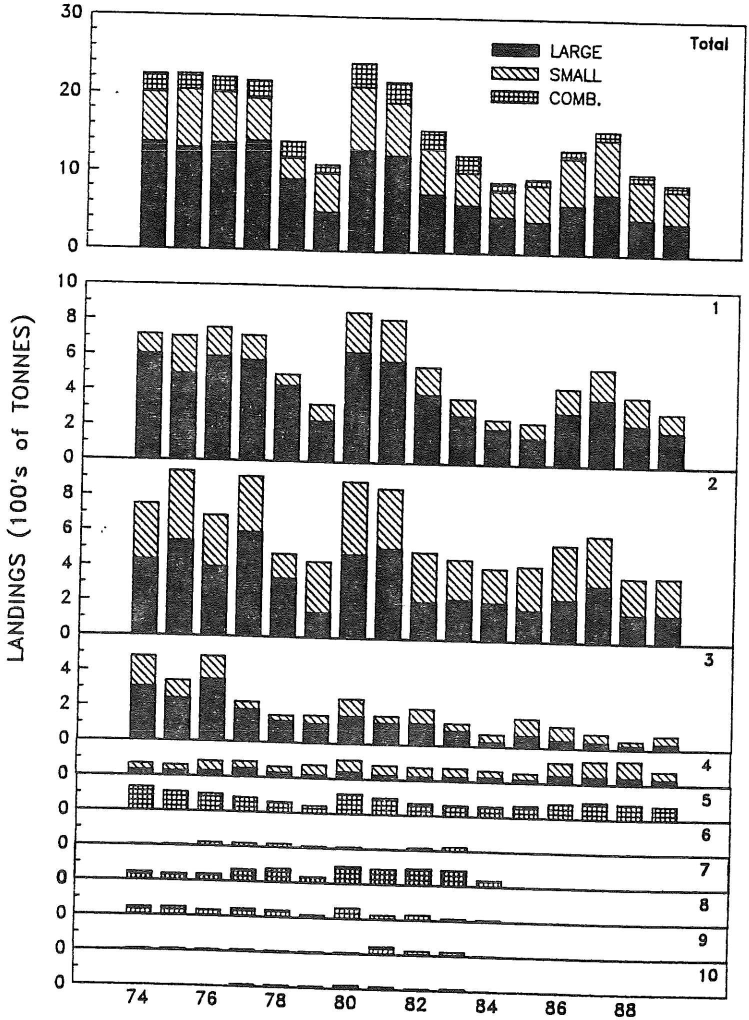
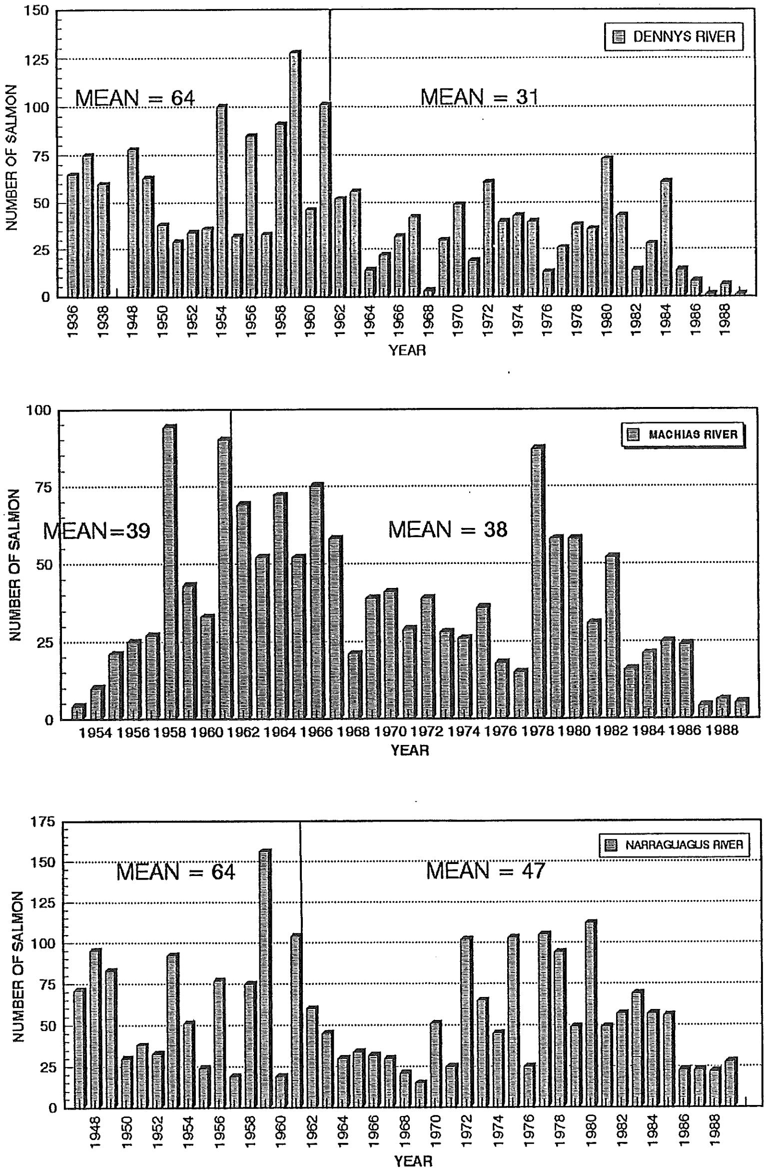


Figure 20 Commercial landings (t) of Atlantic salmon 1974–1989, Canada – Total and; 1–Labrador; 2–East coast Newfoundland; 3–South coast Newfoundland; 4–West coast Newfoundland; 5–North shore and Anticosti Island, Québec; 6–South shore Québec; 7–Gulf New Brunswick and Nova Scotia; 8–Atlantic coast Nova Scotia; 9–Bay of Fundy N.S. and N.B., and 10–Ungava Bay, Québec.

Figure 21 Sport catch of 2SW salmon in three Maine rivers prior to and during the Greenland fishery. (Salmon of hatchery origin removed from 1967-1989 catches.)



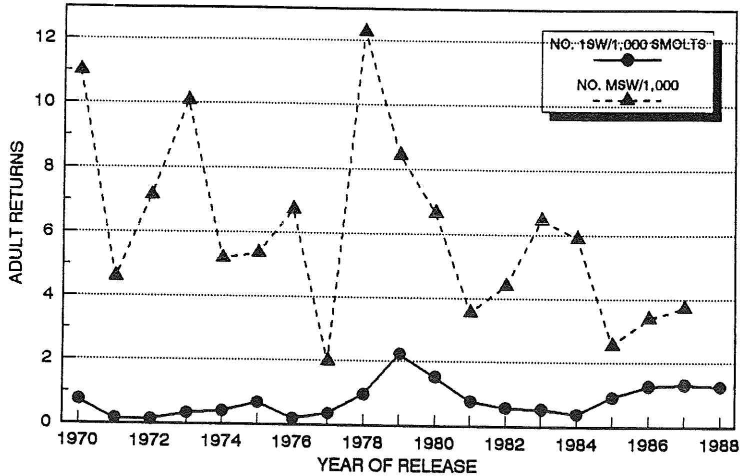


Figure 22 1 SW and MSW salmon returns to the Penobscot River per 1,000 hatchery smolts released, 1970-1988.

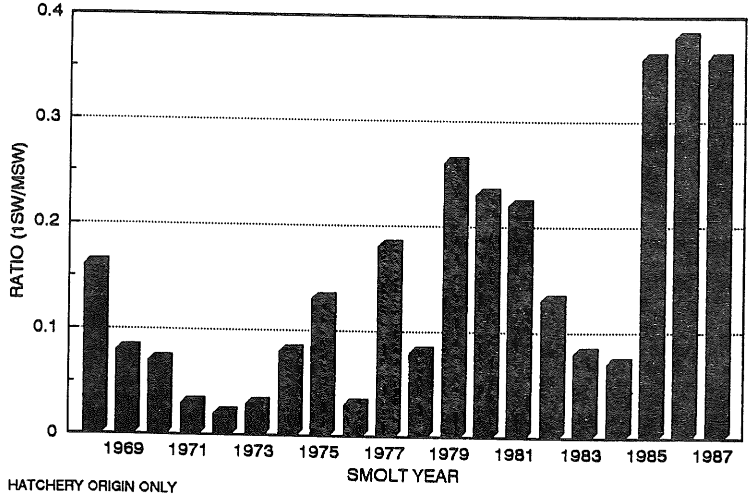


Figure 23 1SW/MSW salmon ratio by smolt run salmon returning to the Penobscot River.

APPENDIX 1

TERMS OF REFERENCE FOR NORTH ATLANTIC SALMON WORKING GROUP

1. With respect to Atlantic salmon in each Commission area, where relevant:

   a) describe events of the 1989 fisheries with respect to gear effort, composition and origin of catch;

   b) estimate exploitation rates and status of the stocks in homewater and interception fisheries on stocks occurring in the Commission area;

   c) continue the development of models to describe the fishing interactions and stock dynamics in order to estimate the effects of management measures, and in particular provide the information required to refine the salmon run reconstruction model;

   d) evaluate the effectiveness of new or proposed management measures for homewaters and interception fisheries on stocks occurring in the Commission area, including the newly-introduced restrictions on drift-netting in Norwegian waters;

   e) review and provide explanation for the difference between the ratios of microtagged to adipose fin-clipped salmon at release and at recapture in fisheries and sampling traps;

   f) advise on the apropriateness of conducting further experimental acoustic surveys for assessing salmon population at sea;

   g) review and provide methods to obtain data on the movements of salmon in the North Atlantic, particularly in relation to fisheries;

   h) specify data deficiencies and research needs.

2. With respect to Atlantic salmon in the North-East Atlantic Commmission area:

   a) with respect to the impact of aquaculture on wild salmon stocks, provide quantative estimates of the effect of escapees on the number of salmon in the open ocean and home waters.

APPENDIX 2

THE STUDY GROUP ON NORWEGIAN SEA AND FAROES SALMON FISHERY

Recommendations:

1. The Study Group should meet in 1991 for 4 days prior to the North Atlantic Salmon Working Group meeting to prepare relevant data. The meeting should begin not earlier than 1 March and there should be at least one week between it and the Working Group meeting

2. All countries should provide data to the next meeting (1991) to construct national run-reconstruction models.

3. The practice whereby selected skippers in the Faroes fishery were asked to land their entire catch, including discards, should be continued. An incentive payment of Danish Kroner 50.00 should be paid for each tag recovered, financed from the market sampling programme.

4. The CPUE data for as many seasons as possible should be analyzed in detail and attempts should be made to relate this measure of abundance to water temperatures. The results of these investigations should be reported to the next meeting of the Study Group.

5. All countries should compile complete records of external tag recoveries in the Faroese fishery for smolts released in their country.

THE STUDY GROUP ON THE NORTH AMERICAN SALMON FISHERIES

Research Requirements:

1. Provide historical records of the recreational harvest (killed) Atlantic salmon in Maine rivers and commercial harvest by year for SFAs 1-14.

2. Review methodology to estimate run-size in Maine rivers without counting traps.

3. Provide estimates of the proportion of Carlin tags that could go undetected where individual salmon are not handled at monitoring facilities.

4. In future, the Study Group report will not include a breakdown of the catches by week in the section of description of Canadian fisheries. This information will be available to the Study Group on computer disc.

5. Investigate discrepancies between recorded landings in the catch statistics and the numbers of salmon reported by crews sampling for CWTs in communities of Newfoundland-Labrador.

6. Examine historical forecast models for MSW salmon and age at maturity as they relate to observed decreases in the numbers of MSW salmon and increases in the numbers of 1SW fish returning to some Canadian and USA rivers, particularly during recent years in which management measures have been introduced to increase home river returns of MSW fish.

7. Investigate the use of the proportional harvest method on salmon of 1-year smolts in communities of Newfoundland-Labrador.

8. Estimate P values (proportion of a stock that was in a particular fishery) for Maine and St. John River stocks that would minimize the differences between exploitation rates generated in the run-reconstruction model and hence advance the understanding of migratory patterns of salmon in West Greenland and Canada.

Recommendation:

It is recommended that the Study Group meet in Leetown, West Virginia, USA at an appropriate time before the meeting of the Working Group on North Atlantic Salmon in 1991.

APPENDIX 3

DOCUMENTS SUBMITTED TO THE WORKING GROUP

1. Anon. 1990a. Report of the Study Group on the North American Salmon Fisheries ICES, Doc. C.M.1990/M.

2. Anon. 1990b. Report of the Study Group on the Norwegian Sea and Faroes Salmon Fishery. ICES, Doc. C.M.1990/M:2.

3. Anon. 1990c. The Appropriateness of Acoustics for Assessing Salmon Populations at Sea.

4. Anon. 1990d. Methods to Obtain Data on the Movements of Salmon in the North Atlantic, Particularly in Relation to Fisheries.

5. Møller Jensen, J. The Salmon Fishery at West Greenland 1989.

6. Møller Jensen, J. The Number of North American and European Salmon Caught at West Greenland 1986 to 1988.

7. Russell, I.C., E.C.E. Potter, D.G. Reddin and K.D. Friedland. Recoveries of Coded Wire Microtags from Salmon Caught at West Greenland in 1989.

8. Friedland, K.D., P.J. Rago and E.T. Baum. Carlin Tag Returns and Harvest Estimates of US Origin Salmon in Greenland, 1967-1989.

9. Friedland, K.D., C. Esteves and D.G. Reddin. Determination of Country of Origin of North American One River Year Atlantic Salmon (Salmo salar L.) in West Greenland, 1989.

10. Rago, P.J. and K.D. Friedland. Estimation of Exploitation Rates of Atlantic Salmon Stocks Originating from the St. John River and Maine in the Fisheries of Newfoundland-Labrador and West Greenland, 1969-1988.

11. Friedland, K.D., L.G. Stolte and T.F. Myers. Estimated Harvest of USA-Origin 1-SW Salmon in Greenland in 1988.

12. Reddin, D.G. and P.B. Short. Length, Weight, and Age Characteristics of Atlantic Salmon (Salmo salar L.) of North American and European Origin Caught at West Greenland in 1989.

13. Reddin, D.G., P.R. Dauntan and E. Vevspoov. 1989 Database for Discrimination at Greenland.

14. Reddin, D.G. and P.B. Short. Identification of North American and European Atlantic Salmon (Salmo salar L.) Caught at West Greenland in 1989.

15. Rago, P.J., K.D. Friedland and D.G. Reddin. Estimation of Harvests of Maine-Origin Salmon in West Greenland Using the Proportional Harvest Model.

16. Baum, E.T., G.E. Horton, K.F. Beland and J.G. Trial. Long-Term Changes in the Composition of the Sport Catch of Atlantic Salmon from Three Maine Rivers.

17. Baum, E.T. and R.C. Spencer. Homing of Adult Atlantic Salmon Released as Hatchery-Reared Smolts in Maine Rivers.

18. Friedland, K.D. Carlin Tag Returns and Harvest Estimates of US Origin Salmon in Coastal USA By-catch, 1967-1989.

19. Crozier, W.W. Homewater Exploitation Rates on Microtagged Salmon Returning to the R. Bush in 1989.

20. Browne, J. Exploitation/Rates in the Irish Drift Net Fishery,

21. Økland, F., R.A. Lund and L.P. Hansen. Contribution of Reared Atlantic Salmon to Spawning Populations in Norwegian Rivers.

22. Lund, R.A., F. Økland and L.P. Hansen. Contribution of Reared Atlantic Salmon to Marine and Freshwater Fisheries in Norway.

23. Appelberg, M., E. Degerman, A. Johlander and L. Karlsson. Liming Increases the Catches of Atlantic Salmon on the West Coast of Sweden.

24. Niemelä, E. Some Facts on the Development and changes in the Salmon Catches and Juvenile Densities.

25. Thibault, M. and P. Prouzet. Atlantic Salmon in France for 1989.

26. Zubchenko, A., A. Sharov and O. Kuzmin. The River Tuloma as an index river.

27. Chadwick, M. Annual and seasonal variation in the grilse-salmon ratio.

APPENDIX 4

REFERENCES

Anon. 1985a. Report of Meeting of the Working Group on North Atlantic Salmon. St. Andrews, New Brunswick, Canada, 18-20 September 1984. ICES, Doc. C.M.1985/Assess:5.

Anon. 1985b. Report of Meeting of Working Group on North Atlantic Salmon. Copenhagen, 18-26 March 1985. ICES, Doc. C.M.1985/ Assess:11.

Anon. 1986a. Report of the Working Group on North Atlantic Salmon, Copenhagen. 17-26 March 1986. ICES, Doc. C.M.1986/Assess:17.

Anon. 1986b. Report of Meeting of the Working Group on North Atlantic Salmon. Woods Hole, Massachusetts, USA, 16-20 September 1985. ICES, Doc. C.M.1986/Assess:8

Anon. 1987. Report of the Working Group on North Atlantic Salmon. Copenhagen, 9-20 March 1987. ICES, Doc. C.M.1987/Assess:12.

Anon. 1988a. Report of the Working Group on North Atlantic Salmon. Copenhagen, 21-31 March 1988. ICES, Doc. C.M.1988/Assess:16.

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.

Anon. 1988c. 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.

Anon. 1989a. Report of the Working Group on North Atlantic Salmon. Copenhagen, 15-22 March 1989. ICES, Doc. C.M.1989/Assess: 12.

Anon. 1989b. Report of the Study Group on the North American Salmon Fishery. Leetown, W. Va. USA, 28 February - 3 March 1989. ICES, Doc. C.M.1989/M:3.

Anon. 1989c. Report of the Study Group on Norwegian Sea and Faroes Salmon Fishery. Helsinki, 7-9 February 1989. ICES, Doc. C.M.1989/M:2.

Anon. 1990a. Report of the Study Group on the North American Salmon Fishery, Halifax, Nova Scotia, 26 February - 2 March, 1990. ICES, Doc. C.M.1990/M:3.

Anon. 1990b. Report of the Study Group on the Norwegian Sea and Faroes Salmon Fishery, Copenhagen, 12-15 March 1990. ICES,Doc. C.M.1990/M:2.

Anon. 1990c. ICES compilation of microtag, finclip and external tag releases in 1989. ICES, Doc. C.M.1989/M:4.

Cayan, D.R. 1986. Seasonal sea surface temperature anomalies and associated statistics. SIO Reference 85-19.

Chadwcck, E.M.P., Reddin, D.G., and Burfitt, R.F. 1985. Fishing and natural mortality rates of 1SW salmon (Salmo salar L.). ICES, Doc. C.M.1985/M:18/

Hansen, L.P. and Jonsson, B. 1986. Salmon ranching experiments in the River Imsa: Effects of day and night release and of seawater adaptation on recapture-rates of adults. Rep. Inst. Freshwat. Res. Drottningholm, 63:47-51.

Hansen, L.P., Døving, K.B. and Jonsson, B. 1987. Migration of farmed Atlantic salmon (Salmo salar L.) with and without olfactory sense, released on the Norwegian coast. J. Fish. Biol., 30:713-721.

Hansen, L.P. and Jonsson, B. 1989. Salmon ranching experiments in the River Imsa: Effect of timing of Atlantic salmon (Salmo salar) smolt migration on survival to adults. Aquaculture 82:367-373.

Hansen, L.P., Jonsson, B. and Andersen, R. 1989. Salmon ranching experiments in the River Imsa: Is homing dependent on sequential imprinting of the smolts?. In: Brannon, E.A. and Jonsson, B. (eds.) Salmonid Migration and Distribution Symposium. Univ. Washington, Seattle, USA, NINA, Trondheim, Norway, pp:19-29.

Jonsson, B., Jonsson, N. and Hansen, L.P. 1990. Does juvenile experience affect migration and spawning of adult Atlantic salmon? Behav. Ecol. Sociobiol., 26 (in press).

Lund, R.A., Hansen, L.P. and Järvi, T. 1989. Indentifisering av oppdrettslaks og vill-laks ved ytre morfologi, finnestørrelse og skjellkarakterer. (Identification of reared and wild salmon by external morphology, size of fins and scale characteristics.) NINA Forskningsrapport, 1:1-54. (In Norwegian with English summary.)

Moen, V. and Gausen, D. 1989. Rømt oppdrettsfisk i vassdrag 1988. DN-rapport, 3:1-26. (In Norwegian.)

Murray, A.R. 1968. Smolt survival and adult utilization of Little Codroy River, Newfoundland, Atlantic salmon. J.Fish. Res. Bd. Canada, 25(10):2165:2218.

Møller Jensen, J. 1980. Recaptures from international tagging experiments at West Greenland. Rapp. P-v. Reun. Cons. int. Explor. Mer, 176:122-135.

Pratt, J.D., Hare, G.M., and Murphy, H.P. 1974. Investigations of production and harvest of an Atlantic salmon population, Sandhill River, Labrador. Fish. and Mar.Serv. Tech.Rept., Ser.No. NEW/T-74-1, 27 pp.

Reddin, D.G. and Shearer, W.M. 1987. Sea surface temperature and distribution of Atlantic salmon in the Northwest Atlantic Ocean. American Fisheries Society Symposium 1:262-275.

Sokal, R.R. and Rolhf, F.J. 1969. Biometry; the principles and practice of statistics in biological research. San Francisco, W.H. Freeman, 776 pp.

Starr, P. and Hilborn, R. 1988. Reconstruction of harvest rates and stock contribution in gauntlet salmon fisheries: application to British Columbia and Washington sockeye (Oncorhynchus nerka). Can. J. Fish. Aquat. Sci. 45:2216-2229.

Wilkinson, L. 1988. SYSTAT: The System for Statistics. Evanston, Illinois. SYSTAT Inc.

APPENDIX 5

The proposed format for the presentation of national run reconstruction models is given below.

Rearing area (sq. meters) ____________________

Drainage Area ____________________

Estimate of smolt numbers) ____________________

For each INDEX RIVER within a region provide

RIVER NAME ____________________

YEAR or PERIOD OF YEARS FOR DATA ____________________

PHYSICAL DATA:

Drainage area (m^2)	Rearing area (m^2)
____________	____________

BIOLOGICAL DATA:

Stratify by time or run components if possible

Smolts

Mean or Median Time of Run (std week)	Length (cm)	Weight X (cm)	Weight SD (cm)	% Frequency River Age 1	2	3	4	5	6	7
________	____	___	___	__	__	__	__	__	__	__

The proposed format to document the timing of fisheries and returns of salmon to home rivers is presented below. These data would be computed for each index river. If precise information on timing is not known, median times for runs would be adequate.

Name	Location	Year	Age	Mode	Standard Week Start	End	Cumulative 25	50	75	Catch in mode (No.)	Catch in mode (Wt.)	% of total catch
SFA1	3	89	1	1	30	45	33	35	37	2,300		100
SFA16	1	89	0	1	24	30	26	27	28	10,000		100
SFA16	1	88	1	1	24	33	26	29	31	600		60
SFA16	1	88	1	2	35	43	39	41	43	400		40

Name: NAFO Division, Salmon Fishing Area, country.
Location: 1 = at river mouth, 2 = coastal, 3 = high seas.
Age: Number of years at sea, 0 = smolt.
Mode: First peak in migration as catch, mode = 1, second peak mode = 2 etc.
Start: Beginning date of mode.
End: Ending date of mode.
25: Week when 25% of cumulative catch is taken within mode.
50: Week when 50% of cumulative catch is taken within mode.
75: Week when 75% of cumulative catch is taken within mode.
Catch: Numbers of fish counted or captured within timespan of mode.
Per cent: Percentage of catch by number within mode of total year's catch.

In addition, the Working Group noted that construction of run reconstruction models for multiple countries or fishing areas will require descriptive information on the fisheries and the distances between fisheries and salmon producing areas. The Working Group proposed the following format:

Country	Fishery name	Median date juldate	Size group	Mean weight (kg)	Mean catch (kg)	Location Latitude	Longitude
Canada	SFA11	145	small	2.2	4,000		
		230	large	4.1	2,500		
Norway	N. Coast etc.						

Distances between fisheries and salmon producing areas are important for defining plausible migration routes. Data on mean sizes of smolt runs and of fish within fisheries will be used to predict swimming speeds and minimum migration times among areas.