International Council for the
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REPORT OF THE WORKING GROUP ON NORTH ATLANTIC SALMON

Copenhagen, 14-21 March 1991

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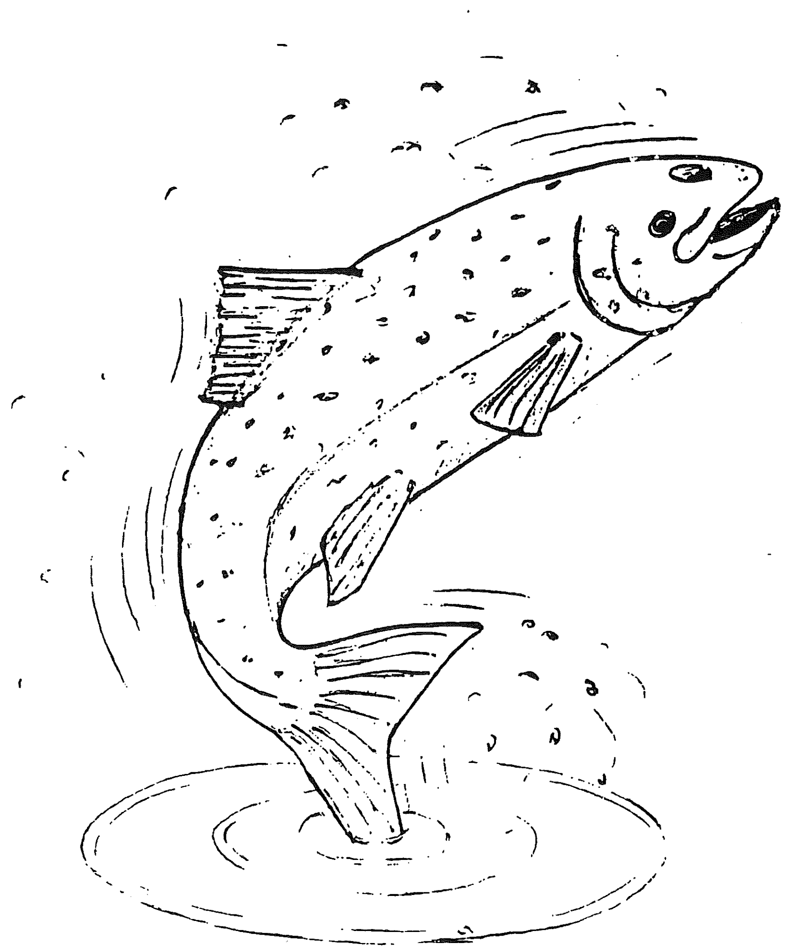

"CWT recovery can be a real headache."

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1 INTRODUCTION

1.1 Main Tasks

At its 1990 Statutory Meeting, ICES resolved (C.Res.1990/2:5:8) that the Working Group on North Atlantic Salmon should meet at ICES Headquarters from 14-21 March 1991 to consider questions which include those posed to ICES by NASCO (Appendix 1).

Three Study Groups and one Workshop met prior to the Working Group and submitted reports: The Study Group on the Norwegian Sea and Faroes Salmon Fishery, the Study Group on the North American Salmon Fisheries, the Study Group on Genetic Risks to Atlantic Salmon Stocks and the Workshop on Identification of Fish Farm Escapees and Wild Salmon.

The Working Group considered a further 26 papers submitted by participants (Appendix 2). References cited in the report are given in Appendix 3.

1.2 Participants

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Browne, J.		Ireland
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Hansen, L.P.		Norway
Hansen, T.		Norway
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Marshall, T.L.		Canada
Meerburg, D.J.		Canada
Møller Jensen, J.		Denmark
Niemelä, E.		Finland
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Tomasson, T.		Iceland
Zubchenko, A.		USSR

2 CATCHES OF NORTH ATLANTIC SALMON

2.1 Nominal Catches of Salmon

Total nominal catches of salmon by country in all fisheries for 1960-1990 are given in Table 2.1.1, and nominal catches in homewater fisheries for 1960-1990 are given in Table 2.1.2. These catch figures incorporate revised values for Scotland and St. Pierre and Miquelon.

Catch statistics in the North Atlantic area also include fish farm escapees and in the North-East area ranched fish. The updated total catch for 1989 of 5,894 t is 1,822 t less than the total catch in 1988 of 7,716 t. Total landings for 1989 were the lowest recorded and show decreases for many countries. Figures for 1990 (4,554 t) are provisional, but it appears likely that the final data will show a substantial decrease from 1989. This is the fourth year in which the total catch has decreased from the previous year. The decline in catch of wild stocks may be greater than suggested by the total due to the probable additions of fish farm escapees and ranched fish.

The 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 2.2.1. As in Tables 2.2.1 and 2.1.2, catches in some countries include both wild and reared salmon and fish farm escapees. Figures for 1990 are provisional. The methods used by the different countries to break down their total catch by sea age are described in Anon. (1986a and 1987).

2.3 Unreported Catches

The total unreported catch in 1990 was estimated to be approximately 1,640 t.

Instances of fishing in international waters in the Norwegian Sea are discussed in Section 4.4, and these unreported catches are not included in the above estimate or in the tables.

2.4 Production of Farmed Salmon

The reported production of farmed salmon by several countries was 224,259 t in 1990 (Table 2.4.1). This is larger than the wild catch by a factor of about 50.

3 QUESTIONS OF INTEREST TO THE WEST GREENLAND COMMISSION

3.1 Description of the Fishery at West Greenland, 1990

In 1990, the fishery in West Greenland (NAFO subarea 1) was opened on 1 August and ended in November, although the official closing day was 31 December. The total nominal catch was 227 t (Tables 3.1.1 and 3.1.2), which is 110 t less than in 1989, when the total landings were 337 t. The catch in 1990 is the lowest recorded since 1961, when it was 127 t.

The TAC agreed upon for 1988 to 1990 was 840 t each year, with an opening date of 1 August, and with some possibilities of transfer from one year to the next, as long as the total for 1988-1990 did not exceed 2,520 t.

In 1990, the TAC was set at 924 t, and was divided into a "free quota" of 457 t and a "small boat quota" of 467 t. This arrangement had no practical implications as the total landings did not exceed the "free quota".

The geographical distribution of the fishery in 1990 (Table 3.1.2) was similar to previous years. The landings in NAFO Divisions 1A and 1B were low, and the landings in Division 1C were highest with 99 t and decreased to 29 t in Division 1F (Figure 3.1.1).

The salmon fishery in Greenland is a small boat fishery and therefore an inshore and coastal fishery. Approximately 80% of the total landings were taken by boats smaller than 30 feet. No information on effort is available for 1990, but the landings during the two first two weeks may have indicated a low abundance, which may have lead to lower effort (see text table below).

The nominal landings during the two first weeks, 1980-1990 (in tonnes).

Year	First week	First two weeks
1980	260	711 (1 - 14 Aug)
1981	465	735 (15 - 28 Aug)
1982	470	766 (25 Aug - 7 Sep)
1983	105	192 (10 - 23 Aug)
1984	17	58 (10 - 23 Aug)
1985	204	361 (1 - 13 Aug)
1986	509	848 (15 - 28 Aug)
1987	439	737 (25 Aug - 7 Sep)
1988	219	337 (25 Aug - 7 Sep)
1989	131	219 (18 - 31 Aug)
1990	12	38 (1 - 14 Aug)

As shown in the text table, the landings in 1990 during the first week, and the two first weeks, are the lowest in the time series.

The reason for low catches in 1989 and 1990 may be different. The cooling of the surface waters in the Labrador Sea during the first months of 1989 may have affected salmon migration into the areas of West Greenland and thereby their abundance; that phenomenon also took place in 1983 and 1984 resulting in low catches in those two years (Anon., 1985b). During the summer of 1990, the water temperature along the bank of West Greenland was lower than usual, which could have influenced the abundance in the fishing area, i.e., mainly inshore and coastal waters. However, the main cause of low catches in 1990 seems to have been a high post-smolt mortality, because catches of 1SW salmon in homewaters were low, especially in Europe, and 90% of the catches in Greenland belong to the same year class as the grilse.

3.1.1 Composition and origin of the catch

The Working Group examined the composition and origin of salmon caught at West Greenland based on discriminant analysis of scale samples from NAFO Divisions 1C, 1D, and 1E. An attempt was made to develop a discriminant function using known-origin salmon from that fishery (123 North American and 8 European). The origin of these fish 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%, based on prior probabilities of 0.5. This data base and the discriminant function were accepted by the Working Group for examination of the 1990 West Greenland fishery. The Working Group expressed concern over the lack of a suitable test sample of known origin salmon collected from the Greenland fishery in 1990. If the nuclear DNA pattern method proves to be useful, it is recommended that it be used to classify samples already collected at Greenland in 1990. Scale samples should be collected in home waters in 1991 in case the DNA analysis is not successful.

The results of classifying salmon in samples from commercial catches in 1990 indicated that the North American proportion was 75% (95% CL = 79,70), and the

European proportion was 25% (95% CL = 30,21) (Table 3.1.3). In 1990, 26% of the catch was taken at the same time as the samples compared to 73% in 1989, 62% in 1988, and 85% in 1987. This suggests that the representativeness of the catch samples has decreased considerably compared to 1987-89. In 1990, 5.8% of the catch was sampled for determination of continental proportions compared to 5.4% in 1989, 3.8% in 1988 and 4.5% in 1987. This suggests that the samples may be representative of catches taken during the same period, but may not be representative of the entire fishery. Table 3.1.3 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 1982-1990 was derived by weighting NAFO division samples by catch in numbers. Information from the nearest NAFO Division was applied to divisions with no samples. The table below gives the results:

Year	Weighted by catch in numbers				Percentage of all samples combined	
	NA		EU		NA	EU
	%	Wt(t)	%	Wt(t)		
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
1990	74	168	26	59	75	25

In 1990, the estimated number of fish caught was 62,353 from North America and 21,721 from Europe for a total of 84,074.

As in previous years, there were no temporal trends in the proportions of fish by continent. Significantly higher proportions of North American salmon were observed in Divisions 1C and 1D than in 1E:

NAFO Division	Nominal catch (t)	% N. American origin	% European origin
1A	3	*	*
1B	18	*	*
1C	99	81	19
1D	44	81	19
1E	34	57	43
1F	29	*	*

*Not sampled.

Information on country of origin can be derived from recoveries of tags (both Carlin and coded-wire) at Greenland in 1990. Salmon landings at Greenland were again scanned in 1990 for adipose finclips and coded-wire tags (CWTs) using procedures similar to those in previous years.

In 1990, a total of 6,410 salmon (7.8% of the West Greenland catch) was examined for adipose finclips and CWTs by Canadian, USA, and Danish scientists. In the sample, 201 (3.14%) had adipose finclips, and CWTs were recovered from 54 (26.9%) of the finclipped fish (Table 3.1.4). Thus, the overall proportion of the catch sample that was coded-wire tagged was 0.84%, compared to 0.64% in 1989, 0.50% in 1988, and 0.58% in 1987. The proportions of fish having CWTs sampled at each port were not uniformly distributed (X^2 = 9.6) in common with the years 1985-1987 and 1989 but differed from 1988 when the proportions were evenly distributed throughout the fishery. In 1990, the proportion of fish sampled at each port having adipose finclips was not evenly distributed (X^2 = 31.2) and the overall proportion was the highest recorded since scanning commenced in 1985.

CWTs were recovered in 1990 from 6 countries and were apportioned as follows: 37 (69%) from the USA, 9 (17%) from Canada, 3 (6%) from Ireland, 2 (4%) from England and Wales, 3 (6%) from Iceland (Table 3.1.5). All of these tags came from 1SW salmon, most having been released as hatchery-reared smolts in 1989. One fish from England and Wales and one from Ireland were released as hatchery-reared parr in the spring of 1988, but did not migrate as smolts until 1989. Also, one salmon was tagged in England and Wales in 1989 as a wild smolt.

The contribution by various countries to the 1991 West Greenland harvest cannot be determined at this time due to differential survival 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 Maine 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 Maine and Canadian hatcheries. The contribution to the Greenland harvest of other US origin (i.e., Merrimack, Connecticut) smolts was considered negligible. The proportional harvest method was used to provide a current year estimate of the harvest.

Input data for the method are shown in Tables 3.1.6 and 3.1.7. The estimate of the North American harvest given in Table 3.1.7 differs slightly from that given in Section 3.1.2 because it is derived in a different way. The difference is small, however, and in order to maintain consistency in the method between years, the estimate has not been adjusted. Based on this method, the estimate of Maine salmon harvested at Greenland in 1990 was 3,968 (Table 3.1.8).

3.1.2 Biological characteristics of the harvest

Biological characteristics (length, weight, and age) were recorded from samples of commercial catches from NAFO Divisions 1C, 1D, and 1E in 1990 using the results of discriminant analysis to divide samples into North American and European components. A summary of these data is provided in Table 3.1.9.

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. Samples from coded-wire tagged salmon also confirmed that North American 1SW salmon were shorter and lighter than their European counterparts. However, the small sample of 2SW salmon of North American origin examined were not different in length and weight from European-origin salmon, either overall or at the Division level.

The sea age composition in 1990 (Tables 3.1.10 and 3.1.11) of 95.9% 1SW, 3.2% 2SW, and 0.9% previous spawners indicated that there were proportionally more 1SW salmon and fewer 2SW and previously spawned salmon than in 1989. In 1990, the 2SW components for both North American (3.4%) and European (3.0%) salmon were lower than their respective components in 1989.

Based on 75% North American salmon by number in the 1990 West Greenland salmon catches, the catch at age by continental origin was as follows:

Sea age	NA	EU	Total
1	59,672	20,917	80,589
2	2,120	652	2,772
PS	561	152	713
Total	62,353	21,721	84,074

Another method of deriving numbers of salmon of North American and European-origin was also examined. It utilized information on sea age and continent of origin from the sampling program weighted to landings reported in size categories (1-3 kg, 3-5 kg, and >5 kg). The result was as follows:

Sea age	NA	EU	Total
1	52,679	27,462	80,141
2	863	531	1,394
PS	252	98	350
Total	53,794	28,091	81,885

The catch weighting technique is the preferable method, but catch weighted estimates currently available are not bias-corrected. The Working Group recommended that this be done for as many years as possible and these numbers be used in future reports.

The mean smolt age of salmon of North American origin has varied more than that of European fish (Table 3.1.12). There are no trends in the mean smolt ages of European-origin salmon between 1968-1990. It was observed that the proportion of North American-origin river age 1 salmon has been increasing steadily from 2% in the 1986 samples to 8.8% in the 1990 samples. This could be the result of increasing production of North American hatchery-origin salmon or because of increasing numbers of fish farm escapees of unknown origin in the fishery. The decrease in numbers of North American salmon of river age 4 years and older from the mean value of 22.5% from 1968-89 to 15.1% in 1990 suggests that either production or migration of salmon from the northerly portion of the range in North America has decreased.

3.2 Composition and Origin of the Catch, Historical Data

3.2.1 Tag returns and harvest estimates

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 (updated in Section 3.1.1) and the image analysis method, provide estimates for the current fishery year. The image analysis method was not used for 1990. 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.

Carlin tag method

The parameters in the Carlin tag harvest model for 1SW salmon remain as reported in the previous assessment (Anon., 1990a). 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 1 SW 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). Ratio values are shown in Table 3.2.1. 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. Only harvest for an assumed passage efficiency of 85% is presented. As described in Anon. (1991a), minor changes have been made to the historical angling catch which are related to methodology used to assign unaged catches to age groups.

The updated time series of tag returns from Maine-origin 1SW salmon in West Greenland can be found in Table 3.2.2. Tag returns (to date) for the 1990 fishery total 13 tags with the largest recovery occurring in NAFO Division 1C. Estimated harvest of 1SW salmon in West Greenland is summarized by year for 85% passage efficiency (Anon., 1990a) in Table 3.2.3. The harvest estimates for the 1989 fishery totalled 3,784 salmon at 85% efficiency and are primarily distributed in NAFO Divisions 1B to 1E. This is the highest harvest estimate of Maine origin 1SW salmon from Carlin tag data ever computed for the Greenland fishery.

Tag returns from 2SW salmon of Maine origin intercepted in West Greenland are summarized in Table 3.2.4. For the purposes of harvest estimation and run reconstruction modelling, 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 the summary for 1SW returns, harvest estimates are presented by year and computed with an 85% fishway passage efficiency factor in Table 3.2.5. An estimated thirty-six 2SW salmon of Maine origin were harvested in West Greenland in 1990.

CWT method

In 1989, coded wire tags (CWT) from USA-origin salmon, including fish from the Connecticut, Merrimack and the Penobscot rivers, were recovered in West Greenland. Using the methodology in Anon. (1988a), the Working Group estimated harvests based on the CWT sampling programs at both West Greenland and in home waters. Ratios of CWT tagged to untagged 2SW salmon (RATIO) returning to the Connecticut, Merrimack and Maine rivers in 1990 were 0.802, 0.502 and 0.104, respectively. Harvest estimates for these three stocks for 1989 were:

CWT Harvest Estimates
(Variance)

STOCKS

Year	Connecticut	Merrimack	Maine
1987	112 (802)	49 (318)	5538 (102 166)
1988	230 (3601)	0 -	4236 (105 593)
1989	117 (1463)	209 (2944)	3533 (77 680)

These estimates of harvest were based on the recovery of CWTs in the Greenland fishery in 1989 during the sampling programme. As not all weeks or areas of the fishery were sampled, assumptions concerning the numbers of tags caught in those weeks and areas were again necessary (Anon., 1989a). The assumptions were that if scanning had occurred in them, the recovery of tags per fish scanned for NAFO Divisions 1A, 1C, and 1F would have been the same as for 1B, 1D and 1E, respectively. As well, fisheries which occurred both prior to and subsequent to scanning were assumed to contain the same number of tags per fish scanned as in the first or last sampling week, respectively, in that (or the adjacent) NAFO division. The US origin tags and the number of fish scanned were distributed in the following way during 1989:

NAFO Division

	1B		1D		1E	
Std. week	tags C/M/P	scanned	tags C/M/P	scanned	tags C/M/P	scanned
33	0/1/2	294	0/0/0	146	0/0/0	702
34	4/5/9	2474	6/5/12	4207	1/0/2	2006
35	1/1/8	772	2/3/5	3144	0/2/0	1447
36	-	-	-	-	0/0/1	123

C = Connecticut M = Merrimack P = Penobscot

As noted last year, the CWT harvest estimate, similar to the proportional harvest method, is not dependent upon an assumed reporting rate as is the Carlin harvest estimate. Some concern was expressed that a substantial proportion of the harvest estimate could be based on a limited number of tag recoveries. The Working Group recommended that the stratification procedure be reinvestigated.

3.2.2 Carlin tag reporting rates

The three methods of harvest estimation available for US-origin salmon in the West Greenland fishery (Carlin tag recoveries, CWT recoveries, proportional harvest) provide independent and complementary results. Comparison of the available time series of harvest estimates (Figure 3.2.1) shows that the proportional harvest model averaged several-fold greater than the Carlin estimates over most of the series. Since 1983 the fraction of 2-yr smolts in USA hatchery releases has decreased with a concomitant reduction in the variability of the estimate (see Section 3.1.1). The CWT harvest estimate is based on the scientific sampling program in West Greenland and is potentially the most accurate and precise of the available methods (note concerns in Section 3.2.1).

Neither the CWT estimate nor the proportional model rely on voluntary returns of tags to estimate harvest. Therefore, the ratio of Carlin-based estimates to the other methods provides an indirect estimate of reporting rate. Because the Carlin estimates reported in Table 3.2.3 already incorporate a reporting rate, it is necessary first to remove the effect of that rate. This is accomplished by multiplying the annual estimates by their respective reporting rates (Rc(t)). Previous comparisons of Maine-origin tag recoveries in Greenland and Canada (Anon., 1987) led the Working Group to infer that reporting rates in Greenland had decreased after the imposition of the quota in 1976. The reporting rate values used to date in the Carlin harvest model are:

1967-75	76	77	78	80	81	82	83-90	(t)
0.8	0.6	0.4	0.4	0.5	0.6	0.8	0.8	Rc(t)

The revised estimate of Carlin harvest (Hc'(t)) is defined as

$$Hc'(t) = Hc(t) * Rc(t)$$

The ratio of Hc'(t) to either the CWT harvest (Hcw(t)) or proportional harvest (Hp(t)) is assumed to be an estimate of reporting rate for the Carlin tags. Thus

$$R'(t) = Hc'(t)/Hcw(t) \quad \text{and}$$

$$R''(t) = Hc'(t)/Hp(t)$$

where R' = reporting rate calibrated against CWT estimate and R'' = reporting rate calibrated against proportional estimate.

Figure 3.2.2 shows the estimates of R'(t) and R''(t) for the period 1976-1989. Results suggest a steady increase in apparent reporting rate since the early 1980s when estimates were below 20% for the period.

Estimates of reporting rate derived from comparison with CWT harvest estimates are available only for 1987-89 (Figure 3.2.2). Estimates of R'(t) and R''(t) show remarkable agreement during this period with both estimates increasing significantly during 1989. The 1989 estimates may have been influenced by the NASCO lottery but previous analyses (Anon., 1989a) suggested that several years would be necessary to determine statistically significant differences.

Reporting rates may have been as high as 85% in 1989 and about 40% previously.

Estimates of error have been derived only for the CWT and proportional harvest methods (Figure 3.2.3). Error bounds for the derived reporting rates were approximated by simply dividing the Hc'(t) by the upper and lower bounds of Hcw(t) and Hp(t). As shown below, the reporting rate estimates vary widely.

	Lower	Upper
R'(1987)	.27	.34
R''(1987)	.26	.30
R'(1988)	.37	.50
R''(1988)	.35	.41
R'(1989)	.57	1.71
R''(1989)	.62	.71

Factors responsible for variable reporting rates are difficult to ascertain. A hypothesis that high rates of catch per unit effort would lead to decreased reporting rates was examined by plotting R''(t) vs average catch per day in the first 14 days of the Greenland fishery (Figure 3.2.4). The overall correlation was negative but not statistically significant. Different relationships appear to hold for the time periods 1980-85 and 1986-89. The higher level of overall reporting rate in the latter period may be related to the increase in tag rewards from 25 to 100 DKr in 1986, the initiation of the NASCO lottery in 1989, and increased scientific sampling in recent years.

Conclusions

1. Absolute reporting rate estimates would require sampling by research vessels to compare tags per ton with commercial landings. Alternatively, samplers in the fisheries could examine fish for the presence of scars (none, fresh, healed) to provide an indirect estimate of reporting rate. The frequency of fresh scars would estimate the number of tags removed from the fishery which could be compared with numbers of tags reported. The Working Group felt neither option was practical.

2. None of the available comparisons support the previously-used baseline reporting rate of 80%, but wide confidence intervals on estimates and considerable inter-annual variability were observed. The Working Group agreed that a range of reporting rates of 0.4 and 0.8 for years since 1982 would be appropriate to address this variability. For the historical time series, the inter-annual pattern of variability in reporting rates could be sufficiently characterized by multiplying the Carlin harvest estimates by 2.

3. Data were not available to revise the estimates of historical reporting rates given in Anon. (1987). The temporal pattern of changes had been accepted previously as reasonable. The absolute reference point (i.e., 0.8) was determined for non-monitored vessels during the ICES/ICNAF Salmon Tagging Experiment in 1972 (Jensen, 1980). Multiplying the Carlin harvest estimate by 2 implies that the baseline reporting rate is 0.4.

4. Hindcasting of reporting rates based on the proportional harvest estimates is limited by uncertainty of the estimates in the early time periods. This is related to the large number of 2-yr smolts factored into the proportional harvest estimator. Reporting rates of less than 10% were considered implausible by the Working Group.

5. The relationship between reporting rate and catch per effort should be tested for other tagging programs.

6. Error estimates for the Carlin harvest estimates should be derived, if possible.

3.3 Stock Abundance and Exploitation at West Greenland

The term exploitation rate as defined by the Working Group (Anon., 1985b) is based on the number of fish of the appropriate stocks and smolt classes extant at the time of the fishery. In the following discussion this is referred to as the 'extant exploitation rate'. Estimates are also made of the level of exploitation on that proportion of the appropriate stocks and smolt classes estimated to be within a defined fishery area; these are referred to as 'fishery area exploitation rates'.

3.3.1 Exploitation on the extant stocks of 1SW and 2SW Maine-origin salmon

In (Anon., 1990a), a model to calculate extant exploitation rates of 1SW and 2SW Maine-origin salmon was presented. These calculations were updated by including the 1989 Greenland and Newfoundland catches and 1990 homewater returns (Tables 3.3.1-3.3.3). The extant exploitation rates for 1SW Maine salmon in 1989 were higher than in the previous year and the long-term average. The extant exploitation rates for 2SW salmon in 1989 were approximately equal to the average and lower than in 1988.

3.3.2 Fishery area exploitation on 1SW Maine origin salmon at Newfoundland and West Greenland

Fisheries for non-maturing 1SW salmon of North American origin salmon occur simultaneously in West Greenland and in Canada. Exploitation rates in these fisheries depend on what proportion of the extant stock is vulnerable to each fishery. Assuming that the population of 1SW Maine-origin salmon is available to only the Newfoundland and West Greenland fisheries, estimates of exploitation rates are presented in Table 3.3.4. A monthly natural mortality rate of 0.01 was used in all cases. Two assumed levels of reporting are included; where the Carlin adjustment of 1.0 is used, the reporting rate is that which has been used in Section 3.2.1, where the Carlin adjustment of 2.0 is used, the reporting rates are halved. Varying levels of P between 0.1 and 0.9 (the proportion of stock migrating from Canada) are evaluated.

The values calculated for 1989 show an increase in exploitation in Canada, above the previous three years, if the fraction of the population migrating from the respective fisheries has remained the same, whereas, in West Greenland exploitation appears to have remained about the same level as in the previous three years. The effects of different reporting rates of Carlin tags and different proportions of the stock population available to each fishery, are presented in Figure 3.3.1 and these indicate the possible range of fishery area exploitation in 1987-1989.

Maine-origin 1SW salmon have also been captured outside of the fishing areas in West Greenland and Canada, including the Labrador and Irminger seas. The number of the tag recaptures (and associated harvest estimates) were evaluated to investigate the possible range of the factor (FU) which describes the proportion of the stock unavailable to either of the West Greenland or Canadian fisheries. For years in which Maine tags were reported from the Angmagssalik district, possible fishery area exploitation rates in East and West Greenland and Canada were calculated assuming a fraction of the total population between 0.05 and 0.35 did not migrate to either West Greenland or Canada (Table 3.3.5).

In Anon. (1990a), a maximum value of the FU term was assumed to be 0.10. This appears to be too low because it implies that the sporadic fishery in a small fjord at Angmagssalik generates a fishery area exploitation rate of 0.08-0.31 for the total area outside the West Greenland and Canadian fishery areas. Such exploitation rates, therefore, seemed unrealistically high to the Working Group.

More realistic exploitation rates imply a value of FU much greater than 0.10. This in turn implies higher fishery area exploitation rates on these stocks in both West Greenland and Canada. The range of increase in the derived exploitation rates for Canada and West Greenland was 5-9% (e.g., from 50 to 55% or 50 to 59%), depending on the value of FU used.

Further developments in the modelling approach to evaluate exploitation rates in West Greenland and the relative contributions of different countries to the fishery are explored in Section 7.

3.4 Effects of Management Measures in the Fishery at West Greenland

The total TAC agreed for the period 1988-1990 was 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%. The total harvest for the period corrected for an opening date of 1 August was 1,360 t and in no region was the annual limit exceeded. Only in 1988 was the catch (820 t) limited by the quota.

3.5 Quantitative Estimates of the Effects of Fish Farm Escapees

No quantitative estimates of fish farm escapees were available. Examination of the scale characters of samples from West Greenland in 1990 indicates that there may be some fish farm escapees in the catch. The Working Group recommended that studies be conducted to investigate the incidence of fish farm escapees in the catch at West Greenland.

4 QUESTIONS OF INTEREST TO THE NORTH-EAST ATLANTIC COMMISSION

4.1 Description of the Fishery in the North East Atlantic

4.1.1 Changes in gear and effort in the Faroes fishery

Gear in use in the Faroes fishery did not change in 1990. Fishing is carried out by means of floating long-lines, 800 to 3,000 hooks being set each day per vessel.

The numbers of licences issued for the 1989/90 and 1990/91 seasons were 14 and 13, respectively, but, of these, only 11 and 8, respectively were used. This shows a continuing reduction in the number of vessels participating in the fishery from 1988/89, when 19 licences were issued, 12 of which were used.

In the 1989/90 season, the licensed vessels were allowed to fish from 1 November to 20 December and 3 January to 12 April. Few vessels started fishing early in November, but after some good catches most vessels joined in, resulting in high effort until the Christmas closure. The weather in January was poor with the result that few vessels went out and catches were low. Fishing effort increased in February and was high for the rest of the season, especially in late March and April.

As in 1988/89, no fishing took place outside the Faroes EEZ. (The extent of the Faroes EEZ is shown in Figure 4.1.1.) At the beginning of the season, the fishery was concentrated in an area about 50 miles north-west of the Faroe Islands. Later in the season, most fishing took place in the northern and north-eastern parts of the EEZ.

4.1.2 Catch at Faroes in the 1989/90 and 1990/91 seasons

The total nominal catch in the 1989/90 season was 361 t. This was considerably lower than the catches reported for the 1981/82 to 1986/87 seasons (Table 4.1.1), but was 50 t greater than in 1988/89 and 150 t greater than in 1987/88. The catches in numbers by statistical rectangle are shown for the whole season in Figure 4.1.2. The best catches were recorded in December and April (Table 4.1.2) when 36% and 26% of the total catch, respectively, were landed.

The catch for the calendar year 1990 was 312 t (Table 4.1.1) and the preliminary catch figure for the first half of the 1990/91 season (1 November - 20 December 1990) was 120 t; this was taken by 6 vessels. (The estimated catch to the end of February 1991, however, was only 160 t, suggesting that the total catch for the 1990/91 season is likely to be low.)

The discard rates for the five samples collected during the 1989/90 season ranged from 3.6% to 18.5%. These samples comprised a total of 16,357 fish of which 1,533 (9.4%) were less than 60 cm; no discards of fish greater than 60 cm were reported. This is within the range observed in the seasons 1982/83 to 1988/89, and no trend is apparent over this period (Table 4.1.3).

4.1.3 Catch per unit effort in the Faroes fishery

The catch in numbers per 1,000 hooks (CPUE) by statistical rectangle is shown for the whole 1989/90 season in Figure 4.1.3. The CPUE was high at the beginning of the season, decreased in January and February but improved again for the remainder of the season (Table 4.1.4a). In December, the highest CPUE was recorded close to the islands, but as the season progressed, the best catch rates were recorded further to the north. Thus, it is apparent that fishing effort tends to be highest in the areas where the CPUE is best.

The CPUE has been calculated for the areas south and north of latitude $65^0$30'N for each month of the 1981/82 to 1989/90 seasons (Table 4.1.4a and 4.1.4b). The southern area includes most of the Faroes EEZ; no fishing has been reported by Faroese vessels outside the EEZ since 1988. The CPUE data in these tables have been compiled from log books, but records have only been used where the catch reported in the logbook is within 10% of the number of fish landed from that trip. As a result, these CPUE data may differ from those given in earlier reports. Tables 4.1.4a and 4.1.4b show the great variability in the distribution of CPUE from season to season. At most times when fishing took place to the north of $65^0$30'N, the CPUE was higher than to the south.

It is evident that the CPUE has increased in the past two seasons, particularly at the beginning and end of the season. However, this increase does not necessarily imply that the abundance of salmon in the Faroes area has increased. This is because the small number of vessels that participate in the fishery tend to stop fishing when catch rates become too low. This tendency has been reinforced by the falling price of salmon.

The Working Group noted that more detailed CPUE data were available to the Faroes Fisheries Laboratory and considered that these may provide useful information on the movements of stocks in the area. However, the logbook data need to be carefully verified before a more detailed analysis can be carried out. The Working Group felt that it would be very useful if the data could be verified and some analysis undertaken for their next meeting.

4.1.4 Biological characteristics of the catch at Faroes

The sea age distribution of landings at Faroes by month in 1989/1990 is shown in Table 4.1.5. These distributions have been determined from length distributions of 1579 salmon measured during the season using the length splits shown below; the length splits for previous years are shown for comparison.

	1986/1987	1987/1988	1988/1989	1989/1990
1SW to 2SW	-	58 - 59cm	57 - 58cm	55 - 56cm
2SW to 3SW	85 - 86cm	83 - 84cm	84 - 85cm	83 - 84cm
3SW to 4SW	102 - 103cm	113 - 114cm	-	-

As in previous years, the catch is predominantly 2SW salmon (92.8%) with small numbers of 1SW and 3SW and older fish.

Table 4.1.6 summarizes the sea age distribution by fishing season in the Faroes salmon fishery. In all years, the total catches were dominated by the 2SW age class with the 3SW group next most numerous in all seasons except 1987/88, when the 1SW group was second largest. 4SW fish appeared in samples in only three seasons (1983/84, 1985/86, and 1986/87). The sea age distribution by month was similar in all seasons except for 1987/88 when the proportion of 1SW fish in the catch increased from 3% to 20% in the second half of the season; there was a corresponding decline in the 2SW component. This change is also reflected in the weight distribution of landed fish in the 1987/88 season compared with other years. A large change in weight distribution of the catch between the periods up to and after 1985/86 probably reflects the move of the fishery closer to the Faroe Islands.

The smolt age distribution of the fish from which scale samples were taken during the 1983/1984 to 1989/1990 seasons is given in Table 4.1.7. These samples have not been weighted according to the catch. The increase in the proportions of river age 1 and 2 and the decrease in the proportions of river age 3 and 4 fish caught in the fishery have continued. This may reflect changes in the stocks contributing to the fishery, including an increase in fish farm escapees.

4.1.5 Origin of salmon in the Faroes fishery

The data on microtag recoveries in the Faroes fishery were rechecked and updated for the period 1984 to 1990 (Table 4.1.8). The number of tags recovered in 1989/1990 (56) was only slightly less than in the previous season (59), and these returns greatly exceeded the returns from any other seasons. The raising factors generated for each year for the discards and the fishery are also included, and the method for calculating these factors is shown in Table 4.1.9.

The estimates of the total numbers of microtagged fish from each country caught in the Faroes fishery for each year of release have been corrected and updated for the 1989/90 season (Table 4.1.10). The following points were noted for recoveries by country:

> Microtagged salmon from the Faroe Islands have been recaptured predominantly as 2SW fish in the Faroes fishery. Recaptures from Ireland and UK (N. Ireland) have been mainly 1SW, many being in the discard catch. Recovery rates for tagging in the remainder of UK have been fairly evenly split between 1SW and MSW fish. One microtag from each of the USA and Canada were recovered in 1988/1989 but this type of tag from these countries has not been recovered in the fishery in any other year.

Of the 221 external tags recovered in 1990, 205 (93%) were of Norwegian origin. Tags were also recovered from Sweden (11) and Scotland (4). Historical data on external tag recoveries need checking before further analysis can be carried out.

4.1.6 Exploitation rates in the Faroes fishery

The estimates of extant exploitation rates in the Faroes fishery for fish tagged at various experimental units in the North-East Atlantic are summarised in Table 4.1.11.

Extant exploitation rates on 2SW salmon from the Imsa (Norway) have generally been high (up to 50%), although there has been a fairly steady decrease from the 1982/83 season to 1989/90. The decrease in recent seasons probably reflects the lower total catches in the Faroes fishery and possibly the cessation of fishing outside the Faroes EEZ. However, there appears to have been a corresponding increase in the exploitation of 2SW salmon from the R. Drammen.

New data have been provided on the River Lagan stock (Swedish west coast) showing that extant exploitation rates on 2SW salmon in the Faroes fishery have averaged about 10% in the last three seasons. Data from Ireland and all parts of UK confirm the conclusion (Anon., 1990a) that those countries are relatively minor contributors to the Faroes fishery with extant exploitation rates on both 1SW and 2SW fish being <1%, although rates on R. North Esk salmon have been higher at some times in the past.

4.2 Effects of Fish Farm Escapees on Catches at Faroes

The results of the Workshop on Identification of Fish Farm Escapees and Wild Salmon are reviewed in Section 10.

Hansen et al. (1987) reported on an experiment to investigate the migratory behaviour of farmed fish. Of 497 fish which were tagged and released in Norway, 98 were recaptured, 7 of them in the Faroes fishery. Thus, there is direct evidence that farmed fish from Norway contribute to the Faroes fishery.

Detailed examination of fish caught in the Faroes fishery was not carried out in the 1989/90 season. However, a proportion of the 200 scale samples collected in the Faroes fishery in November 1989 were said to appear to be slightly abnormal, possibly indicating artificial rearing. This suggested that 13.5% may have been of hatchery origin, including stocked fish and farm escapees. A similar analysis of 282 fish caught in January 1990 indicated that 21.6% may have been of reared origin. Dorsal fin measurements were taken for 73 of these fish; about 15% had abnormally short dorsal fins, possibly indicating that they were hatchery reared. However, there was little agreement between the groups identified as abnormal by the two techniques. This sample of 73 scales was also examined using the method in Anon. (1991a); 42% were identified as reared, although the method has only been calibrated for Norwegian fish. These results can only be taken to confirm that there is likely to be a substantial catch of reared fish, including farm escapees, at Faroes.

4.3 Effects of Management Measures at Faroes

At the 1989 meeting of the North-East Atlantic Commission of NASCO the following regulatory measure was agreed for salmon fishing in the Faroe Islands for the calendar years 1990 and 1991:

> "The fishing effort shall be targeted at an average annual catch so that the total nominal catch for the duration of the trial period shall not exceed 1,100 t. However, in any given year the annual catch shall not exceed 15% more than the annual average."

The following additional measures also apply to the Faroes fishery for 1990 and 1991:

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

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

3. The salmon fishing season will be limited to 150 days between 1 January and 30 April and 1 November and 31 December. The Faroese Authorities shall inform NASCO before 15 December of the fishing season for the coming calendar year.

4. Subject to the maximum annual catch the total allowable number of fishing days for the salmon fishery in the Faroese Islands zone shall be set at 1600 each year."

The Working Group assessed the operation of these measures. The nominal catch of 312 t in the Faroes fishery in 1990 was only 49% of the permitted maximum of 632.5 t. Discard rates were estimated for 2 landings during 1990 (in January and April) as part of the biological sampling programme. No additional data were collected by coastguard vessels, and no area closures were ordered. The Working Group again noted that area closures were unlikely to be an effective measure without extensive monitoring or the cooperation of the fishermen.

Licences are issued for the fishing season November to April. The numbers of licences issued for the 1988/89 and 1990/91 seasons were only 54% and 50% of the permitted maximum, respectively. In 1990, salmon fishing was permitted for 150 days for vessels over 50 GRT. Effort data are not available for the calendar year of 1990. A total of 532 sets was estimated to have been fished in the 1989/90 season. This is 33% of the total of 1600 permitted in both 1989 and 1990.

The Working Group, therefore, concluded that, as effort had been well below that permitted, the catch had not been limited by the effort or quota measures agreed by NASCO.

4.4 Salmon Fishing in International Waters

The Working Group was aware of reports circulated by the NASCO Secretariat that vessels registered in countries that are not Parties to the NASCO Convention were continuing to fish in international waters to the north of the Faroes EEZ, although it was understood that measures have been taken to prevent Panamanian registered vessels from fishing. In 1990, it was suggested that the potential unreported catch from this source in the 1989/90 season was of the order of 630 t, although this might not have been realised because of adverse weather conditions. There were no new data to allow this estimate to be updated or improved.

5 QUESTIONS OF INTEREST TO THE NORTH AMERICIAN COMMISSION

5.1 Description of the Fishery in Canada, 1990

Two new management measures were introduced in the Newfoundland and Labrador commercial fisheries in 1990:

1) Quotas by Salmon Fishing Area (SFA) (Figure 5.1.1) were introduced in the Newfoundland commercial salmon fishery. The 1990 quotas are shown in Table 5.1.1. Salmon Fishing Area 1 had an allowance of 80 t. An allowance is an estimate of expected catch and not a limitation on allowable harvest. Monitoring of the quotas was conducted by fisheries officers who were in contact with buyers and fishermen on a weekly or daily basis.

2) Caution notices were moved seaward to increase spawning escapement in specific rivers and to reduce commercial harvest on salmon stocks when salmon are congregating in or near the estuaries during periods of low river discharge. Commercial fishing, for any species, is prohibited inside (towards the river) these caution notices. Fishing effort was displaced to berths further out in the bays. It is not possible to quantify the effects on the harvests outside the caution notices.

Along the Quebec North Shore, the opening of the commercial fishing season, previously 1 June, was delayed by 10 days in Q7 and Q8 and by 1 month in Q9 (Figure 5.1.1). Total quota in numbers was reduced by 12% to 29,605 salmon. Commercial fishing was prohibited within a 500 m zone from the mouth of the rivers.

A more detailed description of other aspects of the commercial fisheries was provided in Anon (1985a) and updated annually by the Working Group.

The total salmon landings for Canada in 1990 were 870 t (Table 2.1.2); this is the lowest recorded landings in the 1960-90 data set. The landings (405 t) of 1SW salmon (≤2.7 kg or ≤63 cm) in 1990 were 26% below the 1989 landings (549 t) and 41% below the previous 5-year mean (686 t). The landings (465 t) of 2SW salmon (>2.7 kg or >63 cm) in 1990 were 21% below the landings of large salmon in 1989 and 34% below the previous 5-year mean (699 t). Of the total Canadian landings by weight, 17% were in Quebec, 74% in Newfoundland and Labrador, and 9% in the Maritimes. The recreational fisheries harvested 22%, commercial fisheries 74%, and native fisheries harvested 4% of the total landings by weight. The decline in total commercial landings from 1,596 t in 1987 to 652 t in 1990 was spread over all Salmon Fishing Areas of Newfoundland and Labrador and the Quebec North Shore (Table 5.1.1). Landings in Newfoundland and Labrador of 586 t were the lowest of a 20-year data set (1971-90) (Table 5.1.2). A description the commercial, recreational and native fisheries in 1990 in Atlantic Canada, are provided by Salmon Fishing Area in the North American Study Group Report (Anon 1991a). The most significant change in the fisheries from the description reported for 1989 (Anon, 1990b) was the imposition of quotas in the commercial fisheries for SFAs 2-14 which resulted in early closure of the commercial fisheries in SFAs 4, 5, 6, 8, 10, 11, 13, and 14. Additional analysis of the 1990 quota are contained in Section 5.4.

The landings in the commercial (in weight), and angling fisheries (in numbers) in 1990 by SFA and comparisons to the mean landings 1984-89 are provided in Tables 5.1.3 and 5.1.4, respectively. Historical commercial and recreational landings are presented in Figure 5.1.2.

The commercial landings of small and large salmon, by weight, declined from the mean landings 1984-89 throughout Newfoundland and Labrador SFA 1 to 14 (Table 5.1.3). The early closure in some Salmon Fishing Areas, due to the quotas being reached, contributed to the decrease in landings. However, low abundance of salmon also appears to be a contributing factor, particularly in SFAs 1, 2, and 3. The landings of small salmon in Q7 and Q9 (Quebec north shore) increased by 66% and 7% respectively over the mean landings 1985-89; but, declined by 36% in Q8. The declines in large salmon catch in Q7 (32%), Q8 (9%) and Q9 (8%) may be related to the delay in opening of the fishing season, reductions in quotas and displacement of some fishing gear.

5.1.1 Composition and origin of the catch

Salmon of Canadian and USA origin were caught in Canada during 1990. Recaptures of tagged 1SW salmon of USA and Canadian origin occurred in the Newfoundland and Labrador fisheries.

Salmon in twelve commercial salmon fishing ports in Newfoundland and Labrador were scanned for CWTs in 1990. All sampling ports were located within the southern portion of SFA 2 and SFAs 3 and 4. A total of 19,953 salmon (about 16% of the total landings in the SFAs sampled) were examined from the landings of commercial vessels. Of this sample, 112 salmon were found to be adipose clipped, of which 44 contained coded wire tags (Table 5.1.5). Approximately 8% of the salmon examined were from catches in the Labrador location (SFA 2) with the balance coming from Newfoundland (SFAs 3,4). The highest percentage of tagged salmon was observed in Harbour Deep, but this could be misleading since the port was not sampled through the entire season.

Of the 44 CWT recovered, 40 were from USA-origin hatchery releases in the Penobscot, Connecticut and Merrimack rivers. All recoveries were from 1989 releases except one USA tag from a 1988 Penobscot release. The Canadian origin tags were from 1989 releases in the Saint John River and a 1987 release in the Margaree River. 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, and the location and time of sampling.

There were 8 Carlin tags reported (to date) in 1990 from the Penobscot River tagging experiments. This is an 85% decrease from the 1989 recaptures. Some of this decrease may be due to a 50% decline in the number of Carlin-tagged smolts from 100,000 in 1988 to 50,000 in 1989. Most tags were recovered in southern Labrador (SFA 2) and northern Insular Newfoundland (SFAs 3, 4).

	Salmon Fishing Areas							
	1	2	3	4	5	6	7-14	Total
Penobscot Carlin Tags	0	2	2	2	0	0	2	8

Estimates of harvest of USA-origin salmon captured in the 1990 fishery will not be available until the balance of the smolt class returns to homewaters in 1991.

5.1.2 Exploitation rates in Canadian fisheries

No new information on exploitation rates in commercial fisheries was available to the Working Group. Exploitation rates in the recreational fisheries of three SFA's not previously reported in Anon. (1990b) are shown in Table 5.1.6. These rates were estimated from mark recapture studies and include adjustments for reporting rate and tag availability with the exception of Restigouche River, where exploitation rates were estimated from angled fish divided by angled fish plus spawners (obtained by visual counts from canoes after closure of the river to angling). Angled MSW salmon are fish caught and released. Exploitation rates on 1SW salmon for Restigouche River have been higher than for the other rivers. Exploitation rates on early run 1SW and MSW salmon were higher than on late run salmon. Exploitation rates on MSW salmon from Margaree have consistently been lower than on 1SW salmon. Variation in the estimated rates suggest that exploitation rates should be calculated annually or that a range of rates be used when returns to a river are calculated from recreational catch.

5.2 Status of Canadian Stocks

Annual estimates of run size and spawning escapements relative to target spawning requirements are provided in Table 5.2.1. The absence of predictions on all rivers in recent years reflects major changes in 1SW:MSW ratios from the same smolt class which reduced the precision of parametric predictors of MSW returns to the extent that they became unreliable.

Estimates of egg depositions in 1990 may have approximated (Restigouche), and approximated or exceeded (Conne, de la Trinité, Miramichi, Margaree and LaHave) target egg requirements in six rivers. In the Miramichi River, 38% of MSW spawners were repeat spawning salmon, the highest proportion or number on record. Egg deposition was 32% below target on the Saint John River. Targets were approximated or exceeded for the first time in nine years on the Restigouche River, for the seventh time in the last nine years on the Miramichi River, for the eighth time in nine years on the Rivière de la Trinité, for the sixth time in the last eight years on the Margaree River and for the eighth and fifth consecutive years on the LaHave and Conne rivers, respectively (Table 5.2.1). Egg depositions were below target for the fifth consecutive year on the Saint John River. With the exception of the Conne River, most rivers obtained a major component of eggs from MSW salmon.

Additional assessments (based on counts obtained at fishways, counting fences and by divers) made in 1990 suggest that target egg depositions were about 65% below requirements on Gander River (SFA 4) and about 35% below requirements on Middle River (SFA 19), Liscomb River (SFA 20) and Western Arm Brook (SFA 14). Four rivers (Big Salmon, Alma, Point Wolfe and Petitcodiac) of inner Bay of Fundy (SFA 23), had returns that were down relative to historical returns. Reasons for shortfalls in target egg deposition vary by river system and include the effects of low water levels on juvenile survival in 1987, natural cycles, low pH and increased marine mortality.

Counts of 1SW fish at 10 of 12 fishways on systems in insular Newfoundland were down from the 1984-1989 mean (Anon., 1991a). In 8 of 12 cases, the few large salmon counted in Newfoundland were below the 1984-1989 mean. In the Maritime provinces, counts of 1SW salmon were similar to or above the mean at all 3 fishways (in SFA 20, 21, 23); counts of MSW salmon declined at all fishways. Counts of 1SW fish in Quebec increased over the 1984-1989 mean at all fishways; counts of MSW salmon were similar to or increased above the mean at 2 out of 4 fishways.

5.3 Harvest Estimates of USA-Origin Salmon in Canada

5.3.1 Carlin-based estimates for Canada

Neither the structure of the harvest model nor its parameter values were changed from the previous assessment in Anon. (1990a). Updated values and the new data for the 1990 run size used to calculate the RATIO parameter are in Anon. (1991a). Estimates for tags and total run size of 2SW salmon to Maine rivers, using a fishway efficiency of 85%, are presented in Table 3.2.1. For 1990, the estimates of tags and run size were 172 tags and 4,355 fish, respectively; the RATIO parameter was 0.0394.

The Working Group updated the time series of tag returns and harvest estimates of Maine-origin 1SW salmon in Newfoundland and Labrador. Tag returns for Maine-origin 1SW salmon can be found in Table 5.3.1. Estimated harvest of 1SW salmon in Newfoundland and Labrador are summarized by year for 85% fish passage efficiency in Table 5.3.2. The total harvest of 1717 Maine-origin salmon in the 1989 fishery was distributed primarily in SFAs 1-5. Harvests in SFA 1 were the highest on record for that SFA and were centered around the Nain area. Nearly 90% of the harvests in SFA 1 occurred after standard week 29 (July 22); in the other SFAs most of the catches occurred prior to standard week 30 (July 30). The harvest total of 1717 for the fishery was an increase from the relatively low harvests that occurred during the years 1986 to 1988. Updated values for 1SW:2SW ratios and ratios of harvest to run size of 2SW salmon are presented in Table 5.3.3.

Detailed summaries of the tag returns and harvests for 1SW salmon in mainland Canada and 2SW salmon in Newfoundland-Labrador and mainland Canada (Anon., 1990b, Tables 39-52) are not presented in this assessment since there were no new tag returns for these areas and age groups.

5.3.2 CWT-based estimates for locations sampled

The Working Group considered harvest estimates of Maine-origin stocks in Newfoundland and Labrador, derived from CWT- and Carlin-tagged salmon for areas sampled. Estimates based on Carlin tags for the 1989 fishery were calculated identically to the methods used in other reports of Carlin-derived harvest estimates (Anon., 1987; Anon., 1990a). CWT harvest estimates were computed identically to the methods used in Anon. (1990a). To compute the tag raising factor for the 1989 recovery the following input data were used:

	2SW salmon
Run Estimate	4355
Total CWT	454
CWT at the trap	334
Angled CWT	61
Untagged at the Trap	2298
Untagged Angled	336

From these data, the CWT to run ratio was 0.10424 and the raising factor for tags was 9.593. The estimated number of tags for a sample strata in the fishery was first raised for non-catch fishing mortality (Anon., 1989b) and then raised to total harvest for the strata.

Comparative harvest estimates based on CWT and Carlin tag recoveries were calculated for the communities and Statistical Sections sampled. As observed in Anon. (1989a) and Anon. (1990a), the ratio between the two estimates varied among locations, but unlike previous experiments, the sectional and community sums tended to suggest parity between the two estimation procedures. Whereas the experiments in 1987 and 1988 suggest the reporting rate may be overestimated in the commercial fisheries, the results for 1989 do not support that conclusion.

5.3.3 Proportional harvest model for sampled locations

The proportional harvest model was used to estimate the harvests of 1SW Maine hatchery-origin salmon in two communities in Labrador and one in Newfoundland. The methodology used was similar to that used for West Greenland (Anon., 1990a). Information provided on the river age distribution of salmon landed in two communities in SFA 4 indicated that salmon caught in the inner parts of bays had a different age distibution than salmon caught in the outer parts of bays. The Working Group concluded that the proportional harvest method could not be used to estimate the total harvest of Maine-origin salmon in the Newfoundland and Labrador commercial fisheries without a greatly expanded scale sampling program for river age data.

5.4 Evaluate the Effects of the 1990 Quota on the Commercial Salmon Fishery of Newfoundland and Labrador

In 1990, Canada introduced quota management for the Newfoundland and Labrador commercial salmon fisheries. The quotas, in tonnes, were set by Salmon Fishing Area (SFA) (Table 5.4.1, Figure 5.1.1). The fishing season in 1990 began on June 5 and closed in each SFA when the quota was reached, or October 15 as in previous years, whichever came first. The quota was controlled by weekly and daily monitoring of landings by fisheries officers. Quotas were attained in 8 of the 12 SFAs (4, 5, 6, 8, 10, 11, 13 and 14) resulting in closing dates in these fisheries ranging from June 21 to July 25 (Table 5.4.1). The fisheries in SFAs 1-11 and 14 harvest salmon of Canadian and U.S.A. origin (Anon., 1990a,b).

To evaluate the effects of the closures, the Working Group used two approaches, both of which relied on the weekly distribution of landings by SFA for 1984 to 1989. In the first approach, the closure date that occurred in each SFA in 1990 was applied to each SFA and year (1984-1989) to compute the percent reduction in harvest for that year. The minimum, maximum and mean percents were then applied to the 1990 catches to predict the range of catches forgone in 1990. This approach was called the "Fixed Closure Date Predictions". In the second approach, the 1990 quota was applied to the temporal distribution of catches in each SFA for the years 1984 to 1989. The Working Group computed the date on which the quota used in 1990 would have been fulfilled, the landings that would have been caught, and the estimated reduction in the interceptions of Maine-origin salmon. This approach was called the "Fixed Quota Predictions".

5.4.1 Fixed closure date predictions

The effects of the quotas on Canadian stocks were evaluated by examining the seasonal distribution of catches, 1984-89, in SFAs 4, 5, 6, 8, 10, 11, 13, and 14. The minimum and maximum percent of the total catch of a given year caught during a time period similar to that in which the fishery operated before being closed in 1990, varied among SFAs. For small salmon (mostly 1SW), the range varied from 3%-15% for SFA 8 to 35%-89% for SFA 11 (Table 5.4.2a); similarly, the harvests of large salmon during the same period varied from 2%-14% for SFA 8 to 19%-72% of the total landings of large salmon for SFA 11 (Table 5.4.2b). It would appear that, in the SFAs where the quotas limited the catch, the reduction in the catch of 1SW salmon was greater than in the catch of large salmon. This is to be expected since large salmon tend to migrate along the coast earlier than 1SW salmon. It is estimated that the catch of 1SW salmon forgone in SFAs 4, 5, 6, 8, 10, 11, 13, and 14 due to early closure was between 20,000 and 120,000 fish (Table 5.4.3a). The catch of large salmon forgone in these SFAs was between 4,000 and 22,000 fish (Table 5.4.3b). Some salmon affected by the closure may have been caught in commercial fisheries which remained open or in recreational fisheries. No estimates were made of additional spawning escapement because of the unknown composition of the population affected by the closures and possible subsequent exploitation.

The effects of the introduction of quotas on the harvest of 1SW Maine-origin salmon was evaluated by examining the estimates of the weekly distribution of the harvests during 1984-89 in SFAs 4, 5, and 6 (Anon., 1990b). The total average harvest of 1SW Maine-origin salmon, 1984-89, was 159 fish, with a range of 0 to 327 fish (Table 5.4.4). It is apparent that the number of 1SW Maine-origin salmon in SFAs 4-6 is small and there is a high variability, between years, in the percent and numbers of salmon in these SFAs. Also, the temporal variability in the distribution is high. Thus it is difficult to estimate the effects of the quota on 1SW Maine-origin salmon. The effects could range between 0% and 71% reduction in the harvest, equivalent to 0 to 185 fish.

5.4.2 Fixed quota predictions

The Working Group examined the effects that the quotas, introduced in 1990, would have had on landings if the quotas had been in effect in 1984-89. There was no quota limitation in SFA 1, and SFA 12 was closed since 1984. The landings after October 15 in 1984 and 1985 were deducted from each SFA since the fisheries were closed on this date in subsequent years. The date that the fishery would have been closed in each SFA, in each year (1984-89) was determined from cumulative catch curves. The predicted reduction in catch and harvest of 1SW salmon of Maine origin is the landings in each SFA, each year after the predicted closure date up to October 15. The Maine-origin harvest of unknown week of capture was prorated over the weekly harvests.

The predicted closure dates are highly variable among years in some SFAs, particularly SFAs 2, 3, and 4. In years of low abundance, the closure dates would be later and have less effect on reducing the total catch and the mortality of 1SW Maine-origin salmon. Some salmon released from one SFA due to closure of fisheries may be caught in fisheries that are still open. This may lower the predicted reduction in harvests.

The predicted reduction in total catch, 1984-89, ranged from 98 t (13%) to 746 t (53%) with a mean predicted reduction of 321 t (30%) (Table 5.4.5). The total predicted reduction in harvests of 1SW salmon of Maine-origin ranged from 130 to 364 fish with a mean reduction of 228 fish (Table 5.4.5). The range in the predicted percent reduction was 16 to 75%. The predicted percent reduction of 1SW salmon of Maine-origin was greater than the percent reduction of total landings in SFAs 2, 3, and 4 (Table 5.4.6).

The average number of fishing days for each SFA varied between 26 and 60 (Table 5.4.5). The high standard deviation indicates the high variability between SFAs.

The Working Group noted that Maine-origin fish were harvested in 45 of the 72 cells in the year and SFA matrix (6 years and 12 SFAs). Of those 45 cells, reductions in harvest would have occurred in 24 totalling 1,369 fish (57 on average over the 24 cells) or 80.4% of total catch from the SFAs by year. Reduction in harvest over the 1984-1989 period would have averaged 228 fish, ranging between 130 and 364.

The mean predicted reduction in catch and mean reduction in 1SW salmon of Maine-origin by SFA, 1984-89, are provided in Table 5.4.6. The highest predicted reduction in landings occurred in SFAs 2 (70 t) and 3 (48 t); although the highest percentage reduction occurred in SFAs 8 (52%) and 5 (51%). The highest predicted reduction in harvest of 1SW salmon of Maine-origin occurred in SFA 3 (64 fish); whereas, the highest percentage reduction occurred in SFA 5 (46%). It was noted that there was low variability of effort within SFAs over years.

5.5 Description of the Fishery in the USA, 1990

5.5.1 Composition and origin of the catch

The unadjusted rod catch (number of fish killed) by sea age for Maine rivers in 1990 was as follows:

River	Number of Atlantic Salmon				Total 1990	Total 1989
	1SW	2SW	3SW	P.S		
St. Croix	2	(grilse only)			2	7
Dennys	1	31	0	1	33	12
E. Machias	1	46	0	1	48	31
Machias	0	2	0	0	2	16
Pleasant	0	(grilse only)			0	0
Narraguagus	1	49	0	1	51	39
Union	0	0	0	0	0	4
Penobscot	45	348	12	11	416	368
Ducktrap	0	3	0	0	3	0
Sheepscot	1	8	0	0	9	5
Kennebec	1	45	0	0	46	2
Saco	0	16	0	0	16	3
Other (Marine)	0	1	0	0	1	0
Total	52	549	12	14	627	487

Recreational catches of Atlantic salmon were about 30% higher in 1990 than in 1989. The increased catch was attributed to increased effort as evidenced by higher sales of licenses, excellent angling conditions and, in some instances, larger runs of salmon. The number of salmon caught and released in Maine rivers exceeded the number caught and killed.

The catches in USA rivers in 1990 are believed to have been of USA origin.

5.5.2 Exploitation rates

The angling exploitation rate on combined age classes in the Penobscot River for 1990 (13.0%) was the same as for 1989 (12.6%) based upon the fish passage efficiency (.85) and reporting rate (.80) adopted by the Working Group in previous years.

5.6 Status of the USA Stocks

Catches in 1990 in Maine rivers with salmon runs that are primarily of wild origin increased but were 44% below the long-term average.

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

River (Target:MSW Females)	Year Size	Total Run (both sexes)	No. MSW Females
Penobscot River (Target = 3,000)	1985	3,356	1,400
	1986	4,529	1,750
	1987	2,510	858
	1988	2,855	1,002
	1989	3,087	972
	1990	3,341	1,219
Merrimack River (Target = 1,537)	1985	214	105
	1986	103	53
	1987	139	62
	1988	65	33
	1989	84	41
	1990	248	134
Connecticut River (Target = 4,076)	1985	310	153
	1986	318	170
	1987	353	193
	1988	95	59
	1989	109	57
	1990	263	147

Documented (counted or reported) Atlantic salmon returns to rivers in the United States totalled 4,442 in 1990. This figure is 23% greater than that recorded for 1989.

The Working Group noted that the number of wild-origin 1SW and 2SW salmon in the Penobscot River has been increasing in recent years. The percent of wild 2SW salmon in Penobscot River trap counts has increased from less than 1% in 1981 to over 8% in 1990; increases for wild 1SW salmon have been even greater, up to 17% in 1990.

5.7 Description of the Fishery in the Islands of St. Pierre and Miquelon (France)

Catches for the Islands of St. Pierre and Miquelon can be found in Table 2.1.1.

These catches were made by professional fishermen and do not include catches by pleasure boat fishermen. In 1989, there were 13 professional fishermen and 37 licensed pleasure boat fishermen. Tag returns from previous years indicate that salmon of Canadian and US origin have been captured in the commercial fisheries of St. Pierre and Miquelon.

5.8 Quantitative Estimates of the Effects of Fish Farm Escapees

5.8.1 USA

The total number of salmon that escape from net pens in the USA is unknown, since most rivers in the vicinity of net pens do not have fish trapping facilities. About 20% of the 1990 angling catch in the East Machias River was of salmon of aquaculture origin. Small numbers of fish were also documented in two other Maine rivers. The effects of fish farm escapees on USA salmon stocks is unknown, but thought to be low.

5.8.2 Canada

Most of the production in Canada occurs in southern New Brunswick, where aquaculture production is based primarily upon the Saint John River stock, close to the culture area.

The number of salmon that escape from net pens annually is unknown, although it is known that there are occasionally losses of fish due to predators or storm damage. A recent example occurring in 1990, was the loss of about 19,000 large salmon from one cage site in southern New Brunswick. The Working Group noted that the aquaculture facility in Quebec is land-based, therefore, the probability of escape from this facility is very low.

Documentation of aquaculture escapees in Canadian rivers during 1990 was restricted to the Saint John River at the Mactaquac trap facility. A provisional estimate is that 6% (221) of the total MSW returns were of farmed origin. The effects of the escapees on the wild stocks could not be quantified.

5.8.3 Summary

Total annual aquaculture production in the Atlantic Coast of North America now exceeds landings of wild salmon by nearly ten fold. The Working Group recommended that the USA and Canada maintain an inventory of aquaculture production and escapees and continue monitoring for the presence of escapees in rivers and fisheries.

6 HOMEWATER FISHERIES

6.1 North America

Canada

The total salmon landings in Canada in 1990 were 870 t consisting of 405 t and 465 t in the small and large categories, respectively. The commercial fisheries harvested 74% (644 t), and recreational fisheries 22% (191 t), and the native fisheries 4% (35 t). Further information is available in Section 5.1.

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 1990 was 627 (2.4 t) salmon, of which 8% were 1SW and 92% MSW salmon. The total catch was 30% higher than in 1989. More detailed information related to USA homewater fisheries is given in Section 5.5.

6.2 North-East Atlantic

6.2.1 Changes in gear and effort

No changes in regulations affecting fishing gear for salmon in 1990 were reported for France, Ireland, Norway, UK (England and Wales), UK (Northern Ireland) and USSR.

In Iceland, there were changes affecting mesh sizes, length of net and identification of net ownership for sea charr nets reduced illegal salmon fishing. In Sweden, areas closed for fishing were extended around the mouths of a number of small rivers, the area of closure being related to the local geography. Regulations prohibiting the use of natural prawns or shrimps as baits or lures in rod and line fisheries were introduced in four Scottish rivers.

Small reductions in fishing effort were reported for fisheries in seven countries; however, most of these reductions could not be quantified. In Iceland, Ireland and UK, effort was reduced in response to poor catches. In Sweden, an algal bloom made fishing difficult and less efficient, and in USSR fisheries on four rivers were not operated. There was also a widespread feeling that the low price of wild salmon, which is probably linked to the availability of farmed fish, was resulting in a gradual decline in netting effort in many areas.

6.2.2 Nominal catches of salmon in homewaters

Total nominal catches of salmon by country in all homewater fisheries in the North-East Atlantic area for 1980-1990 are given in Tables 2.1.1 and 2.1.2. Catches of ranched fish and fish farm escapees are included in these statistics. Data for 1990 for Ireland and UK (Scotland) are incomplete.

The updated total catch for 1989 is lower than for any previous year in the time series. Figures for 1990 are provisional, but it is likely that the total catch will show a substantial decrease from 1989. Total landings are well below the 5- and 10-year averages and show decreases for most countries, although catches for UK (England and Wales), France, and Sweden were similar to 1989.

In Iceland, catches were well above the 5- and 10-year average, reflecting increases in the contribution of ranched salmon to the fishery, but returns to rod and net fisheries in the rivers were poor. The reduction in fishing effort due to the new management measures in Norway resulted in reduced catches for a second year. The decrease in Scottish catches over recent years is partly due to a substantial reduction in fishing effort.

Reported national salmon catches for several North-East Atlantic countries by sea age are summarised in Table 2.2.1. In several countries there was a reduction in the proportion of 1SW fish in the catch. In UK (England and Wales), 1SW fish accounted for 65% of the catch, compared to 69% in 1989, while Scotland showed a reduction from 63% to 47%, and France from 51% to 43%. In Scotland there were reports of smaller-than-normal 1SW fish and some of these fish were said to be in poor condition. In Sweden, however, 1SW fish accounted for 70% of the catch in 1990, compared to 41% in 1989. In Norway, 1SW fish accounted for 73% of the catch in 1989 and this declined to 68% in 1990. In the USSR, 73% of the catch in both 1989 and 1990 was 1SW salmon. This was 7% greater than for 1987/88.

6.2.3 Exploitation rates

The Working Group examined updated estimates of exploitation rates using the run reconstruction model for tagging data from various monitored rivers in the North-East Atlantic. These data are summarised in Table 6.2.1 along with additional data from Iceland and UK (England and Wales).

Exploitation rates in Ireland, Norway, Sweden and UK (Northern Ireland) were considerably lower than the averages for recent years, while estimates for one stock in Iceland and two in UK (England) were within the ranges previously observed.

Exploitation on the River Burishoole (Ireland) and River Bush (UK (Northern Ireland) stocks in coastal fisheries decreased in 1990. This is partly attributed to reduced effort (see Section 6.2.1).

The regulatory measures introduced in Norway in 1989 have resulted in a considerable decrease in the exploitation rate on Norwegian stocks. The effects of these management measures are discussed in Section 6.2.6.

In the USSR, exploitation rates on most rivers were about 50% except for the Kola river, where all fisheries were removed, and the Keret and Varzuga rivers, where it was 25-30%.

6.2.4 Status of stocks

There are numerous factors affecting freshwater and marine production of salmon stocks. Low escapement, acid rain, diseases and parasites as well as environmental and climatic conditions can all affect freshwater productivity. Natural variations in oceanic conditions can have great influence on marine survival, especially in northern latitudes.

As no targets for stock production were available, the Working Group considered that it could only assess the status of particular stocks on the basis of changes in production or survival at different life stages. The Working Group, therefore, compiled available time series of counts (or estimates) of smolt and adult runs and estimates of juvenile production (Tables 6.2.2 and 6.2.3). Estimates of marine survival (smolt to return to freshwater) were also compiled on the basis of returns of tagged smolts to freshwater as 1SW and 2SW fish (Tables 6.2.4 and 6.2.5).

Counts and estimates of wild smolt runs were provided for five stocks (Table 6.2.2) as indicators of freshwater production. Although these may not be representative of groups of stocks they might indicate trends in freshwater production. However, in most stocks, there have been irregular fluctuations in smolt production with no clear trends between years. Smolt production in these rivers has varied by a factor of between 2 and 7 over the past 10 years, with variation being greater in the smaller stocks. There was no evidence of common patterns between regions.

Adult salmon counts for seven rivers in the North-East Atlantic are shown in Table 6.2.3. Runs have been very variable in all rivers, but there are no apparent trends during this period and no clear common patterns between systems.

Wild and hatchery smolts are tagged and released on various rivers in the North-East Atlantic area. Estimates of marine survival for wild smolts from six such river stocks are shown in Table 6.2.4, and returns of hatchery smolts into freshwater in five rivers are shown in Table 6.2.5. These data show considerable variation between years, but the marine survival of the 1983 smolt year class appears to have been poor for most stocks examined, while survival of the 1987 smolt year class appears to have been good in many areas. The following additional observations were made:

Iceland: Returns of 1SW salmon into the River Ellidaar during the 1989 and 1990 fishing seasons have averaged 10%. Comparable figures for the Ellidaar in the 1976 season exceeded 20% (Isaksson, Rasch and Poe, 1978). Return figures for the north and east coast stocks, such as Rivers Midfjardara and Vesturdalsa (Table 6.2.4) have been much lower (0.4-4.6%), indicating a problem in estuarine or marine survival.

Marine survival of Icelandic salmon stocks has been depressed in the 1989 and 1990 seasons, particularly in the north coast stocks. Similar low periods were observed in the 1965-70 and 1984-85 seasons. Icelandic marine stocks, such as capelin and cod, seem to have been affected by adverse marine conditions which are the result of an unusually high influx of cold and less saline seawater from the polar seas.

The data from Kollafjordur demonstrate clearly the low survival of hatchery smolts in the 1983 and 1988 release years, and similar results were obtained for the 1989 releases. A substantial decrease in the size of 1SW salmon and an increase in the 2SW contribution was also noted in those years, demonstrating effects on growth and maturity.

Ireland: Returns of 1SW salmon to the Irish coast from the 1987 and 1988 smolt years were very high but were seriously depressed for the 1989 smolts.

Norway: Returns of 1SW salmon into the River Imsa trap have been considerably higher for the 1988 and 1989 smolt years than recorded prior to 1987, demonstrating the continued effect of the 1989 management measures.

UK (Northern Ireland): The high survival of 1SW salmon from the 1987 smolt migration was followed by a record low survival to the River Bush catchment from 1988 smolt migration. This was possibly due to low river flows, which prevented fish from entering freshwater. In 1990, the survival of 1SW salmon to the R. Bush was 9.6%. This is greater than the average (7.8%) for the period 1974-1989 and reflects the low catch in homewaters.

UK (Scotland): Estimates of sea survival of North Esk salmon are not available for all years as it has not been possible to make smolt production estimates for every year. Survival to 1SW for 1989 smolts (2.1%) was the lowest in the time series and less than 50% of that recorded for 1987 smolts. Survival to 2SW and 3SW has remained similar throughout the time series.

USSR: Spawning escapement in 1990 is summarised in the text table below:

Rivers	No. of spawners	Difference from 1989
Barents Sea rivers	10,874	+10%
White Sea rivers	48,977	-20%
Pechora river	60,000 (estimate)	(50% less than in late 1970s)

6.2.5 Effects of fish farm escapees on stocks and catches in homewaters

Salmon escape from fish farms at all life stages. The survival of such fish is highly dependent on their size and the time of their escape. Experiments in Norway have shown that there is a seasonal variation in survival. Survival of salmon which escaped as smolts during the spring was much higher than for those escaping from the same locality during the rest of the year. Older fish escaping during the summer seem to enter rivers at random. Smolts and post-smolts escaping from marine sites return as adults to the area from which they escaped and enter local rivers to spawn. However, salmon which escape during February and March in their first sea-year stray more and farther than fish escaping during the rest of the year. It has been observed in both Norway and Scotland that farmed salmon spawn in freshwater, although preliminary results suggest that their spawning success, especially the males, is low compared with wild fish.

Farmed salmon have no home rivers and may not be motivated to enter a particular river before sexual maturation forces them. The proportion of reared salmon in the marine catches increased significantly with the number of smolts stocked into cages in the same area during the previous year (Figure 6.2.1). Furthermore, there was negative correlation between the mean distance to the nearest 5 and 10 fish farms and the proportion of reared fish in the catch (Figure 6.2.2).

Estimates of the incidence of farmed fish in catches and spawning stock in 1990 are summarised in Table 6.2.6. The greatest proportions of farm escapees were found in catches in Norway, Scotland and Iceland; in Iceland there were also substantial numbers of ranched fish. Negligible numbers of farm escapees were reported in catches from other countries.

Estimates of the proportion of ranched and farmed salmon in angling catches were obtained for five rivers in southwestern Iceland. The fish were classified using scale pattern analysis. In total, the estimated proportion of farmed fish in these rivers varied between 9.6% and 25.2% whereas the proportion of ranched fish was estimated at between 16.1% and 36.1%. The proportion of both ranched and farmed salmon in the catches tended to increase towards the end of the fishing season.

The rapid increase in the fish farming industry in Norway has resulted in large numbers of farmed fish escaping from the cages. These fish appear in marine and freshwater fisheries and in spawning stocks in freshwater. In the marine fisheries, catches have been sampled over the entire fishing season while in rivers, point estimates have been obtained from samples taken during a limited time period and in parts of the rivers. Samples were obtained by angling and netting both within and outwith the angling season. The estimates of farmed fish were highly variable among sites. However, catches in outer coastal fisheries contained a higher proportion of farmed fish during the fishing season than did catches at fisheries in fjord areas (Table 6.2.6). The incidence of farmed fish was much lower in samples taken in freshwater during the angling season than in samples taken during the autumn after the angling season had finished. The reason for this is that farmed fish enter the fjords and the rivers later in the season than wild fish.

The incidences of abnormal scales in samples collected in Scottish net fisheries have been recorded since 1981. These show an increasing number of reared fish in the north and north-west coast samples in recent years.

6.2.6 Effects of regulations introduced in Norwegian salmon fisheries in 1989

Full details of the management measures introduced in Norway in 1989 are given in Anon. (1990c), Appendices 2 and 3. The most significant of these measures was the total ban on drift netting. Additional measures restricted effort in other net fisheries, especially those using bend nets, while salmon fishing by all methods was banned in 74 out of a total of approximately 500 rivers.

The impact of the measures on catches in Norwegian home waters in 1989 and 1990 is shown in Table 6.2.7. In the period 1982-1988, the total nominal catch of salmon fluctuated between 1,076 and 1,623 t. It decreased to 905 t in 1989 and 908 t in 1990, probably as a result of the new management measures. In 1989 and 1990, the marine catches of salmon were 488 and 504 t, respectively, which is much lower than for 1982-1988, when this catch varied between 841 t 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 marine homewater fisheries. The additional regulation of these fisheries has probably resulted in a substantial increase in freshwater escapement as suggested by increased catches in freshwater. In 1989 and 1990, freshwater catch increased by 35% over the average catch for 1982-88 and accounted for 45% of the total nominal catch compared to 21% in the period 1982-88. 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, because drift net exploitation on this stock has always been low.

The salmon fishery on the west coast of Norway intercepts stocks from the USSR, Finland and the Swedish west coast on their return to their home rivers. Exploitation on 1SW fish tagged as smolts on the River Lagan (Sweden) was lower in 1989 and 1990 (average 2%) than in 1985-88 (average 7%) (Table 6.2.8). This suggests that the management measures introduced in Norway in 1989 also affected Swedish west coast stocks.

The frequency of net-marked salmon entering a river may also give information about changes in netting effort on the migration route. The proportion of net-marked salmon has been recorded in several Norwegian rivers since 1978. In most of these rivers sampling took place from 1978 to 1986 and was then re-established in 1990. Table 6.2.9 shows unweighted means of the proportion of net-marked salmon in angling catches from 10 rivers in the period before the extensive homewater regulations were introduced, and the proportion of net-marked salmon in the same rivers in 1990. In all rivers, the proportion of net-marked salmon recorded in 1990 was much lower than the unweighted means during the period 1978-88. The proportion of net-marked salmon in 1990 was within the range from the earlier years in only two rivers. The reduced proportion of net-marked fish may be accounted for by the management measures introduced in the Norwegian home water fishery in 1989.

7 ADVANCES IN MODELLING APPROACHES TO DESCRIBE FISHERY INTERACTIONS AND EFFECTS OF MANAGEMENT

7.1 Index Rivers

The Working Group was asked to provide a definition of "index rivers" and provide comments on how they could be used to assess the status of stocks.

The term "index river" has previously been used (e.g., Anon., 1985b) to describe a small number of rivers in the North Atlantic that are monitored in detail; patterns of change in the salmon stocks in these rivers are not necessarily considered to be representative of larger groups of stocks. The Working Group has also defined the theoretical concept of 'indicator stocks or rivers' (Anon., 1987a) which may be representative of a larger region or of a number of rivers.

The Working Group feels that there is now confusion arising because the terms are very similar and suggests that "index rivers" should be referred to as "monitored rivers". The term "indicator river" should only be used for rivers where changes in some measurable parameter, such as catch, are indicative of the status of stocks in other rivers.

"Monitored rivers" provide indices of the status of the stocks in those rivers, such as marine survival or survival back to the river. They can also provide estimates of exploitation. Changes in such indices can be compared for several "monitored rivers" to investigate changes in the status of stocks throughout large parts of the North Atlantic.

"Indicator rivers" provide a long time series of data describing some parameter such as catch or target egg deposition. It is suggested that these rivers could be related to other rivers particularly in the immediate area and be used as a barometer of the status of the stocks. At present the Working Group is aware of no rivers that can be used as indicators.

7.2 Estimation of Maturation Rates in Newfoundland-Labrador Fishery

The Working Group reviewed three techniques to determine the state of maturity of 1SW salmon caught in the Newfoundland commercial fishery. This fishery exploits 1SW salmon that would have matured and spawned in the year in which they were caught and immature salmon that would not have matured until at least one year following the fishery. The proportion of mature 1SW salmon caught in the commercial fishery in Newfoundland and Labrador is an important parameter in models designed to assess the harvests of non-Newfoundland origin salmon and in models recently developed to assess the Greenland fishery.

The three techniques examined for estimating the state of maturity were: fork length distributions, gonadal development, and discriminant analysis of Gonadal Somatic Index (GSI). The usefulness of the fork length and gonadal development techniques appeared limited by the the lack of bimodality in the fork length distributions and high level of misclassified salmon from gonadal development analysis (Anon., 1991a).

The discrimination technique used GSIs from presumed-immature salmon caught in the Labrador Sea in September and October and from maturing salmon caught in the Conne River estuary as a database. The methodology and data used in this technique are described in Anon. (1991a). The discriminant analysis was used to determine the maturity of salmon sampled in the commercial fishery at Twillingate (SFA 4, Newfoundland) and Square Islands (SFA 2, Labrador). The weekly maturation rates at Twillingate in 1987 were weighted to the weekly catches. The catch-weighted fractions immature were 15.5% for males and 28.6% for females for samples collected in 1987 at Twillingate.

River age distributions of mature and immature salmon were plotted to show the maturation rates estimated for Twillingate and Square Islands. Details of this investigation are given in Anon. (1991a). All of the river age distributions of immature salmon are significantly different from the maturing salmon (Figures 7.2.1 and 7.2.2). This test of GSI discriminant technique supports its utility, but the high proportion of river age 1 and 2 fish classified as maturing (Figure 7.2.2) was disturbing because most of these fish are thought to be destined for rivers south of Newfoundland and, therefore, classed as immature.

The Working Group concluded that of the three techniques used to estimate maturation rates in the Newfoundland and Labrador fishery, the discriminant model was best. This technique indicated that the fractions of immmature salmon range from 0 to 30% in the fisheries sampled. However, the Working Group was hesitant to use the rates generated from this analysis because:

1) The samples came from only two sites and estimation of maturation rates for the entire fishery in Newfoundland and Labrador will require a much more extensive sampling programme than that which is currently, or ever likely to be,conducted.

2) All maturation rates should be weighted by weekly catches.

3) The discriminant technique, by substituting GSIs of samples from the Labrador Sea for samples of known immature fish at 13-14 months of age, assumes that relative somatic growth and gonadal growth rates are similar from 13 months to 16 months of age.

4) GSIs have been shown to be significantly different between different stocks.

The Working Group identified the following data requirements:

1) It is recommended that samples be obtained to test the hypothesis of equivalent rates of gonadal and somatic growth.

2) The discriminant technique assumes that no between-stock differences or timing differences in GSIs exist and that Conne River estuary and Labrador Sea samples are representative of maturing and immature salmon, respectively. It is recommended that this assumption should be tested with the Miramichi River and Norwegian aquaculture data.

3) Both analyses assume that there are no timing differences in GSI and maturity over the weeks of the fishery. It is recommended that future analyses should include known maturity samples collected over time and that maturation rates be catch- weighted.

7.3 Regional Run Reconstruction Models

7.3.1 Introduction

Single Stock Models

In 1989 the Working Group first addressed the utility of run reconstruction models as an aid to understanding the dynamics of Atlantic salmon in the North Atlantic (Anon., 1989a). Since then, models have been developed for a variety of river systems with varying degrees of completeness. Run reconstruction models have been applied to extensive time series of data on the salmon rivers in Maine and the Saint John River in New Brunswick. Estimates of exploitation have also been developed for numerous European rivers including the Drammen, Imsa (Norway), North Esk (Scotland), Bush (Northern Ireland), Burrishoole (Ireland) and the Lagan (Sweden). These applications have illustrated the utility of single river models in defining basic interactions among fisheries, interannual patterns of exploitation rates, migratory patterns of salmon, and comparisons for hatchery and wild fish. The models allow interpretation of tag recoveries and the estimation of exploitation rates on components of the extant stocks. Time series of model outputs can serve as indicators of general stock abundance and comparisons of values among stocks may indicate patterns of exploitation in fisheries.

A limitation of single stock models is that they do not provide estimates of fishery area exploitation rates. When fisheries exist simultaneously in other regions it is necessary to assume the fraction of the stock present in each fishery (p) in order to derive area-specific exploitation rates. If a large fraction of the population exists outside the fisheries then it is necessary to determine the stock fraction unaccounted for (FU) in the fishery.

Regional and Continental Models

Regional models consist of two or more run reconstruction models for stocks whose biological characteristics are sufficiently similar to allow description of a broader geographical area. The object of such an exercise is to use the similar behavior of the stocks to estimate, rather than assume, key parameters. For example, a regional model for the Saint John and Maine rivers allowed estimation of exploitation rates in Greenland and the fractions of each stock migrating from the fisheries of Greenland and Newfoundland (Anon., 1990a). Unfortunately few data sets are available to permit extensive comparisons over time.

Continental models can be developed either as a collection of individual stocks, each appropriately weighted, or as total, age-specific catches of a continent.

The first approach can be called a "bottom-up" approach; the second can be called a "top-down" approach. The "bottom-up" approach is more mechanistic since it weights individual stocks to assemble a continental stock. Scaling individual stocks by homewater catches is difficult, particularly if the age composition of the monitored river differs sharply from the nominal catch. Relative homogeneity of rivers and stocks within an area is a pre-requisite for this approach. The "bottom-up" approach further requires adjustments to exploitation rates to allow for calibration of model predictions with observed catches in interception fisheries and elsewhere. As this type of adjustment is arbitrary, the need for extensive calibration reduces confidence in the model structure.

"Top-down" approaches are those based on the age or size structure of catches in fisheries. Numbers of fish surviving fisheries are exploited in subsequent fisheries and comparisons of predicted and observed spawning escapements can be made. Deductions from the models apply to broad geographical regions but offer no insights into specific stocks. "Top-down" models allow utilization of existing catch data, but the issues of the reliability of nominal landings, estimates of river and sea-age composition and difficulties in distinguishing maturing and non-maturing fish need to be addressed. A highly simplified continental model is presented in Anon. (1991a).

The "top-down" and "bottom-up" approaches are complementary and provide valuable checks on the validity of model assumptions. In the following sections the Working Group examined the applicability of run reconstruction models to the North American and European stocks. First there is a statistical analysis of general relationships among 1SW salmon in West Greenland and the Faroes compared to catches of 2SW salmon in the fisheries of Canada and Europe (Section 7.3.2). Results of these analyses and the parameter estimates derived in Section 7.2 are then incorporated into a run reconstruction model to provide estimates of exploitation in West Greenland for the 1986 and 1989 fisheries (Section 7.3.3). Model predictions are compared with observed values to constrain the estimates of exploitation to feasible ranges. An initial attempt to develop a "bottom-up" model for European stocks is presented in Section 7.3.4. Finally, Section 7.3.5 summarizes the overall section and defines objectives for future modelling efforts.

7.3.2 Catch trends in fisheries and homewaters

The proportions of reported catches of 2SW (MSW) salmon in fisheries at Greenland, Faroes, and in homewater fisheries in North America and Europe were examined (Tables 7.3.1., 7.3.2 and Figure 7.3.1). The proportions were calculated based on reported catch statistics and the proportions of North American- and European-origin salmon caught at West Greenland. Only the MSW salmon component of the catches was used and where no MSW salmon component was available it was estimated as the average of available data. Apportionment of the catch into age classes was only necessary for the European catch and it never exceeded 25% of the total catch in any year. It should be noted that these calculations do not imply that all European and North American MSW salmon go to Greenland.

The West Greenland catch that is of North American origin is on average 43% (1981-1989) of the total landed MSW catch of North American salmon. The corresponding figure for salmon of European-origin is 17% (1982-1989). The difference in these proportions suggests that the proportion of North American salmon available to the Greenland fishery appears to be about twice as high as the proportion of European salmon available to the same fishery. This assumes similar levels of exploitation on both North American and European stocks in both homewaters and at West Greenland. The catch at Faroes has been 20% of all reported MSW catches of European origin. The low catches at West Greenland in 1983 and 1984 is reflected by low total catch of the cohort from both North America and Europe. These figures provide a useful check on exploitation estimates and support the range of estimated exploitation rates in the West Greenland fishery (see Section 3.3).

Trends in MSW fisheries in homewaters for Canada and Scotland were compared with 1SW catches in Greenland the year before (correlations were with salmon from the same smolt class).

Homewater catch	Correlated with	Greenland catch	Spearman correlation
Labrador large		N.A., 1SW 4 river years or older	0.74
Canadian large		N.A., 1SW 3 river years or younger	0.67
Scottish MSW		European 1SW total	0.74

(See Figures 7.3.2-7.3.4 for plots of catch against time/year of the Greenland fishery). All correlations are significant ($P<0.05$).

The significant relationships between the Labrador, Canadian, and Scottish MSW catches and their corresponding components at Greenland suggest that as abundance of a smolt class up to recruitment to the fishery increases, the catches of the various Greenland components and homewater catches will also increase. In addition, as the abundance of smolt classes decreases, the catches in Greenland and homewaters will also decrease. Further, the above relationships are also consistent with initiatives to reduce the overall exploitation on MSW stocks by reducing catches at Greenland and in homewaters in Canada and Scotland. The declining trend in catches in Labrador of both small and large salmon and the corresponding component at Greenland of river age 4 and older 1SW salmon must be related to declining population sizes rather than management regimes, as management changes in Canada were not expected to substantially reduce the catch in Labrador. These relationships do not imply that catches of the various components in Greenland have a direct effect on homewater catches, i.e. there is no cause and effect.

7.3.3 Constraints on exploitation rates in West Greenland

A strong positive correlation between the catches of 1SW salmon in Greenland and catches of 2SW salmon in Canada was demonstrated in Section 7.3.2. Such a relationship cannot be used to estimate the fishery area exploitation rate in Greenland without applying the general principles of run reconstruction. Run reconstruction techniques cannot provide statistical estimates of population parameters. Models can indicate, however, feasible ranges of parameters.

To illustrate the potential applicability of run reconstruction to large groups of stocks, the Working Group examined the West Greenland fishery and its relationship to the landings in Canada for two recent catch years. The exercise is considered exploratory but indicative of how run reconstruction models synthesize available information on catches, runs, and ancillary parameters.

Model Derivation

Define the following variables:

T2 = Total population size of 2SW salmon prior to fishery in home waters in year i+1

Hw2 = Harvest of 2SW salmon in home waters in year i+1

Hg1 = Harvest of 1SW salmon in Greenland in year i

p = fraction of extant population available to fishery in Canada

FU = fraction of population not available to any fishery (e.g., Labrador Sea or Irminger Sea)

1- p - FU = fraction of extant population available to fishery in Greenland in year i

u = exploitation rate in home waters

R2 = total 2SW run to rivers in homewaters in year i+1

M = Natural mortality rate (.12/yr)

t1 = time between the midpoint of the homewater fishery and run

t2 = time between the midpoint of Greenland fishery and homewaters

Define S1=exp(-M t1) as the survival rates of 2SW salmon between the homewater fishery and the return to river and S2=exp(-M t2) as the survival rate of fish between the West Greenland fishery and the homewater fishery.

Applying the general principles of run reconstruction models, the harvest of 2SW salmon in homewaters is defined as

(1) Hw2 = u*T2 (Note: T2 = Hw2/u)

and the 2SW run to the river is

(2) R2 = (1-u)*T2* S1.

Substituting (1) into (2) gives

(3) R2 = (1-u)*(Hw2/u)*S1

The 2SW salmon landed in Canada in year i+1 were either in Canada, Greenland or elsewhere (i.e., unexploited) in year i. If p is the fraction of the 2SW salmon that was in Canada in year i and FU is the fraction elsewhere, then the population in Greenland immediately after the fishery is

(4) Tga1 = (1-p-FU)*T2 / S2

Assuming a type I fishery (Ricker, 1975) the population in Greenland before the fishery is

(5) Tgb1 = Tga1 + Hg1

and the fishery area exploitation rate is

(6) $$Eg = Hg1 / Tgb1$$

Substituting the above equations into Eq (6) gives

(7) $$\begin{aligned} Eg &= Hg1 / (Tga1 + Hg1) \\ &= Hg1 / ((1-p-FU)*(T2 / S2) + Hg1) \\ &= Hg1 / ((1-p-FU)*((Hw2/u)/S2) + Hg1) \end{aligned}$$

The cohort of 2SW salmon alive prior to the homewater fishery in year i+1 consists of the survivors of the non-maturing fraction of the population in year i. The model can be used to estimate the number of non-maturing fish in the homewater fishery as follows:

Let Tca1 be the population of non-maturing 1SW salmon alive after the Canadian fishery in year i. Using the relationships above,

Tca is defined as:

(8) $$Tca1 = p*(T2 / S2)$$

The number alive before the fishery is

(9) $$Tcb1 = Tca1 /(1 - u)$$

so that the expected harvest of non-maturing 1SW salmon in year i is defined as

(10) $$Hw1nm = u*Tca1 / (1-u)$$

The above equations were used to define a range of plausible fishery area exploitation rates for North American stocks present in the West Greenland fishery.

Constraints

The actual fraction of the population present in an area is unknown and the fishery area exploitation rate in homewater fisheries is also uncertain. However the values of these unknown parameters have implications for measurable variables such as total MSW runs to rivers (Eq. 3) and the numbers of non-maturing salmon in the Canadian fishery (Eq. 10). The value of the run reconstruction model is that it shows the implications explicitly. By applying information on what is known about the population, certain combinations of the unknown parameter values can be excluded from further consideration.

Minimum estimates of 2SW runs to Canadian rivers were estimated by summing the spawning runs reported for some rivers, the total recreational catch and the numbers of salmon counted in traps and at counting fences. The uncertainty in the range of these values led to low and high estimates, R2lo and R2hi, respectively.

The estimated number of non-maturing salmon present in the Canadian commercial landings was estimated by restricting the landings only to those SFAs in which non-maturing 1SW salmon (NM_1SW) are believed present in sizable numbers. Therefore, only catches from Labrador and SFAs 3, 4, and 5 were included. The number of NM_1SW salmon depends on the fraction of 1SW salmon present in the "large" market category (q) and the fraction of 1SW salmon that are immature (f_imm). If Hw_S is the number of "small" salmon caught and Hw_L is the number of "large" salmon caught, then

(11) $NM\_1SW = f\_imm*(Hw\_S + q\ Hw\_L)$.

Note that Eq. (11) assumes that all "small" salmon are 1SW fish. Estimates of fractions of non-maturing salmon present in the Labrador-Newfoundland catch are presented in Section 7.2. The reported estimates of the immature fraction have not yet been developed for the entire fishery so the actual fraction may be lower or higher. To investigate this possibility, estimates of NM_1SW were computed for a range of f_imm from 0.1 to 0.2. Similarly, the sea-age composition of the "large" market category is not known with precision. An assumed plausible range of q between 0.1 and 0.2 was examined. A summary of data inputs and model constraints is provided in Table 7.3.3.

Model Analyses

To illustrate the utility of the model, runs were reconstructed for the 1989 and 1986 fishery years in Greenland. These years reflected "poor" and "good" fisheries since 1983. Estimated fishery area exploitation rates in West Greenland were computed for a range of fractions of the population present at Greenland (i.e., 1-P-FU) and exploitation rates (u) on large salmon in homewaters. Predicted numbers of 2SW returns in year i+1 and non-maturing 1SW catches were then compared to actual estimates of these variables.

Application of the constraints to fishery area exploitation estimates is shown conceptually in Figure 7.3.5. The estimates of exploitation in West Greenland (Eg, Eq. 7) can be constrained in three ways. First the predicted 2SW run (R2, Eq. 3) cannot be outside the range of observed values {R2lo, R2hi}. Second, the feasible values of Eg must correspond to the range of values of 1-p-FU and u that generate estimates of NM_1SW near the observed value of NM_1SW. Finally, the fraction of the population in West Greenland cannot be less than zero. In other words, one cannot simultaneously postulate that p=0.9 and FU=0.3 (i.e., 1 - 0.9 -0.3 = -0.2). The range of FU values examined was 0.0 to 0.3. The effects of these constraints are illustrated schematically in Figure 7.3.5.

Application of the model to the 1986 and 1989 fisheries is illustrated in Tables 7.3.4 to 7.3.5. For both exercises the assumed fraction of the 1SW population unavailable (FU) to either fishery was set at 15% and the proportion of 1SW salmon in the "large" market category was assumed to be 0.1. The vertical lines in the Tables 7.3.4A and 7.3.5A illustrate the constraints imposed by the 2SW run estimates (R2). The horizontal line in these tables illustrates the consequences of the FU parameter. Values below the horizontal line are infeasible because the fraction of the population returning from Greenland cannot exceed 0.85. Note that this constraint also implies that no fish would have survived the fishery in Canada, an equally unlikely conclusion. Finally, the problem is further bounded by the deduced range of non-maturing 1SW salmon in the Canadian fishery during the year of the Greenland fishery. For 1986 the range was 21.3 to 46.6 thousand fish (Table 7.3.4C); for 1989 the range was 16.8 to 36.7 thousand fish (Table 7.3.5C). Applying these constraints to the West Greenland fisheries implies fishery area exploitation rates in Greenland between 0.41 and 0.46 in 1986 (Table 7.3.4A) and between 0.4 and 0.7 in 1989 (Table 7.3.5A).

Uncertainty in the estimated fraction of non-maturing salmon in Canada has a large effect on the estimated range of fishery area exploitation rates. Lower estimates of fractions of immature salmon present in the Canadian fishery imply smaller predicted numbers of non-maturing 1SW salmon (See Tables 7.3.4B and 7.3.5B). Applying this constraint to the table of exploitation rates (See Tables 7.3.4A and 7.3.5A) implies lower estimated rates of exploitation in West Greenland. Greater assumed levels of FU imply increases in the minimum feasible level of fishery area exploitation in West Greenland.

A summary of the estimated ranges of fishery area exploitation in West Greenland for varying model assumptions are presented in Table 7.3.6. These values are approximate because resolution is dictated by the intervals of p and u used in the spreadsheet (i.e., intervals of 0.1 for each). Future work should be done to analytically derive the range of exploitation rates implied by the set of constraints. Examination of longer time series of data, particularly for periods prior to major fishery restrictions in Greenland and Canada, is warranted. Such analyses might detect the effects of management measures, trends in recruitment and patterns of exploitation.

The derived estimates of fishery area exploitation rates apply collectively to most of the North American stocks that frequent the West Greenland area. To the extent that different stocks have different migration patterns, the period of residence within the fishery would determine the actual rate of exploitation on that stock. Fish that reside within the fishery for longer periods would have greater exploitation rates. The range of fishery area exploitation rates derived for Maine-origin salmon (Section 3.3.2) are higher than those derived for the total complex of North American stocks. This may mean that Maine-origin salmon are more vulnerable to the West Greenland fishery than the "average" for North American stocks.

7.3.4 Prediction of national contributions, use of indicator stock data

The Working Group used the "bottom-up" approach to develop a European continental model. The Group considered ways in which data from monitored rivers and other tagging experiments could be used to estimate the contribution of national stocks to fisheries outside national homewaters.

In the simplest situation, a monitored river would be entirely representative of the national stock. All the results of tagging experiments on the river could thus be scaled up by the same factor (f):

where 'f' = home water net catch/number of tags recovered in the net fishery.

It was recognised, however, that MSW/1SW ratios for monitored stocks would often be significantly different from the ratios for national stocks. Nevertheless, it was considered reasonable to assume that 1SW fish from a monitored river would behave in a similar way to other 1SW fish from the same region or country, and that the same would be true for MSW fish. The results of tagging experiments on the monitored river could, therefore, be scaled up if age groups were treated separately. In addition, a correction factor could be introduced if data were available to suggest that exploitation rates on the monitored stock were different from those for national stocks.

This approach was developed into a revised version of the spreadsheet model used by the Working Group in 1990 (Anon., 1990a). In this model, the basic input data are the tag recapture data required for the run reconstruction model and the catch in numbers by sea age in the homewater net fisheries. The run reconstruction model provides estimates of the exploitation rates on each sea age class in each fishery. These estimates are then used to scale the tag data to the national stock level using the following formulae.

Fishery	Sea age	Exp. rate	Catch of national stock
Homewater	1	E_{h1}	C_{h1})
			) input data
Homewater	2	E_{h2}	C_{h2})
Other Interception	1	E_{i1}	$C_{i1} = (C_{h1}/E_{h1}*f1)*Exp^{Mt}*E_{i1}*g1$
Other Interception	2	E_{i2}	$C_{i2} = (C_{h2}/E_{h2};*f2)*Exp^{Mt}*E_{i2}*g2$
W Greenland	1	E_{w1}	$C_{w1} = (C_{i1}/E_{i1}*g1)*Exp^{Mt}*E_{w1}$
NE Atlantic	1	E_{n1}	$C_{n1}=[(C_{w1}/E_{w1})*Exp^{Mt}+(C_{i1}/E_{i1}*g1)*Exp^{Mt}]*E_{n1}$
NE Atlantic	2	E_{n2}	$C_{n2}=[(C_{w2}/E_{w2})*Exp^{Mt}+(C_{i2}/E_{i2}*g2)*Exp^{Mt}]*E_{n2}$

where -

suffixes 'h','i','w' and 'n' refer to homewater, other interceptions, West Greenland and NE Atlantic fisheries, respectively;

suffixes '1' and '2' refer to sea age groups 1SW and 2SW, respectively;

't' in each case is the time in months between the fishery and the previous fishery affecting the year class (as used in the run reconstruction model);

'M' is the instantaneous rate of natural mortality for salmon after the first sea year (taken as 0.01 per month).

'f1' and 'f2' are correction factors for the exploitation rates on 1SW and MSW fish in homewaters where the exploitation rate on national stocks is known or thought to be different from that on the monitored stock.

'g1' and 'g2' are similar correction factors for exploitation rates in the other interception fisheries.

National representatives prepared an average data set based on smolt tagging carried out in 1985, 1986, 1987. Data for France and Finland were estimated on the basis of information available from neighbouring countries. As the numbers of 3SW and older salmon were generally very small, data for all MSW salmon were combined in this exercise. The model provided an estimate of the numbers of salmon from each country caught in the Faroes and West Greenland fisheries. The Working Group considered it inappropriate, however, to publish these preliminary results at this time. The total catches of European fish in the Faroes and West Greenland fisheries are estimated to be as follows:

	Predicted		Observed	
	1SW	MSW	1SW	MSW
Faroes	4 782	101 435	11 836[1]	91 741
Greenland	119 779	-	145 152	

[1] Includes 10% discard rate.

The Working Group was encouraged that the total catches for the Faroes and West Greenland fisheries derived from the model were fairly close to the recorded catches. However, the fact that most of the Faroes catch appears to come from Norway and USSR and most of the Greenland catch from UK and Ireland means that the overall result is very much dependent upon the reliability of the tagging data from these countries.

The Working Group emphasised that this was a very preliminary assessment and noted that some of the data used in the national models were very limited. In particular, it was noted that the model was very sensitive to the parameters f and g which effectively have a direct scaling effect on the estimated contributions of national stocks to the high seas fisheries. Scaling factors for external tag recoveries, which are generally only roughly estimated or guessed, can also have a very significant effect on the results.

The Working Group recommended that further attempts be made to refine each national model before 1992. Further, it was agreed that all members should review their tagging experiments and consider what additional data were required to improve the reliability of their national model.

7.3.5 Summary

Cohort analyses of catches in the West Greenland and Faroes fisheries demonstrated remarkably consistent relationships with subsequent catches in Canada and Scotland. More refined analyses may allow separation of management effects from apparent downward temporal trends in recruitment.

The problems of developing models applicable to continents were summarized as follows:

1) The reliability of catch data vary among countries.

2) The reliability of catch age compositions depends on fishery monitoring programmes.

3) Migrations vary over years with respect to pathways and the fraction of the stock in a given area (e.g., climatic effects).

4) CPUE within a season is difficult to interpret because the population is open to migration.

5) CPUE is a function of catch and perceived abundance.

In the North-East Atlantic, the development of continental models requires the following assumptions:

1) All fish in homewaters are assumed to be maturing.

2) All fisheries are assumed to be sequential.

Relatively few adjustments to the various weighting factors for monitored river stocks were required to obtain realistic yield predictions for the West Greenland and Faroes fisheries. This is considered encouraging and may suggest that the rivers are reasonably representative. The collection of information on the timing of catches in fisheries by sea age and the timing of tag returns would improve the ability to construct "bottom-up" models.

The applicability "bottom-up" reconstruction models is limited by the relatively few rivers with sufficient tagging information and questions about the representativeness of those rivers with tagging data. A key parameter in North America is estimating the ratio of maturing and non-maturing salmon in interception fisheries of Newfoundland and Labrador. Some progress has been made (Section 7.2) but estimating the fraction of maturing salmon for an entire fishery still needs to be accomplished.

Present run reconstruction models will have limited future utility unless they are linked directly to the catches and ultimately provide estimates of exploitation rates in fisheries. The next generation of run-reconstruction models should consist of multiple stocks linked together to provide descriptions of regions, continents and ultimately, the entire North Atlantic. The Working Group felt that a definition of modeling objectives was worthwhile. The first objective of large scale run reconstruction models is to provide estimates of national contributions to fisheries, patterns of migrations, exploitation rates on extant stocks, and exploitation rates by fisheries. Once the descriptive aspects of the model have been refined, the second objective is to predict the consequences of changes in fisheries on other fisheries and on escapement.

The Working Group noted that models designed to predict future smolt production and recruitment to fisheries would not be feasible due to wide variations among rivers and a poor understanding of factors affecting marine survival. The Working Group noted, however, that determination of spawning targets and egg depositions would greatly benefit the objective evaluation of management measures. With defined spawning targets, the requisite changes in fisheries could be determined.

8 DISTRIBUTION OF PARASITES AND DISEASES

The Working Group reviewed the Report of the Working Group on Pathology and Diseases of Marine Organisms (WGPDMO). The WGPDMO was asked by ICES to consider the distribution of parasites and diseases harmful to Atlantic salmon in the North-East Atlantic and West Greenland areas and to report to the North Atlantic Salmon Working Group. The WGPDMO felt that the purpose of the request was unclear and intimated that a more detailed request from NASCO should be obtained. The North Atlantic Salmon Working Group recognized the difficulty in obtaining quantitative data on the distribution of parasites and diseases, but felt that a qualitative survey and inventory of these organisms could be produced without new research if desired by NASCO.

WGPDMO reported that there was a substantial body of literature on the parasites and diseases of Atlantic salmon already in existence. They recognised that in some cases, the introduction or presence of a disease in a wild population has in the past proved detrimental to stocks. They cited as examples the introduction of the bacterial disease furunculosis (Aeromonas salmonicida) and the parasitic fluke Gyrodactylus salaris. They concluded, however, that quantification of the impact of such introductions cannot easily be evaluated. The presence of a known pathogen in wild stocks does not imply a severe effect on the population as the pathogenicity may vary from area to area and with time within areas (e.g. furunculosis in the UK).

In previous reports (Anon., 1989a; Anon., 1990a), the North Atlantic Salmon Working Group noted that G. salaris, probably introduced into Norway by the import of infected stocks from the Baltic had affected salmon populations in 32 rivers by 1989 and in 33 rivers by 1990. It was suggested that some stocks may be threatened with extinction (Anon., 1991b). Furunculosis had been introduced to Norway by the import of infected smolts from Scotland.

The Working Group reviewed a paper describing a programme to screen disease status of wild salmon for a sea ranching project in the Osterfjorden area of western Norway. The Working Group noted that of 66 fish examined in 1989, no evidence of viral or pathological infections was found. In 1990, a total of 102 salmon was examined; 3 were in infected with IPN virus and 1 with furunculosis. Batches of eggs from infected fish were identified and destroyed.

The Working Group noted that strict controls on the movement of fish were enforced in a number of countries and that, in addition, a number of countries required aquaculturists to record the incidence of various diseases designated as notifiable and to take appropriate action to prevent the spread of such diseases.

The Working Group felt that it would be possible to produce a qualitative list of parasites and diseases that are harmful to Atlantic salmon by region and that this would be useful. However, an assessment of the effects on wild salmon stocks would be difficult, even with detailed specification of distribution and possible mortality rate for each pathogen by region. In the absence of this detailed information, it was not possible to assess the effects on wild stocks.

9 CLASSIFICATION METHODOLOGY

9.1 Scale Character Variables

The Working Group reviewed a paper that described ongoing research aimed at improving the identification of salmon at Greenland by including additional scale characters in the analysis. Scale variables were measured using a Bioscan pattern recognition system. Two basic types of scale characters were examined: life history variables that require some degree of reader interpretation to determine the location of life history markers, location of 1st sea zone, etc. and non-life history variables requiring minimal reader interpretation. Non-life history variables are easiest to automate with a pattern recognition system and are most likely to be repeatable as reader interpretation is not required. The scale samples used were from 16 salmon caught at Greenland and identified to origin by the presence of a CWT. Several types of scale characters of each type were examined in the following data sets:

Life history variables:

a) CS1S45 - circuli counts of the summer period of 1st sea zone at 45 degrees.
b) CS1W45 - circuli counts of the winter period of 1st sea zone at 45 degrees.
c) CS1_45 - circuli counts of the 1st sea zone at 45 degrees.
d) CS1_90 - circuli counts of the 1st sea zone at 90 degrees.

Non-life history variables:

1. Inter-circuli spacings: the pattern recognition system was set to mark and automatically measure the distance between circuli on either side of a line drawn along some axis of the scale. Marks were placed at end of the dark bands.

a) Sea zone: measured from the beginning of the sea zone to the edge of the scale at 45 and 360 degrees.

b) Reversed sea zone: measured from the edge of the scale to the beginning of the sea zone. This was not directly measured but derived from a) by inverting the data set row by row and then left justifying it.

The inter-circuli spacings were computed for a) and b) above by subtracting the location of the 1st circuli from the 2nd circuli, the 2nd circuli from the 3rd, etc out to the edge of the scale. In the same way paired circuli spacings, triplets, quadruplets, and quintuplets were also computed.

2. Shape variables:

a) Circularity
b) Breadth
c) Area
d) Rectangularity
e) Perimeter
f) Major axis

All variables with the exception of the shape variables were interpreted from scale impressions on plastic slides. The shape variables were made on whole mounts on glass slides.

A summary of misclassification rates is shown in Figure 9.1.1. In general, it was possible to discriminate with 4 out of 5 of the data sets. Only with the shape variables were there no discriminating variables. The inter-circuli spacing variables worked best with 0% misclassification and error rates (Figure 9.1.1). This was encouraging, as the inter-circuli spacings are the easiest to measure and require the least reader interpretation.

In summary, it was recommended that these investigations continue but using a larger data set. The inter-circuli spacings look most promising of the 5 data sets examined but the analysis should be restricted to single combinations of variables to avoid colinearity. Also, the efficacy of Fourier coefficients for discriminating continent of origin should also be investigated.

9.2 Discriminant and Maximum Likelihood Techniques

Alternative methods for discriminating continent of origin of salmon at Greenland were investigated for the effect on classification accuracy of stratifying by river age and a comparison wasd made of the performance of the classification correction and maximum likelihood estimators of composition. Two performance indicators were used to measure the accuracy and precision of the methods:

1) Accuracy was measured by the error rate that was calculated by subtracting the estimated proportion from the known proportion.

2) Precision was measured by the mean squared error of the estimated proportion.

Scale data on known origin salmon for years 1982 and 1985-89 were used. Scatter plots of the two measured scale variables were produced and based on these plots it was decided to look at years 1985 and 1989 in more detail. Stratifying by river age degraded the 1985 classification rates, but produced a slight improvement for the 1989 data. Simulation studies were performed to show the accuracy and precision of the composition estimators. One hundred simulations were performed in each run. For the small mixed fishery sample, each simulation constructed a mixed fishery sample of size 100 from a mixed fishery with true composition (0.5,0.5). For the large mixed fishery sample, each simulation constructed a mixed fishery sample of size 400 from a mixed fishery with true composition (0.5,0.5). The results (Tables 9.2.1a and b) indicate:

1) Accuracy: for both small and large mixed-fishery samples, the classification correction estimator performed better than maximum likelihood. Stratifying by river age gave mixed results, sometimes improving accuracy and other times degrading it.

2) Precision: for small mixed-fishery samples, the maximum likelihood estimator was more precise than the classification correction technique. But for large mixed- fishery samples the classification correction estimator was better. Stratifying by river age gave mixed results, sometimes improving accuracy and other times degrading it.

Since it is very easy to calculate both the unstratified and stratified classification matrices it is recommended that this be done as a matter of course. If the river age stratification gives better classification rates then simulations should be performed to see if improvements in composition estimation due to stratification can be realized. This could be done annually and the technique with the best error rate used to estimate the composition of the fishery at Greenland. It is recommended that work continue in this area. In particular, the classification method used (i.e., linear discriminant analysis) could be improved upon by using a quadratic discriminant analysis which may perform better.

9.3 <u>Biochemical Techniques</u>

In previous years, protein electrophoresis was used to establish a database of known origin samples to determine the continental composition of the West Greenland fishery. Scale characters interpreted from these samples and from unknown origin samples were collected at Greenland and used to estimate the annual proportion of North American and European salmon in the commercial fishery. However, it has been suggested that genetic markers should be available that can identify the continent of origin of an individual salmon. This hypothesis is based on the following assumptions:

1) European and North American Atlantic salmon do not interbreed with one another.

2) The populations of Atlantic salmon on either side of the Atlantic have been separated for sufficiently long for different alleles (polymorphisms) to have been fixed in both populations.

Protein electrophoresis (allozyme analyses) has failed to identify a continent-specific genetic marker although allele frequencies certainly support the notion that the salmon populations from Europe and North America are genetically different. Similarly, mitochondrial DNA studies have not identified markers that can be used for this purpose. Preliminary observations using the nuclear ribosomal RNA gene complex (rDNA) suggested that a polymorphism detected with a combination of the restriction endonucleases Xba I and Sac I yielded markers that were restricted to populations from Scotland and Norway or populations from Newfoundland and Nova Scotia, respectively. However, eleven specimens from Ireland were analyzed and identified from North American genotypes. Additional investigations are required to resolve the discrepancy with the original analysis.

The objectives of these studies were twofold:

1) To extend the preliminary survey so that it includes a larger population base of salmon from both sides of the Atlantic.

2) To test the effectiveness of this technique in analysing samples collected under less than ideal conditions (i.e. muscle samples from salmon in fish plants in Greenland).

A sampling program was carried out in Greenland in 1990. The details are given in the following text table:

Location	No. of Samples	DNA Preparations	No. of Analyses	NA	Eu
Maniitsoq	19	2	0	0	0
Nuuk	80	65	41	18	23
Paamiut	79	70	63	17	46
Total	178	132	104	35	69

It should be noted that the DNA that was prepared was not always of high molecular weight (i.e., it was partially degraded, probably as a result of post morten deterioration of the samples and a lack of freezing the tissues during storage and transportation. This accounts for the incomplete analyses of some samples).

The utility of this procedure for analysing the continental composition of the West Greenland salmon fishery is in doubt until methodological problems are resolved. If it turns out that the "North American" rDNA phenotype is occurring naturally in European salmon, then this polymorphism is distributed on both sides of the Atlantic and as such it will not provide a genetic marker that can tell the continent of origin of an indiviual salmon. If, as appears likely, this is the situation, it is difficult to envisage another region of the genome that will prove more useful. Single copy genes will reflect the results of protein electrophoresis whereas segments that are more variable (e.g. variable number of tandem repeats, VNTRs) identify individual salmon from one another but do not provide population markers, especially over the range of a continent. It may well be time to reconsider the underlying assumptions that must be invoked if the existence of continent-specific genetic markers are to be predicted for Atlantic salmon. Also there are not nearly enough samples from European rivers.

It is recommended that the necessary samples be collected to establish the reliability of the rDNA technique to identify salmon collected at Greenland as North American or European. Also, in the absence of data of known origin from Greenland in 1990 it is recommended that the scale database collected from 1986-89 be used to estimate the continental proportions in 1990.

9.4 Neural Networks

The Working Group considered a working paper which explored the use of neural networks for discriminating salmon of North American and European origin on the basis of scale characteristics. Neural networks are computer models which are designed to operate in a similar way to the brain.

In a neural network, perceptrons are arranged in three layers, an input layer, an output layer and a central 'hidden' layer; this increases the resolving power of the network. A single perceptron can define a single line in the pattern space (visualising the problem in two dimensions). In a two layer system several perceptrons (each defining a line) can be combined, producing more complex space partitioning. Regions defined in this way are called 'convex hulls' and have the property that any two points within them can be joined by a straight line that does not cross the boundary of the region. If a third layer of perceptrons is added, it will not be combining lines but convex hulls. This can produce arbitrary complex shapes in the pattern space. Adding extra layers will not help improve the resolving power of the network further.

The Working Group considered the results of a trial analysis using neural networks to classify salmon of unknown origin. The neural network was trained and tested on the data base of characteristics for the period 1986-89 used for the discriminant analysis (Anon., 1990a). The data for all four years were combined, randomised and divided in half. One half was used as the 'learning' set and the other as the 'test' set.

In the trial analysis, the four variables, CSIW, CSIS, fork length and river age were split into groups in order to provide more input neurons and thus improve the discriminatory power of the network. The network was set up with 32 input neurons, 22 hidden neurons and 2 output neurons.

The neural network was trained by repeated presentation of the 'training' half of the data set. For training the tolerance was set at 0.1. This means that if a fish was European the network would be said to be correct if it assigned a value of over 0.9 to the 'European' output neurone. The trained network was tested against the second half of the data base using a tolerance of 0.4. This meant that if the network assigned a value of over 0.6 to the European output neuron, it would identify the fish as European, and similarly for American fish.

The network achieved optimal training after about 70 runs through the training data set. Although, with more training, the network became very accurate at discriminating the training data set, its discriminating power with the test data set declined slightly. The classification of the test data set by the network after 70 training runs was as follows:

		Classification		
Origin	Sample	Correct	Incorrect	Unsure
American	379	339 89.4%	35 9.2%	5 2.2%
European	134	115 84.4%	18 13.4%	3 1.3%

These results appear to be slightly better than those achieved with the discriminant analysis. It is felt that further improvements could be achieved with some fine-tuning of the network. The result also suggests that neural networks may offer a useful alternative to discriminant analysis for other data sets, for example where scale data are collected by image analysis.

9.5 Summary

The Working Group was very encouraged by the substantial advances to discriminating continent of origin at Greenland and pointed out that the techniques should be applicable to other situations as well. It is recommended that the investigations continue and the technique with the lowest misclassification and error rates be used to discriminate continent of origin of salmon in the 1991 fishery at Greenland. Also, if possible, new scale character variables derived from the use of the pattern recognition system should be incorporated into the discrimination to continent of origin at Greenland in 1991.

10 WORKSHOP ON IDENTIFICATION OF FISH FARM ESCAPEES AND WILD SALMON

Because of the large number of fish farm escapees (see Section 6.2.5) observed in salmon fisheries and salmon spawning populations in some countries, ICES decided to hold a Workshop to develop and report on techniques that could be used to distinguish wild salmon from fish farm escapees. Based on the report of the Workshop (Anon. 1991d) the Working Group noted that several different techniques were available. These are listed below.

(1) Morphology

In hatcheries and fish farms, salmon develop morphological characters that differ from those of wild fish. The most striking difference is that many reared salmon have eroded fins, in particular the tail, dorsal and pectoral fins. Other characters such as deformation of the snout, shortening of the gill cover and different levels of pigment spotting are frequently observed on reared fish. A combination of such characters can be used to distinguish between the groups. However, as regeneration of fins occurs, fish that have been at liberty for a long period may not be detected by this method. This method will, therefore, tend to underestimate the proportion of reared fish. In small rivers with clear water, skilled persons may identify fish farm escapees by using a range of field characters such as fin size, shape and form; body shape; scale loss; and behaviour. The efficiency of methods relying on morphological characters will depend on (a) the culture environment from which the fish were lost; (b) the developmental stage at loss; (c) the intervening period between loss and the subsequent recapture and (d) the experience of the observer.

(2) Otoliths

From a comparison of otoliths from wild and hatchery-reared parr, it was observed that in wild fish the otoliths were translucent and tended to have distinct annuli. In contrast, the otoliths of juvenile fish from hatcheries were opaque and had few or no distinct zones. Preliminary examination of otoliths of reared and wild adults suggested that this technique was applicable to older fish. However, further tests are required. No physiological basis of the observed differences has been identified.

(3) Scale pattern recognition

Scale patterns can be used to discriminate between reared and wild salmon. The characters used are (a) smolt size; (b) smolt age; (c) transition zone from freshwater to saltwater; (d) sea winter bands; (e) summer checks and (f) the proportion of replacement scales. However, it is difficult to discriminate fish that escaped from fish farms at an early life stage.

(4) Biochemical and physiological markers

Pigments added to the salmon feed can be detected in the fish at a later stage. The pigments in current use are synthetic canthaxanthin and synthetic astaxanthin. They can be detected in farmed fish, and in the progeny of farmed females up to the alevin stage. Astaxanthin is the main natural red colour pigment in salmonids and exists in three different optical isomers. The synthetic form could easily be detected, as the ratio of the isomers differs from that of the natural pigment. The use of antibiotics and fatty acids which are in current use in fish farms, and of trace minerals were considered to be of little practical value at present. However, their feasability has not been properly tested.

(5) Genetic markers

The value of genetic markers, as opposed to other marks or tags, is that they may be detected in all life stages and can be transmitted to subsequent generations. In addition, genetic marks are not lost by the individual and ideally there should be no differential mortality resulting from the mark. The markers could be (a) morphological-genetic markers; (b) biochemical-genetic markers (isozymes); (c) DNA-fragments and (d) cytological or chromosomal markers. At present, no naturally-occurring genetic markers have been identified which can distinguish between wild and reared salmon. Research is underway to find such markers.

(6) Cytological markers

The use of triploid salmonids in aquaculture is widespread. Triploid fish having 3 sets of chromosomes rather than the normal 2, can be identified easily and reliably from a blood sample because of their greater cell nucleus size. The mark is life long.

(7) Large-scale group marking of salmon in farms

The large-scale group marking of reared salmon would allow identification of escapees and assessment of their interaction with natural populations. The feasibility of using external, internal, biological, chemical and genetic marks in large scale group marking of salmon in farms was discussed. However, several problems arise when marking large numbers of salmon. These are of a practical, economical and biological nature. It is of great importance that the marks can be detected easily during the entire life span of the fish.

It was concluded that morphological characters, scale characters and otolith structure, used alone or in combination, are the least expensive and most discriminatory methods available. However, the use of these methods will almost certainly underestimate the true numbers of reared fish in mixed groups of wild and reared salmon. In some circumstances, tissue pigment analysis is diagnostic for farmed escapees. The intended withdrawal of canthaxanthin as a feed pigment makes development of a quick and inexpensive method for examining isomeric ratios of astaxanthin of special importance. In some circumstances, fortuitously or by experimental design, genetic methods may be used to distinguish wild salmon from reared.

The Working Group noted that fish farm escapees could be identified most easily using seven external characteristics which were associated with rearing. These characteristics were the erosion and deformation of the tail, dorsal and pectoral fins, the snout and gill covers; and a greater degree of spotting. The Working Group noted that the first four characteristics are the most diagnostic and recommended that at least two characteristics should be present before fish were provisionally classified as escapees.

The Working Group endorsed the recommendations of the Workshop (Appendix 4) and also noted that further research on otoliths may lead to the development of techniques to identify fish escaping at the smolt stage. The Working Group also suggested that methods of artificially marking otoliths of farmed fish, such as with oxytetracycline or by the deliberate introduction of growth zones (e.g., by temperature shock) should be investigated.

11 STUDY GROUP ON GENETIC RISKS TO ATLANTIC SALMON STOCKS

11.1 Introduction

The Working Group considered the report of the Study Group on Genetic Risks to Atlantic Salmon (Anon., 1991e). The questions asked of the Study Group were to:

1) review, consolidate and report on the current status of techniques to detect changes in Atlantic salmon stocks due to inbreeding of wild and cultured populations;

2) provide the experimental design for a research programme to evaluate the possible effects (including genetic, ecological and behavioural interactions) of fish farm escapees of Atlantic salmon on wild stocks.

11.2 Considerations

The Study Group reviewed available data on the genetic structure of wild salmon populations and genetic differences between wild and farmed salmon, as these will have a bearing on the likelihood of genetic change by introgression of these types and our ability to detect it.

Atlantic salmon are divided into a large number of reproductively isolated populations. Most studies have shown that more than 90% of anadromous individuals return to their native river to spawn, thus leading to a restricted pattern of interbreeding. Genetically different populations may arise through genetic drift and/or natural selection for adaptation to local environmental conditions. Examination of over 300 salmon populations throughout the species' natural range has indicated significant genetic differentiation among populations within and between river systems. Large differences have been detected among regions and between continents.

In spite of the large number of studies undertaken, understanding of the adaptive importance of the genetic differences is limited, with only a few examples of clear connections between genetic variability and adaptation.

In respect of genetic differences between wild and cultured salmon, the Study Group identified three sources of potential differentiation:

1) Use of non-local wild populations to found farmed strains. For example, transfer of Scottish, Norwegian, Icelandic and Finnish salmon to Maine for cage rearing.

2) Differentiation as a result of artificial selection for farm-advantageous traits (e.g., growth characteristics).

3) Passive selection resulting from the greatly differing conditions in culture relative to the wild situation.

11.3 Experimental Studies

The Study Group noted that the relative performance of farmed and wild salmon in the same natural environment has not yet been examined, but related studies have been performed both on Pacific salmon and other salmonid species.

One way of determining the effects of the spawning of farmed escapees on wild population is to design experiments in order to test specific hypotheses. Such studies should preferably be undertaken cooperatively, because of the costs involved. An additional advantage is that several hypotheses may be addressed at the same time. There are many variables which must be considered which may limit generalisation from single experiments. An important consideration of such studies is that they could be compromised by keeping the groups of fish in culture before the experiment. Genetic markers would, therefore, be particularly suitable for separating the groups. In the light of recent developments in genetic techniques, genetic marking seems feasible.

An alternative means of assessing the effects might be to exploit situations which arise unintentionally. Escapes from fish farms occur in many natural streams, and in some rivers in Scotland and Norway escapees occur in higher number than wild fish. Such sitations can be used to investigate the effect of escapes on wild populations.

11.4 Joint Session with the North Atlantic Salmon Working Group

The Working Group, in joint session with the Study Group, considered the Study Group's proposal for the design of a research programme and commented as follows:

1) The Study Group proposals for an experiment to examine genetic, ecological and behavioural interactions between wild and farmed salmon should provide information on the genetic risks of introgression. However, noting the numerous variables likely to influence interpretation of the results of such an experiment, the Working Group suggested that several less comprehensive experiments might be carried out. These would examine relative performance of farmed and wild salmon at various life stages and would contribute specific information.

2) There is scope for laboratory-based intercomparisons of genetic and behavioural interactions between farmed and wild salmon. These would be viewed as complementary to field experiments and could yield useful information that could not otherwise be obtained.

12 COMPILATION OF TAG RELEASES AND FIN-CLIP DATA FOR 1990

Data were provided by Working Group members on the prescribed form and have been compiled as a separate report (Anon., 1991c). In excess of 1.89 million microtags (CWTs) and 0.28 million external tags were applied to Atlantic salmon released in 1990 (Table 12.1). In addition, 1.73 million salmon were finclipped. Thus, more than 3.90 million marked fish were released.

13 RESEARCH

13.1 Progress on Data Requirements and Research Needs

The Working Group reviewed the list of data requirements and research needs (Sections 12.1 and 12.3; Anon., 1990a). 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 countries of the North-East Atlantic and work on methods using these scales has been carried out.
2. The Working Group requires further work on biochemical techniques, incorporating additional samples, and suggests that this methodology merits further investigations for country of origin.	Information was tabled, (Section 9.3), research is continuing and blood/tissue samples were requested from more stocks, particularily in the North-East Atlantic.
3. 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 recommended that as in earlier years, scale samples should be collected from 2SW salmon in home-waters 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.	All scale samples submitted as requested; another set solicited from 2SW home-water returns in 1991. Separation with tissue samples to continent of origin by DNA techniques still requires further work. Additional tissue samples are required.
4. 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.	No new information tabled, nor expected in the future.
5. The possibility of obtaining data on weight categories recorded by the factories at West Greenland should be investigated.	Information obtained for 1987-90, but presentation delayed until next meeting.

6. The Working Group addresses 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.	No new information tabled.
7. 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.	Data provided where available, see Sec. 2.4, 3.5,. 5.8, 6.2.5.
8. 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.	Annual catches provided, 1976 and 1983-90; no other details made available.
9. 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.	Sources and examples of sea-surface temperatures provided in working paper; no new analyses conducted.

10. 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.	Progress was made in run reconstruction modelling (Section 7.3); format of Appendix 5 not used.

13.2 Progress on Recommendations made in 1989 and 1990

The Working Group reviewed recommendations made in 1989 and 1990 (see Sections 12.2 and 13 in Anon., 1990a).

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;	Some new data provided (see Sections 5 and 6)
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; knowledge extended in run recon-strution models and classification methodology (Sections 7 and 9).
c) exploitation rates should be obtained for stocks in areas where they are currently unavailable;	Some new data provided (Sections 4, 5, 6 and 7). No new field initiatives; further insights gained from modelling (Sections 7.3.2 and 7.3.3).
d) reliable estimates should be obtained for non-reported catches.	Non-reported catches provided by all countries, but reliability was not evaluated (Section 2.3).

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 stocks which might be representative of others.	New monitored stocks available for future analyses.
3. The Working Group recommends that a workshop should be held on techniques to distinguish fish farmed escapees from wild salmon.	The Workshop was held in Trondheim, Norway, 11-13 February 1991 and the report submitted 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.	Microtagging programmes begun on wild smolts of the Saint John, St.-Jean, De la Trinité and Jupiter rivers. Tag recovery program expanded. SSB estimates provided (Section 5.2).
5. 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. Hence the Working Group recommends that:	
a) Research effort should be increased on methods of stock discrimination such as body form and scale analysis, gene frequencies, and other biochemical methods.	New approaches were reviewed to discriminate stocks using scales (Section 9.1) and biochemical methods (Section 9.2).
b) Research effort should be increased on methods to distinguish maturing and non-maturing components of fisheries.	Working Paper presented and results tabled in Section 7.2. Other work in progress, and expected to be presented at the 5th International Symposium on Fish Reproduction, 7-12 July, 1991.

13.3 Requirements for Future Meetings

1. The Working Group expressed concern over the fact that a substantial portion of the CWT estimate of Maine-origin fish harvested in the West Greenland fishery was based on a limited number of tag recoveries and recommended that the method of stratification of CWTs over weeks and areas in which there was no scanning be re-investigated.

2. The Working Group endorsed the recommendations of the Workshop on Identification of Fish Farm Escapees and Wild Salmon (Appendix 4) and also noted that further research on otoliths may lead to the development of techniques to identify fish escaping at the smolt stage. The Working Group also suggested that methods of artificially marking otoliths of farmed fish, such as with oxytetracycline or by the deliberate introduction of growth zones (e.g., by temperature variation) should be investigated.

3. The analysis of the reporting rate for Maine-origin Carlin tags in relation to catch-per-unit-effort for the first two weeks of the West Greenland fishery should be made for other tagging programmes.

4. Error estimates for the Carlin harvest estimates of Maine origin salmon in Greenland should be derived if possible.

5. Studies should be conducted to investigate the incidence of fish farm escapees in the catch at West Greenland.

6. With respect to the 'bottom-up' run-reconstruction models for countries of the North-East Atlantic, further attempts should be made to refine each national model before 1992. Further, it was agreed that all members should review their tagging experiments and consider what additional data would be required to improve the reliability of their national model.

7. The bias-corrected catch-weighting technique by size catagory is the preferred method for determining the number of North American and European salmon captured in West Greenland. Existing catch-weighted estimates (by size category) are not bias-corrected and the Working Group recommended that this be done for as many years as possible for the next meeting.

13.4 Future Meeting

The Working Group enthusiastically entertained an invitation from J. Browne (Ireland) to host the 1992 Working Group meeting in Dublin. The Working Group recommended that it accept the invitation and meet in Dublin, the last week of March - first week of April, 1992.

14 RECOMMENDATIONS

1. The Working Group endorsed the recommendations of the Study Group on the North American Salmon Fisheries, the Study Group on the Norwegian Sea and Faroes Salmon Fishery, the Study Group on Genetic Risks to Atlantic Salmon Stocks and the Workshop on Identification of Fish Farm Escapees and Wild Salmon (Appendix 4).

The Study Groups on the North American Salmon Fisheries and Norwegian Sea and Faroes Salmon Fishery should meet in 1992 to prepare data for the Working Group. Only 3 days should be allocated to the Study Group on the Norwegian Sea and Faroes Salmon Fishery (assuming the remit reverts to the length of that of 1989) 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.

2. The Working Group considered a series of indicators of stock status and sustainability (Hildén 1990) which could be used to advise managers of Atlantic salmon stocks. Members reported on numerous time series of data on catches, spawning escapement, stock-specific exploitation rates, etc., which have not been previously utilized by the Working Group in the preparation of their report. Trends over time in raw, normalized, smoothed-normalized (3-year moving averages) and river-combined smoothed-normalized data provided graphic outputs

which captured trends potentially useful in future Working Group reports and reports of ACFM. The Working Group recommended that participants bring these additional data bases in electronic format for review at future meetings. The Working Group chairman, in collaboration with the chairmen of the two Study Groups, will undertake to standardize the format prior to the 1992 meetings.

3. The Chairmen of the North Atlantic Salmon Working Group and the Baltic Salmon and Trout Working Group discussed a number of topics of interest to both Groups with the intention of holding a Workshop.

4. Tag recoveries are crucial for the improvement of models being developed to assess the West Greenland and Faroes fisheries. The Working Group recommends that an effort be made to improve and increase screening for tags in the catches, especially in West Greenland.

5. The Working Group noted that fish farm escapees could be identified most easily using seven external characteristics which are associated with rearing. These characteristics are erosion and deformation of the tail, dorsal and pectoral fins, the snout and gill covers; and a greater degree of spotting. The first four characteristics are the most diagnostic and the Working Group recommended that at least two characteristics should be identified before fish are provisionally identified as escapees.

6. The Working Group was encouraged by the substantial advances in the discrimination of continent of origin of salmon at Greenland. It was recommended that the investigations continue and that the technique with the lowest misclassification and error rate be used to discriminate continent of origin of the salmon in the 1991 fishery at Greenland. Specific recommendations are:

i) Ongoing investigations into scale character variables require a larger data set; the inter-circuli spacings data set looks the most promising of the 5 data sets examined but the analysis should be restricted to single ombinations of variables so as to avoid colinearity; pattern recognition and the efficacy of Fourier coefficients should be investigated.

ii) Work should continue on discriminant and maximum likelihood techniques, especially the possible use of a quadratic discriminant analysis which may perform better than the linear discriminant analysis.

iii) Samples should be collected to establish the reliability of the rDNA technique to identify salmon collected at Greenland as North American or European.

iv) Investigation of neural networks should continue.

7. Further to the development of techniques to determine the state of maturity of 1SW salmon caught in fisheries it is recommended that:

i) samples be obtained to test the hypothesis that gonadal and somatic growth are equal;

ii) data from the Miramichi River and Norwegian cage experiments be used to test the assumption that there are no differences in GSI between stocks or over time and that Conne estuary and Labrador Sea samples are representative of maturing and non-maturing salmon, respectively;

iii) known maturity samples be collected over time and maturity rates be catch-weighted to test the assumption that there are no timing differences in GSI and maturity over the weeks of the fishery.

8. The Working Group was encouraged by new progress into a "top-down" run reconstruction model which was used to constrain the bounds on possible exploitation rates in the West Greenland fishery. The Working Group recommended that work should be done to analytically derive the range of exploitation rates implied by the set of constraints and to examine longer time series of data, particularly for periods prior to major fishery restrictions in Greenland and Canada. Such analyses might detect the effects of management measures, trends in recruitment and patterns of exploitation.

9. In addition to the experimental design proposed by the Study Group on Genetic Risks, the Working Group suggests that several less comprehensive experiments might be carried out. These would examine relative performance of farmed and wild salmon at various life stages and would contribute specific information. There is scope for laboratory-based intercomparisons of genetic and behavioural interactions between farmed and wild salmon. These would be viewed as complementary to field experiments and could yield useful information that could not otherwise be obtained.

Table 2.1.1 Nominal catch of SALMON by country (in tonnes round fresh weight), 1960-1990

Year	Canada[5]	Denmark	Faroes	Finland	France	East Green-land	West Green-land	Iceland	Ireland[2]	Norway[4]
1960	1,636	-	-	-	75	-	60	100	743	1,659
1961	1,583	-	-	-	75	-	127	127	707	1,533
1962	1,719	-	-	-	75	-	244	125	1,459	1,935
1963	1,861	-	-	-	75	-	466	145	1,458	1,786
1964	2,069	-	-	-	75	-	1,539	135	1,617	2,147
1965	2,116	-	-	-	75	-	861	133	1,457	2,000
1966	2,369	-	-	-	75	-	1,370	106	1,238	1,791
1967	2,863	-	-	-	75	-	1,601	146	1,463	1,980
1968	2,111	-	5	-	75	-	1,127	162	1,413	1,514
1969	2,202	-	7	-	75	-	2,210	133	1,730	1,383
1970	2,323	-	12	-	75	-	2,146	195	1,787	1,171
1971	1,992	-	-	-	75	-	2,689	204	1,639	1,207
1972	1,759	-	9	32	34	-	2,113	250	1,804	1,568
1973	2,434	-	28	50	12	-	2,341	256	1,930	1,726
1974	2,539	-	20	76	13	-	1,917	225	2,128	1,633
1975	2,485	-	28	76	25	-	2,030	266	2,216	1,537
1976	2,506	-	40	66	9	<1	1,175	225	1,561	1,530
1977	2,545	-	40	59	19	6	1,420	230	1,372	1,488
1978	1,545	-	37	37	20	8	984	291	1,230	1,050
1979	1,287	-	119	26	10	<1	1,395	225	1,097	1,831
1980	2,680	-	536	34	30	<1	1,194	249	947	1,830
1981	2,437	-	1,025	44	20	<1	1,264	163	685	1,656
1982	1,798	-	865	54	20	<1	1,077	147	993	1,348
1983	1,424	-	678	57	16	<1	310	198	1,656	1,550
1984	1,112	-	628	44	25	<1	297	159	829	1,623
1985	1,133	-	566	49	22	7	864	217	1,595	1,561
1986	1,559	-	530	38	28	19	960	310	1,730	1,598
1987	1,784	-	576	49	27	<1	966	222	1,239	1,385
1988	1,311	-	243	34	32	4	893	396	1,874	1,076
1989	1,139	-	364	52	14	<1	337	278	1,079	905
1990[1]	870	13	312	59	15	<1	227	421	442	908

cont'd.

Table 2.1.1 cont'd.

Year	Saint-Pierre and Miquelon	Sweden (West coast)	UK England + Wales	UK Scot- land	UK Northern Ireland[2,3]	USA	USSR	Others[6]	Total[1]
1960	-	40	283	1,443	139	1	1,100	-	7,279
1961	-	27	232	1,185	132	1	790	-	6,519
1962	-	45	318	1,738	356	1	710	-	8,725
1963	-	23	325	1,725	306	1	480	-	8,651
1964	-	36	307	1,907	377	1	590	-	10,800
1965	-	40	320	1,593	281	1	590	-	9,467
1966	-	36	387	1,595	287	1	570	-	9,825
1967	-	25	420	2,117	449	1	883	-	12,023
1968	-	20	282	1,578	312	1	827	403	9,830
1969	-	22	377	1,955	267	1	360	893	11,615
1970	-	20	527	1,392	297	1	448	922	11,316
1971	-	18	426	1,421	234	1	417	471	10,794
1972	-	18	442	1,727	210	1	462	486	10,925
1973	-	23	450	2,006	182	2.7	772	533	12,746
1974	-	32	383	1,708	184	0.9	709	373	11,941
1975	-	26	447	1,621	164	1.7	811	475	12,209
1976	2.5	20	208	1,019	113	0.8	772	289	9,537
1977	-	10	345	1,160	110	2.4	497	192	9,495
1978	-	10	349	1,323	148	4.1	476	138	7,650
1979	-	12	261	1,076	99	2.5	455	193	8,090
1980	-	17	360	1,134	122	5.5	664	277	10,081
1981	-	26	493	1,233	101	6.0	463	313	9,930
1982	-	25	286	1,092	132	6.4	364	437	8,645
1983	3	28	429	1,221	187	1.3	507	466	8,732
1984	3	40	345	1,013	78	2.2	593	101	6,893
1985	3	45	361	913	98	2.1	659	-	8,095
1986	2.5	54	430	1,271	109	1.9	608	-	9,249
1987	2	47	302	922	56	1.2	564	-	8,142
1988	2	40	395	882	114	0.9	419	-	7,716
1989	2	29	296	895	142	1.7	359	-	5,894
1990[1]	1	33	297	543	94	2.4	316		4,554

[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 charr included (5% total).
[5] Includes estimates of some local sales and by-catch.
[6] Includes catches in Norwegian Sea by vessels from Denmark, Sweden, Germany, Norway, and Finland.

Table 2.1.2 Nominal catch of SALMON in homewaters by country (in tonnes round fresh weight), 1960-1990.

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	971	472	1,443	-	-	743	139	-	-	1,659	40	-	-	-	1,100	100	-	-	1,636	1	7,219
1961	75	232	811	374	1,185	-	-	707	132	-	-	1,533	27	-	-	-	790	127	-	-	1,583	1	6,392
1962	75	318	1,014	724	1,738	-	-	1,459	356	-	-	1,935	45	-	-	-	710	125	-	-	1,719	1	8,481
1963	75	325	1,308	417	1,725	-	-	1,458	306	-	-	1,786	23	-	-	-	480	145	-	-	1,861	1	8,185
1964	75	307	1,210	697	1,907	-	-	1,617	377	-	-	2,147	36	-	-	-	590	135	-	-	2,069	1	9,261
1965	75	320	1,043	550	1,593	-	-	1,457	281	-	-	2,000	40	-	-	-	590	133	-	-	2,116	1	8,606
1966	75	387	1,049	546	1,595	-	-	1,238	287	-	-	1,791	36	-	-	-	570	106	-	-	2,369	1	8,455
1967	75	420	1,233	884	2,117	-	-	1,463	449	-	-	1,980	25	-	-	-	883	146	-	-	2,863	1	10,422
1968	75	282	1,021	557	1,578	-	-	1,413	312	-	-	1,514	20	-	-	-	827	162	-	-	2,111	1	8,295
1969	75	377	997	958	1,955	-	-	1,730	267	801	582	1,383	22	-	-	-	360	133	-	-	2,202	1	8,505
1970	75	527	775	617	1,392	-	-	1,787	297	815	356	1,171	20	-	-	-	448	195	1,562	761	2,323	1	8,236
1971	75	426	719	702	1,421	-	-	1,639	234	771	436	1,207	18	-	-	-	417	204	1,482	510	1,992	1	7,634
1972	34	442	1,013	714	1,723	200	1,604	1,804	210	1,064	514	1,578	18	-	-	32	462	250	1,201	558	1,759	1	8,313
1973	12	450	1.158	848	2,006	244	1,686	1,930	182	1,220	506	1,726	23	-	-	50	772	256	1,651	783	2,434	2.7	9,844
1974	13	383	912	716	1,708	170	1,958	2,128	184	1,149	484	1,633	32	-	-	76	709	225	1,589	950	2,539	0.9	9,631
1975	25	447	1,007	614	1,621	274	1,942	2,216	164	1,038	499	1,537	26	-	-	76	811	266	1,573	912	2,485	1.7	9,676
1976	9	208	522	497	1,019	109	1,452	1,561	113	1,063	467	1,530	20	-	-	66	772	225	1,721	785	2,506	0.8	8,030
1977	19	345	639	521	1,160	145	1,227	1,372	110	1,018	470	1,488	10	-	-	59	497	230	1,883	662	2,545	2.4	7,837
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	1,076	105	922	1,097	99	1,150	681	1,831	12	-	-	26	455	225	705	582	1,287	2.5	6,382
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	834	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[6]	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	464	431	895	132	947	1,079	142	469	436	905	29	17	35	52	359	278	590	549	1,139	1.7	5,190
1990[1]	15	297	374	169	543	-	-	442	94	528	380	908	33	24	35	59	316	421	465	405	870	2.4	4,000

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 2.2.1 Reported catch of SALMON in numbers and weight in tonnes (round fresh weight). Catches reported for 1990 are provisional. Some countries divide 1SW from MSW salmon based on weight.

Country	Year	1SW		2SW		3SW		4SW		5SW		MSW[1]		PS		Total	
		No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt
France	1985	1,074	-	-	-	-	-	-	-	-	-	3,278	-	-	-	4,352	22
	1986	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6,801	28
	1987	6,013	18	-	-	-	-	-	-	-	-	1,806	9	-	-	7,819	27
	1988	2,063	7	-	-	-	-	-	-	-	-	4,964	25	-	-	7,027	32
	1989	1,351	4	-	-	-	-	-	-	-	-	1,296	6	-	-	2,647	10
	1990	1,886	5	2,186	9	146	1	-	-	-	-	-	-	-	-	4,218	15
Scotland	1982	208,061	416	-	-	-	-	-	-	-	-	128,242	596	-	-	336,303	1,092
	1983	209,617	549	-	-	-	-	-	-	-	-	145,961	672	-	-	320,578	1,221
	1984	213,079	509	-	-	-	-	-	-	-	-	107,213	504	-	-	230,292	1,013
	1985	158,012	399	-	-	-	-	-	-	-	-	114,648	514	-	-	272,660	913
	1986	202,861	526	-	-	-	-	-	-	-	-	148,398	745	-	-	351,259	1,271
	1987	164,785	419	-	-	-	-	-	-	-	-	103,994	503	-	-	268,779	922
	1988	149,098	381	-	-	-	-	-	-	-	-	112,162	501	-	-	261,260	882
	1989	174,941	431	-	-	-	-	-	-	-	-	103,886	464	-	-	278,827	895
	1990	68,135	169									76,650	374			144,785	543
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	-	-	364,419	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	220,170	436	-	-	-	-	-	-	-	-	80,880	469	-	-	301,050	905
	1990	191,617	380									91,437	528			283,054	908

cont'd.

Table 2.2.1 (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
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	70,817	158	-	-	-	-	-	-	-	-	20,037	120	-	-	90,854	278
Finland	1990	13,460	24	-	-	-	-	-	-	-	-	5,240	35	-	-	18,700	59
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	304,620	549	-	-	-	-	-	-	-	-	135,484	590	-	-	440,104	1,139
	1990	222,944	405	-	-	-	-	-	-	-	-	101,910	465	-	-	324,854	870
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	1.6
	1990	52	0.1	549	2.2	12	-	-	-	-	-	-	-	14	-	627	2.3
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

Table 2.2.1 (cont'd)

		1SW		2SW		3SW		4SW		5SW		MSW[1]		PS		Total	
		No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt
West Greenland	1982	315,532	-	17,810	-	-	-	-	-	-	-	-	-	2,688	-	336,030	1,077
	1983	90,500	-	8,100	-	-	-	-	-	-	-	-	-	1,400	-	100,000	310
	1984	78,942	-	10,442	-	-	-	-	-	-	-	-	-	630	-	90,014	297
	1985	292,181	-	18,378	-	-	-	-	-	-	-	-	-	934	-	311,493	864
	1986	307,800	-	9,700	-	-	-	-	-	-	-	-	-	2,600	-	320,100	960
	1987	297,128	-	6,287	-	-	-	-	-	-	-	-	-	2,898	-	306,313	966
	1988	281,356	-	4,602	-	-	-	-	-	-	-	-	-	2,296	-	288,233	893
	1989	110,359	-	5,379	-	-	-	-	-	-	-	-	-	1,875	-	117,613	337
	1990	80,589	-	2,772	-	-	-	-	-	-	-	-	-	713	-	84,074	227
England & Wales	1985	-	-	-	-	-	-	-	-	-	-	-	-	-	-	95,531	361
	1986	-	-	-	-	-	-	-	-	-	-	-	-	-	-	110,794	430
	1987	66,371	-	-	-	-	-	-	-	-	-	17,063	-	-	-	83,434	302
	1988	76,521	-	-	-	-	-	-	-	-	-	33,642	-	-	-	110,163	395
	1989	65,450	-	-	-	-	-	-	-	-	-	19,550	-	-	-	85,000	296
	1990	53,000	-	-	-	-	-	-	-	-	-	28,000	-	-	-	81,000	297
USSR	1987	97,242	-	27,135	-	9,539	-	556	-	18	-	-	-	2,521	-	139,011	564
	1988	53,158	-	33,395	-	10,256	-	294	-	25	-	-	-	2,937	-	100,065	419
	1989	78,023	-	23,123	-	4,118	-	26	-	-	-	-	-	2,187	-	107,477	359
	1990	71,035	-	20,675	-	2,919	-	101	-	-	-	-	-	2,010	-	96,740	316

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

Table 2.4.1 Production of farmed salmon in the North Atlantic area (in tonnes round fresh weight), 1980-1990.

Year	Scotland	Norway	Iceland	Canada	Northern Ireland	Faroe Islands	USA	USSR	Ireland	Total
1980	598	4,153	-	11	-	-	-	-	21	4,783
1981	1,133	8,422	-	21	-	-	-	-	35	9,611
1982	2,152	10,266	-	38	-	70	-	-	100	12,626
1983	2,536	17,000	-	69	-	110	-	-	257	19,972
1984	3,912	22,300	-	227	-	120	-	-	385	26,944
1985	6,921	28,655	91	359	-	470	-	-	700	37,196
1986	10,338	45,675	123	672	-	1,370	-	-	1,215	59,393
1987	12,721	47,417	490	1,334	-	3,530	365	-	2,232	68,089
1988	17,951	80,371	1,053	3,542	-	3,300	410	-	4,700	111,327
1989	28,553	114,866	1,480	5,865	-	8,000	890	-	5,068	164,722
1990	32,350	157,944	2,800	7,810	<100	13,000	2,075	5	8,175	224,259

Table 3.1.1 Nominal catches at West Greenland, 1960-1990 (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	900
1990	-	-	-	-	227	227[2]	924

[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 3.1.2 Distribution of nominal catches (tonnes) taken by Greenland vessels in 1977-1990 by NAFO divisions according to place where landed.

Div.	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990[1]
1A	201	81	120	52	105	111	14	33	85	46	48	24	9	3
1B	393	349	343	275	403	330	77	116	124	73	114	100	28	18
1C	336	245	524	404	348	239	93	64	198	128	229	213	81	99
1D	207	186	213	231	203	136	41	4	207	203	205	191	73	44
1E	237	113	164	158	153	167	55	43	147	233	261	198	75	34
1F	46	10	31	74	32	76	30	32	103	277	109	167	71	29
1NK	-	-	-	-	20	18	-	5	-	-	-	-	-	-
Total	1,420	984	1,395	1,194	1,264	1,077	310	297	864	960	966	893	337	227
East Greenl.	6	8	+	+	+	+	+	+	7	19	+	4	-	-
Total	1,426	992	1,395	1,194	1,264	1,077	310	297	871	979	966	897	337	227

[1]Provisional figures.
+ Small catch <0.5 t.
- No catch.

Table 3.1.3 Percentage (by number) of North American and European salmon in research vessel catches at West Greenland (1969-1982) and from commercial samples (1978-1990).

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	39	(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)
	1990	4,897	1,208	75	(79,70)	25	(30,21)

[1] CI - Confidence Interval calculated by method of Pella and Robertson (1989) for 1984-1986 and by binominal distribution for the others)
[2] During fishery.
[3] Research samples after fishery closed.

Table 3.1.4 The number and percentage of fin-clipped and microtagged Atlantic salmon observed during the sampling programme at West Greenland in 1990.

SAMPLING SITE	NAFO DIV.	NO. SALMON EXAMINED				NO. AFC's OBSERVED				% AFC'S	NO.CWT's RECOVERED				% CWT's	% AFC's with CWT's	No.untagged AFC Fish	% untagged
		Weight category				Weight category					Weight category							
		<3 Kg	3-5 Kg	>5 Kg	Total	<3 Kg	3-5 Kg	>5 Kg	Total		<3 Kg	3-5 Kg	>5 Kg	Total				
MANIITSOQ	1C	1088	54	14	1156	63	3	0	66	5.71	16	1	0	17	1.47	25.76	49	4.24
NUUK	1D	3606	188	33	3827	97	8	0	105	2.74	29	3	0	32	0.84	30.48	73	1.91
PAAMIUT	1E	1334	81	12	1427	29	1	0	30	2.10	5	0	0	5	0.35	16.67	25	1.75
TOTAL		6028	323	59	6410	189	12	0	201	3.14	50	4	0	54	0.84	26.87	147	2.29
%		94.04	5.04	0.92		94.03	5.97	0			92.59	7.41	0					

AFC = Adipose fin clip.
CWT = Coded wire microtag.

Table 3.1.5 Mean lengths, weights and distributions of recaptures at West Greenland of microtagged salmon from different release areas. Recovery rates per 1,000 fish examined are also given in parantheses for each NAFO division.

Country	Release site	No. released	Release stage	Total no. recovs.	By NAFO division 1C	1D	1E
USA	Connecticut R.		HS	7	3	4	0
	Penobscot R.		HS	20	5	14	1
	Merrimack R.		HS	9	4	5	0
	Narragansett Bay		HS	1	0	1	0
	Other		HS	0	0	0	0
	Total	660,932	HS	37	12	24	1
				(5.8)	(10.4)	(6.3)	(0.7)
Canada	St. John R. N.B.		HS	7	4	3	0
	Stewart Brook, N.B.		HS	2	0	2	0
	Other		HS	0	0	0	0
	Total	59,178	HS	9	4	5	0
				(1.4)	(3.5)	(1.3)	(0.0)
Iceland	Hraunsfjordur		HS	1	0	0	1
	Vogalax		HS	1	1	0	0
	Rangar		HS	1	0	0	1
	Other		HS/WS	0	0	0	0
	Total	405,363	HS	3	0	1	2
		2,341	WS	(0.5)	(0.0)	(0.3)	(1.4)
Ireland	Castleconnell R.		HS	1	1	0	0
	R. Boluisce		HP	1	0	1	0
	R. Corrib		HS	1	0	0	1
	Other		HS/WS	0	0	0	0
	Total	144,125	HS/P	3	1	1	1
		3,216	WS	(0.5)	(0.9)	(0.3)	(0.7)
Faroes	Total	26,943	HS	0	0	0	0
France	Total	4,018	HS	0	0	0	0
		552	WS				
UK (England & Wales)	R. Wear		WS	1	0	0	1
	R. Ebbw		HP	1	0	1	0
	Other		WS/HP				
	Total	246,405	HP	2	0	1	1
		9,937	WS	(0.3)	(0.0)	(0.3)	(0.7)
UK (Scotland)	Total	24,852	HS	0	0	0	0
		5,436	WS				
UK (N.Ireland)	Total	7,854	HS	0	0	0	0
		1,958	WS				

Key: WS = Wild smolt release.
HP = Hatchery parr release.
HS = Hatchery smolt release.

Table 3.1.6 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	10.75	28,700
1976	6,0229	242,468	5.03	92,636
1977	128,885	245,608	2.91	138,000
1978	168,033	135,014	1.80	132,900
1979	98,693	272,585	3.76	59,800
1980	399,903	282,001	1.71	126,300
1981	24,695	232,348	10.41	97,800
1982	135,007	259,674	2.92	123,700
1983	367,605	170,277	1.46	219,200
1984	657,722	137,203	1.21	254,800
1985	612,548	108,598	1.18	247,400
1986	723,400	55,000	1.08	452,800
1987	637,536	82,759	1.13	449,300
1988	850,900	87,100	1.10	472,500
1989	524,300	80,200	1.15	533,954

Table 3.1.7 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
1990	227	2.69	84,387	63,290	5,557

Table 3.1.8 Harvest estimates in numbers of 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
1990	5,557	3,968	123

Table 3.1.9 Annual mean fork lengths and whole weights of Atlantic salmon caught at West Greenland, 1969-1990. Fork length (cm); whole weight (kg). NA = North American; E = European.

Year	Whole weight (kg)									Fork length (cm)					
	Sea age									Sea age					
	1SW		2SW		PE		Total		Total	1SW		2SW		PS	
	NA	E	NA	E	NA	E	NA	E		NA	E	NA	E	NA	E
1969	3.12	3.76	5.48	5.80	-	5.13	3.25	3.86	3.58	65.0	68.7	77.0	80.3	-	75.3
1970	2.85	3.46	5.65	5.50	4.85	3.80	3.06	3.53	3.28	64.7	68.6	81.5	82.0	78.0	75.0
1971	2.65	3.38	4.30	-	-	-	2.68	3.38	3.14	62.8	67.7	72.0	-	-	-
1972	2.96	3.46	5.85	6.13	2.65	4.00	3.25	3.55	3.44	64.2	67.9	80.7	82.4	61.5	69.0
1973	3.28	4.54	9.47	10.00	-	-	3.83	4.66	4.18	64.5	70.4	88.0	96.0	61.5	-
1974	3.12	3.81	7.06	8.06	3.42	-	3.22	3.86	3.58	64.1	68.1	82.8	87.4	66.0	-
1975	2.58	3.42	6.12	6.23	2.60	4.80	2.65	3.48	3.12	61.7	67.5	80.6	82.2	66.0	75.0
1976	2.55	3.21	6.16	7.20	3.55	3.57	2.75	3.24	3.04	61.3	65.9	80.7	87.5	72.0	70.7
1977	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1978	2.96	3.50	7.00	7.90	2.45	6.60	3.04	3.53	3.35	63.7	67.3	83.6	-	60.8	85.0
1979	2.98	3.50	7.06	7.60	3.92	6.33	3.12	3.56	3.34	63.4	66.7	81.6	85.3	61.9	82.0
1980	2.98	3.33	6.82	6.73	3.55	3.90	3.07	3.38	3.22	64.0	66.3	82.9	83.0	67.0	70.9
1981	2.77	3.48	6.93	7.42	4.12	3.65	2.89	3.58	3.17	62.3	66.7	82.8	84.5	72.5	-
1982	2.79	3.21	5.59	5.59	3.96	5.66	2.92	3.43	3.11	62.7	66.2	78.4	77.8	71.4	80.9
1983	2.54	3.01	5.79	5.86	3.37	3.55	3.02	3.14	3.10	61.5	65.4	81.1	81.5	68.2	70.5
1984	2.64	2.84	5.84	5.77	3.62	5.78	3.20	3.03	3.11	62.3	63.9	80.7	80.0	69.8	79.5
1985	2.50	2.89	5.42	5.45	5.20	4.97	2.72	3.01	2.87	61.2	64.3	78.9	78.6	79.1	77.0
1986	2.75	3.13	6.44	6.08	3.32	4.37	2.89	3.19	3.03	62.8	65.1	80.7	79.8	66.5	73.4
1987	3.00	3.20	6.36	5.96	4.69	4.70	3.10	3.26	3.16	64.2	65.6	81.2	79.6	74.8	74.8
1988	2.83	3.36	6.77	6.78	4.75	4.64	2.93	3.41	3.18	63.0	66.6	82.1	82.4	74.7	73.8
1989	2.56	2.86	5.87	5.77	4.23	5.83	2.77	2.99	2.87	62.3	64.5	80.8	81.0	73.8	82.2
1990	2.53	2.61	6.47	5.78	3.90	5.09	2.67	2.72	2.64	62.3	62.7	83.4	81.1	72.6	78.6

Table 3.1.10 Sea age composition (%) from research vessel and commercial catch samples of Atlantic salmon at West Greenland, 1969-1990.

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
1990	Commercial	95.9	3.2	0.9

Table 3.1.11 The sea age composition of samples from commercial catches at West Greenland, 1985-1990.

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
1990	95.7	3.4	0.9	96.3	3.0	0.7

Table 3.1.12 River age distribution (%) for all North American and European origin salmon sampled at West Greenland, 1968-1990.

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	4.0	0.0
1973	2.0	40.8	34.7	18.4	2.0	2.0	0.0	0.0
1974	0.9	36.0	36.6	12.0	11.7	2.6	0.3	0.0
1975	0.4	17.3	47.6	24.4	6.2	4.0	0.0	0.0
1976	0.7	42.6	30.6	14.6	10.9	0.4	0.4	0.0
1977	-	-	-	-	-	-	-	-
1978	2.7	31.9	43.0	13.6	6.0	2.0	0.9	0.0
1979	4.2	39.9	40.6	11.3	2.8	1.1	0.1	0.0
1980	5.9	36.3	32.9	16.3	7.9	0.7	0.1	0.0
1981	3.5	31.6	37.5	19.0	6.6	1.6	0.2	0.0
1982	1.4	37.7	38.3	15.9	5.8	0.7	0.0	0.2
1983	3.1	47.0	32.6	12.7	3.7	0.8	0.1	0.0
1984	4.8	51.7	28.9	9.0	4.6	0.9	0.2	0.0
1985	5.1	41.0	35.7	12.1	4.9	1.1	0.1	0.0
1986	2.0	39.9	33.4	20.0	4.0	0.7	0.0	0.0
1987	3.9	41.4	31.8	16.7	5.8	0.4	0.0	0.0
1988	5.2	31.3	30.8	20.9	10.7	1.0	0.1	0.0
1989	7.9	39.0	30.1	15.9	5.9	1.3	0.0	0.0
1990	8.8	45.3	30.7	12.1	2.4	0.5	0.1	0.0
Total	4.0	38.8	34.4	15.4	5.9	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	64.5	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	0.1	0.1	0.2
1983	34.7	50.2	12.3	2.4	0.3	0.2	0.0	0.0
1984	22.7	56.9	15.2	4.2	0.9	0.0	0.0	0.0
1985	20.2	61.6	14.9	2.7	0.6	0.0	0.1	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	0.1	0.0
1989	18.0	61.7	17.4	2.7	0.3	0.0	0.0	0.0
1990	15.9	56.3	23.0	4.4	0.2	0.0	0.0	0.0
Total	20.7	61.7	14.9	2.3	0.3	0.0	0.0	0.0

Table 3.2.1 Estimated Carlin tag recoveries and run size in Maine rivers. Ratio of tag to run size of 2SW salmon in homewaters. Ratio (year i) for use in estimation of distant water harvest (year i-1).

Year	Tags	Run	RATIO
1967	0	1019	0.0000
1968	168	729	0.2307
1969	7	690	0.0104
1970	13	856	0.0155
1971	68	687	0.0985
1972	318	1449	0.2197
1973	206	1448	0.1425
1974	215	1411	0.1520
1975	450	2345	0.1920
1976	184	1341	0.1374
1977	97	2025	0.0478
1978	97	4145	0.0233
1979	36	1878	0.0190
1980	0	5662	0.0000
1981	470	5122	0.0918
1982	284	6023	0.0472
1983	138	1930	0.0716
1984	61	3045	0.0202
1985	185	4855	0.0381
1986	309	5568	0.0555
1987	119	2397	0.0498
1988	319	2855	0.1118
1989	190	2946	0.0646
1990	172	4355	0.0394

Table 3.2.2. Carlin 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	20	4	0	105
1989	4	14	44	22	14	8	0	106
1990	1	2	5	3	2	0	0	13
x)	2	11	22	7	8	2	5	57
TOTAL	98	431	467	318	221	158	313	2006

x) Unknown.

Table 3.2.3. Estimated harvest 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	2446
1972	49	39	345	59	148	49	118	809
1973	46	259	231	148	120	111	296	1212
1974	59	549	696	579	234	147	352	2615
1975	102	225	164	51	10	31	716	1299
1976	510	431	353	118	0	0	118	1529
1977	0	81	483	0	81	161	81	886
1978	0	592	237	0	0	0	237	1066
1980	0	1134	613	276	0	0	184	2207
1981	0	811	238	0	0	0	858	1908
1982	26	1100	26	26	0	52	52	1283
1983	0	70	418	0	0	0	0	488
1984	37	332	332	0	37	111	0	849
1985	101	633	177	203	0	127	228	1469
1986	28	283	424	480	311	509	0	2035
1987	25	365	654	541	365	126	0	2075
1988	22	632	523	588	436	87	0	2287
1989	143	500	1571	785	500	286	0	3784
TOTAL	1483	8605	8225	4368	2893	2220	4051	31845

Table 3.2.4. Carlin 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
1990	0	0	1	0	0	0	0	1
TOTAL	5	26	13	5	5	2	14	70

Table 3.2.5. Estimated harvest 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	81	0	0	0	0	0	81
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	105
1984	0	70	0	0	0	0	0	70
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
1990	0	0	36	0	0	0	0	36
TOTAL	59	514	213	44	69	24	268	1191

Table 3.3.1 Input data for exploitation rate calculations for 1SW salmon and 2SW salmon of Maine origin.

Year i	RUN2 i+1	GH2 i+1	CH2 i+1	USAC i+1	NN2 i+1	GH1 i	CH1 i	RUN3 i+2
1967	729	18	50	0	161	226	242	19
1968	690	135	274	0	274	0	411	18
1969	856	0	92	0	92	545	277	17
1970	687	100	135	14	14	828	398	49
1971	1,449	77	12	7	52	2,446	295	13
1972	1,448	118	66	30	20	809	105	59
1973	1,411	65	9	28	38	1,212	220	28
1974	2,345	73	65	30	7	2,615	758	5
1975	1,341	0	8	0	0	1,299	1,014	16
1976	2,025	0	90	30	60	1,529	2,230	32
1977	4,145	81	61	0	0	886	940	4
1978	1,878	0	59	0	0	1,066	309	10
1980	5,122	61	135	0	0	2,207	4,631	36
1981	6,023	143	145	30	61	1,908	1,147	15
1982	1,930	105	31	0	20	1,283	1,603	16
1983	3,045	70	0	0	0	488	1,700	8
1984	4,855	0	96	0	0	849	1,329	24
1985	5,568	51	71	0	0	1,469	2,288	52
1986	2,397	0	0	0	0	2,035	552	7
1987	2,855	38	48	13	0	2,075	580	8
1988	2,946	22	61	44	0	2,287	393	21
1989	4,355	36	0	0	0	3,784	1,717	-

RUN2 = Run to homewaters of 2SW salmon.
RUN3 = Run to homewaters of 3SW salmon.
GH1 = Greenland harvest of 1SW salmon
GH2 = Greenland harvest of 2SW salmon.
CH1 = Newfoundland harvest of 1SW salmon.
CH2 = Newfoundland harvest of 2SW salmon.
USAC = USA Coastal harvest of 2SW salmon.
NN2 = Non-Newfoundland harvest of 2SW salmon by Canada.

Table 3.3.2 Estimated exploitation rate of 1SW salmon for the extant population of Maine origin stocks. Only columns with 0.00 unaccounted are true "extant" exploitation rates.

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
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
1989	0.53	0.69	0.55	0.71	0.50	0.67	0.53	0.69
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 3.3.3 Estimated exploitation rate of 2SW salmon for the extant population of Maine origin stocks. Only columns with 0.00 present unaccounted are true extant exploitation rates.

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
1989	0.78	0.88	0.80	0.89	0.76	0.86	0.78	0.88
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 3.3.4 Estimates of Exploitation Rates for the Reduced Model 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
1989	0.78	0.46	0.42	0.61	0.28	0.89	0.88	0.63	0.59	0.76	0.44	0.94
Average	0.72	0.35	0.38	0.47	0.26	0.77	0.83	0.50	0.54	0.63	0.40	0.85
Average last 10 years*	0.71	0.32	0.39	0.45	0.27	0.78	0.84	0.47	0.55	0.60	0.41	0.87

*Revised.

Table 3.3.5 Results from migration model.

Year	FU	Exp. rate EG.	P = 0.1 Exp. rate WG 0.8-0.4	CAN	P = 0.3 Exp. rate WG 0.8-0.4	CAN
1971	0.05	0.32	0.62-0.77	0.62	0.68-0.81	0.35
	0.10	0.19	0.64-0.78	0.63	0.69-0.82	0.37
	0.15	0.13	0.65-0.79	0.65	0.70-0.83	0.38
	0.20	0.10	0.66-0.80	0.66	0.72-0.83	0.39
	0.25	0.08	0.68-0.81	0.68	0.73-0.84	0.41
	0.30	0.07	0.69-0.82	0.69	0.74-0.85	0.43
	0.35	0.06	0.71-0.83	0.71	0.76-0.86	0.44
1974	0.05	0.14	0.52-0.69	0.72	0.58-0.74	0.46
	0.10	0.08	0.54-0.70	0.73	0.60-0.75	0.48
	0.15	0.05	0.55-0.71	0.74	0.61-0.76	0.49
	0.20	0.04	0.56-0.72	0.76	0.62-0.77	0.51
	0.25	0.03	0.58-0.73	0.77	0.64-0.78	0.52
	0.30	0.03	0.60-0.75	0.78	0.66-0.79	0.54
	0.35	0.02	0.61-0.76	0.79	0.67-0.80	0.56
1985	0.05	0.27	0.21-0.34	0.77	0.25-0.40	0.52
	0.10	0.15	0.21- 0.35	0.78	0.26-0.41	0.54
	0.15	0.11	0.22-0.37	0.79	0.27-0.43	0.55
	0.20	0.08	0.23-0.38	0.80	0.28-0.44	0.57
	0.25	0.07	0.25-0.40	0.81	0.30-0.46	0.58
	0.30	0.06	0.26-0.41	0.82	0.31-0.47	0.60
	0.35	0.05	0.27-0.43	0.83	0.33-0.49	0.62
1986	0.05	0.24	0.45-0.62	0.64	0.52-0.68	0.37
	0.10	0.14	0.47-0.64	0.65	0.53-0.69	0.39
	0.15	0.09	0.48-0.65	0.67	0.54-0.70	0.40
	0.20	0.07	0.50-0.66	0.68	0.56-0.72	0.42
	0.25	0.06	0.51-0.68	0.69	0.57-0.73	0.43
	0.30	0.05	0.53-0.69	0.71	0.59-0.74	0.45
	0.35	0.04	0.55-0.71	0.72	0.61-0.76	0.47
1988	0.05	0.47	0.43-0.60	0.52	0.49-0.66	0.26
	0.10	0.31	0.44-0.61	0.53	0.50-0.67	0.28
	0.15	0.23	0.46-0.63	0.55	0.52-0.68	0.29
	0.20	0.18	0.47-0.64	0.56	0.53-0.70	0.30
	0.25	0.15	0.49-0.66	0.58	0.55-0.71	0.31
	0.30	0.13	0.50-0.67	0.59	0.57-0.72	0.33
	0.35	0.11	0.52-0.69	0.61	0.59-0.74	0.34

Reporting rate in East Greenland = 1.0, and in West Greenland = 0.8 and 0.4.

Table 4.1.1 Nominal landings of Atlantic salmon by Faroes vessels in years 1982-1990 and the seasons 1981/1982 - 1989/1990.

Year	Catch (t)	Season	Catch (t)
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	364	1988/1989	309
1990[1]	312	1989/1990[1]	361

[1] Preliminary catch.

Table 4.1.2 Catch in number of salmon by month in the Faroes fishery for the seasons 1983/1984 to 1989/1990.

Season	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total
1983/1984	8,680	24,882	12,504	26,396	32,712	12,486	6,849	0	124,508
1984/1985	5,884	20,419	14,493	24,380	26,035	25,471	19,095	0	135,776
1985/1986	1,571	27,611	13,992	50,146	25,968	21,209	14,057	0	154,554
1986/1987	1,881	19,693	5,905	15,113	35,241	21,953	39,153	1,365	140,304
1987/1988	4,259	27,125	5,803	9,387	9,592	4,203	4,642	0	65,011
1988/1989	17,019	24,743	2,916	4,663	12,457	31,698	-	-	93,496
1989/1990	13,079	40,168	5,533	11,282	11,379	29,504	570	-	111,425

Table 4.1.3 Estimation of discard rates in the Faroes fishery 1982/1983 to 1989/1990.

Season	No. of samples	Number sampled	No. <60cm	Discard rate %	Range %
1982/1983	7	6,820	472	6.9	0 - 10.4
1983/1984	5	4,467	176	3.9	-
1984/1985	12	9,546	1,289	13.5	3 - 32
1985/1986	7	14,654	286	1.8	0.6 13.8
1986/1987	13	39,758	2,849	7.2	0 - 71.3
1987/1988	2	1,499	235	15.6	-
1988/1989	9	17,235	1,804	10.7	0.4 - 31.9
1989/1990	5	16,375	1,533	9.4	3.6 - 18.5

Table 4.1.4a Catch of salmon in number per unit effort (1,000 hooks) by month in the Faroes longline fishery south of 65°30'N in the seasons 1981/1982 - 1989/1990.

Season	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Season
1981/1982	-	38	41	49	58	51	34	-	46
1982/1983	19	120	-	61	50	39	36	40	48
1983/1984	85	80	86	58	45	28	26	-	51
1984/1985	38	38	32	32	37	39	40	-	36
1985/1986	64	52	68	54	48	78	61	-	56
1986/1987	31	43	34	44	70	111	102	-	64
1987/1988	56	51	-	47	34	25	22	-	43
1988/1989	63	80	48	68	61	76	-	-	71
1989/1990	81	86	38	56	87	77	-	-	76

Table 4.1.4b Catch of salmon in number per unit effort (1,000 hooks) by month in the Faroes longline fishery north of 65°30'N in the seasons 1981/1982 - 1989/1990.

Season	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Season
1981/1982	-		72	69	73	64	65	-	69
1982/1983	-	-	-	-	68	41	-	54[1]	60
1983/1984	102[1]	-	-	-	34[1]	-	-	-	70
1984/1985	-	-	-	46	31	37	43	-	37
1985/1986	-	-	-	-	38[1]	82	84	-	80
1986/1987	-	-	67[1]	64	77	-	94	-	77
1987/1988	48	68	73	71[1]	31[1]	32[1]	-	-	65
1988/1989	-	-	-	-	71[1]	-	-	-	71
1989/1990	-	-	-	-	-	103	-	-	103

[1] Data from less than 6 sets.

Table 4.1.5 Percentage sea age distribution of landed catch by month in the 1989/1990 season, determined by fork length method (see text for details).

Month	Sea age 1	Sea age 2	Sea age 3+	Total
Nov	0.5	97.5	1.9	99.9
Dec	1.0	99.0	0.0	100.0
Jan/Feb	-	-	-	-
Mar	3.6	88.3	8.0	99.9
Apr	0	85.4	14.6	100.0
May	0	94.6	5.4	100.0
Weighted mean	1.4	92.8	5.8	100.0

Table 4.1.6 Catch in number by sea age class by fishing seasons in the Faroes salmon fishery since 1983/1984.

Season	Sea Age 1	%	2	%	3	%	4	%	Total
1983/1984	5,142	3	136,418	86	16,401	10	59	0	157,961
1984/1985	381	0	138,375	92	11,358	8	0	0	150,114
1985/1986	2,021	1	169,462	96	5,671	3	87	0	177,241
1986/1987	71	0	124,628	95	6,621	5	75	0	131,395
1987/1988	5,833	9	55,728	86	3,450	5	0	0	65,011
1988/1989	1,351	1	86,417	92	5,728	6	0	0	93,496
1989/1990	1,560	1	103,407	93	6,463	6	0	0	111,430
Total	16,359	2	814,435	92	55,692	6	221	0	886,648

Table 4.1.7 Smolt age composition from samples taken in the Faroes fishery from 1984/1985 to 1988/1989.

Season	1	2	3	4	5	6	Unknown	Total
1984/1985	1.5	37.9	46.9	12.3	1.5	0.1	0	2194
1985/1986	0.8	20.4	52.7	24.4	1.7	0	0	951
1986/1987	0.2	16.2	48.5	31.8	3.1	0.2	0	575
1987/1988	1.2	35.9	49.5	13.2	0.4	0	0	680
1988/1989	3.5	47.0	40.5	7.0	0.3	0	1.8	798
1989/1990	3.9	52.2	35.5	6.7	1.1	0	0.6	358

Table 4.1.8 Number of microtags recovered at Faroes by country of origin.

Season	Country of Origin	Discards Recovery	1SW	2SW	Total
1981/1982	Ireland	1	-	2	3
	UK (Scotland)	-	-	2	2
1982/1983	Ireland	4	2	2	8
	UK (Scotland)	-	-	1	1
1983/1984	UK (Scotland)	-	-	1	1
1984/1985	Iceland	2	-	-	2
	Ireland	15	-	3	18
	UK (Scotland)	3	-	-	3
	Raising Factors	14.2	3.55	3.55	
1985/1986	Ireland	8	-	5	13
	Faroe Islands	-	-	3	3
	UK (England + Wales)	-	-	1	1
	Raising Factors				
1986/1987	Faroe Islands	-	-	29	29
	Ireland	8	-	1	9
	UK (England + Wales)	1	-	5	5
	UK (N. Ireland)	4	-		4
	UK (Scotland)	2	-	1	3
	Raising Factors				
1987/1988	Faroe Islands	-	-	20	20
	Iceland	-	1	-	1
	Ireland	3	1	4	8
	UK (England + Wales)	1	-	3	4
	Raising Factors	51.5	2.7	2.7	
1988/1989	Canada	1	-	-	1
	Faroe Islands	2	-	-	2
	Iceland	-	-	15	15
	Ireland	17	-	2	19
	UK (England + Wales)	2	1	13	16
	UK (N. Ireland)	-	-	1	1
	UK (Scotland)	2	-	2	4
	USA	-	-	1	1
	Raising Factors	5.4	1.8	1.8	
1989/1990	Faroe Islands	-	-	30	30
	Ireland	14	-	3	17
	UK (England + Wales)	3	1	5	9
	Raising Factors	7.7	2.3	2.3	

Table 4.1.9 Calculation of Raising Factors for the Microtag data from the Faroes Fishery 1984/1985 to 1989/1990

			A	%	B	C	Discard	D	1SW 2SW
Season	No. trips	Total sample	No. of discard	Discard rate	Total landed	Total discard	Raise by C/A	Total observed	Raise by B/D
1984/1985	12	9,546	1,289	13.5	135,776	18,330	14.2	38,276	3.55
1985/1986	7	14,654	368	1.8	154,554	2,782	10.4	52,186	2.96
1986/1987	13	39,758	2,849	7.2	140,304	10,102	3.5	47,347	2.96
1987/1988	2	1,264	235	18.6	65,011	12,092	51.5	24,160	2.69
1988/1989	9	17,235	1,840	10.7	93,496	10,004	5.4	51,562	1.81
1989/1990	5	16,375	1,533	9.4	111,430	11,811	7.7	48,352	2.30

Table 4.1.10 Estimated numbers of discards, 1SW and 2SW microtagged salmon caught in the Faroese fishery for smolt releases between 1984 and 1989 (year of fishery for 2SW is n+1).

Year of migration yr(n)	Country of origin	Number released	Discards yr(n)	1SW yr(n)	Number in catch All 1SW yr(n)	2SW yr(n+1)	Total	Rec./rel x 10^{-3}
1984	Faroe Islands	19,620	-	-	-	9	9	0.46
	Ireland	260,816	213	-	213	15	228	0.87
	N. Iceland	72,352	28	-	28	-	28	0.39
	UK (Engl.+ Wales)	39,780	-	-	-	3	3	0.08
	UK (Scotland)	30,040	43	-	43	-	43	1.42
1985	Faroe Islands	30,079	-	-	-	87	87	2.89
	Ireland	220,000	83	-	83	3	86	0.39
	UK (Engl.+ Wales)	53,347	-	-	-	15	15	0.28
	UK (Scotland)	13,497	-	-	-	3	3	0.22
1986	Faroe Islands	43,000	-	-	-	54	54	1.26
	Ireland	143,866	28	-	28	11	39	0.27
	UK (Engl.+ Wales)	177,071	4	-	4	8	12	0.07
	UK (N. Ireland)	26,320	14	-	14	-	14	0.53
	UK (Scotland)	16,217	7	-	7	-	7	0.43
1987	Ireland	162,189	155	3	157	4	161	0.99
	N. Iceland	27,978	-	3	3	27	30	1.06
	UK (Engl.+ Wales)	195,373	52	-	52	23	75	0.38
	UK (N. Ireland)	20,145	-	-	-	2	2	0.09
	UK (Scotland)	20,876	-	-	-	4	4	0.17
	USA	640,400	-	-	-	2	2	0.00
1988	Canada	13,322	5	-	5	-	5	0.38
	Faroe Islands	43,481	11	-	11	69	80	1.84
	Ireland	165,841	92	-	92	7	99	0.60
	UK (Engl.+ Wales)	189,913	11	2	13	12	25	0.13
	UK (Scotland)	31,331	5	-	5	-	5	0.16
1989	Ireland	185,439	108	-	108	N/A	108	0.58
	UK (Engl.+ Wales)	256,342	23	2	25	N/A	25	0.10

Table 4.1.11 Estimated extant exploitation rates 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%, Norwegian home water fisheries 50% and Sweden 65%.

	Norway						Scotland			Sweden	
	R. Drammen		R. Imsa				North Esk			R. Lagan	
	Hatchery		Wild		Hatchery		Wild			Hatchery	
Season	1SW	2SW	1SW	2SW	1SW	2SW	1SW	2SW	3SW	1SW	2SW
1981/1982			0	-	1	-	<1	0	0		
1982/1983			0	25	2	38	0	6	0		
1983/1984			0	50	1	45	<1	13	7		
1984/1985	5	-	0	33	2	39	0	9	29	0	
1985/1986	0	30	0	38	0	30	0	0	9	3	22
1986/1987	0	3	0	13	1	28	<1	4	0	2	0
1987/1988	0	6	0	5	1	21	0	5	0	0	9
1988/1989	0	36	0	3	0	10	0	0	0	0	13
1989/1990[1]	0	45	0	5	0	15	0	<1	0	2	9

[1] Provisional exploitation rate estimates.

Table 5.1.1 Nominal catch in tonnes of Atlantic salmon of all ages for Salmon Fishing Areas of Newfoundland and Labrador and Quebec commercial fisheries in 1986-1990. Numbers in parentheses are catch totals in numbers of fish. Catches for 1990 are preliminary.

Salmon Fishing Areas	1986	1987	1988	1989	1990 Catch	1990 Quota
1	89	75	65	76	30	80[1]
2	309	407	292	213	151	200
3	192	369	192	151	135	155
4	200	180	104	133	92	100
5	61	60	39	37	15	25
6	54	48	25	27	12	20
7-11	167	137	82	108	64	82
13-14	159	212	174	122	87	95
Q7-Q9	85	97	89	79	64	NA[3]
	(21,802)[4]	(23,525)[4]	(22,863)[4]	(20,525)[4]	(19,249)	(29,605)
Q11	15	11	9	1	1	15
Total	1329	1596	1071	947	652	692[2]

[1]Allowance.
[2]Excludes an allowance of 80 t for SFA 1.
[3]NA=Not Applicable-Quote expressed in numbers rather than weight.
[4]Quotas for 1986 to 1989 were 33,125 per year.

Table 5.1.2 Nominal catches (tonnes) in Newfoundland and Labrador commerical Atlantic salmon fishery, 1971-90.

Year	Small	Large	Total[1]	Quota
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	431	436	867	-
1990	265	322	586[3]	677[2]

[1] Differences between total and sum of small and large are due to rounding
[2] Excludes an allowance of 80 t for SFA 1.
[3] Preliminary.

Table 5.1.3 Preliminary landings, in tonnes, of Atlantic salmon harvested in the commercial fisheries in Atlantic Canada, 1990. Comparison are made to the average landings, 1984-89.

SFA	Small		Large		Total	
	Weight(t)	% Change 1984-89	Weight(t)	% Change 1984-89	Weight(t)	% Change 1984-89
1	8	-58	22	-57	30	-58
2	52	-41	100	-40	151	-41
3	43	-57	92	-3	135	-31
4	61	-30	31	-43	92	-35
5	9	-71	7	-70	15	-72
6	7	-73	4	-75	12	-72
7	3	-56	3	-76	6	-70
8	1	-91	2	-83	3	-87
9	2	-70	1	-50	3	-67
10	16	-36	7	-30	23	-34
11	9	-66	20	-21	29	-42
12	0	0	0	0	0	0
13	29	-28[1]	14	-31[1]	43	-29[1]
14	25	-48[1]	19	-54[1]	44	-51[1]
15-23	0	0	0	0	0	0
Q1-6	0	0	0	0	0	0
Q 7	<1	66[1]	8	-32[1]	8	-27[1]
Q 8	<1	-36[1]	30	-9[1]	30	-10[1]
Q 9	4	7[1]	21	-8[1]	26	-4[1]
Q10	0	0	0	0	0	0
Q11	NA	-	NA	-	NA	-

[1]Percent change from 1985-89.
NA=Not Available.

Table 5.1.4 Preliminary landings, in numbers, of Atlantic salmon harvested in the recreational fisheries in Atlantic Canada, 1990. Comparisons are made to the average landings, 1984-89.

	Small		Large		Total	
SFA	Numbers	% Change 1984-89	Numbers	% Change 1984-89	Numbers	% Change 1984-89
1	272	-62	70	-50	342	-60
2	1,971	-9	189	-9	2,160	-9
3	17187	54	0	0	1,718	-54
4	5,662	-37	0	0	5,662	-37
5	2,414	-24	0	0	2,414	-24
6	334	-10	0	0	334	-10
7	49	-51	0	0	49	-51
8	86	-14	0	0	86	-14
9	1,866	4	0	0	1,866	4
10	835	-34	0	0	835	-34
11	4,446	-16	0	0	4,446	-16
12	853	-24	0	0	853	-24
13	6,689	6	0	0	6,689	6
14	6,121	4	97	-41	6,218	2
15	4,277	-9	0	0	4,277	-9
16	12,060	-21	0	0	12,060	-21
17	768	192	0	0	768	192
18	1,115	50	0	0	1,115	50
19	896	6	0	0	896	6
20	2,995	38	0	0	2,995	38
21	3,747	15	0	0	3,747	15
22	312	-69	0	0	312	-69
23	2,613	-20	0	0	2,613	-28
Q 1	1,399	49[1]	3,054	14[1]	4,453	23[1]
Q 2	608	119[1]	1,020	-27[1]	1,628	-3[1]
Q 3	881	111[1]	1,233	27[1]	2,114	36[1]
Q 4	0	0	0	0	0	0
Q 5	70	223[1]	81	212[1]	151	221[1]
Q 6	368	68[1]	744	44[1]	1,112	51[1]
Q 7	1,244	40[1]	630	-7[1]	1,874	20[1]
Q 8	977	33[1]	4,211	86[1]	51,880	73[1]
Q 9	947	-13[1]	470	-24[1]	1,417	-17[1]
Q10	465	-9[1]	398	-50[1]	863	-34[1]
Q11	792	-19[1]	590	-30[1]	1,382	-24[1]

[1]Percent change from 1985-89.

Table 5.1.5 The number of salmon examined for CWTs, periods of sampling and origin of tags recovered in Canada, 1990.

Location	Sampling Period	Number Examined	Adipose Clipped	Percent Clipped	Origin Canada	USA	Total CWT	Percent CWT
Fox Harbour	6/28-7/28	1566	8	0.51	0	0	0	0.00
Goose Cove	6/18-7/24	5140	3	0.06	0	2	2	0.04
Croque	6/14-7/31	1773	9	0.51	1	3	4	0.23
Conche	6/25-7/21	1567	2	0.13	0	0	0	0.00
Englee	6/15-7/24	1961	12	0.61	1	3	4	0.20
Harbour Deep	7/14-8/3	566	24	4.24	2	11	13	2.30
Shoe Cove	6/13-7/23	4746	26	0.55	0	15	15	0.32
Leading Tickles	6/15-7/23	613	12	1.96	0	2	2	0.33
Campbelton	6/25-7/5	15	0	0.00	0	0	0	0.00
Twillingate	6/6-7/23	1121	9	0.80	0	2	2	0.18
Fogo	6/16-7/21	885	7	0.79	0	2	2	0.23
Musgrave	6/25-7/21	114	0	0.00	0	0	0	0.00
Total Average		19953	112	0.92	4	40	44	0.35

Table 5.1.6 Summary of exploitation rates in the Canadian recreational fisheries from SFA's 15, 16, and 18. Early season refers to exploitation on fish entering the river prior to September 1 while late season refers to fish entering after August 31.

		Exploitation Rate				Reporting
River	Season	N	Mean	SD	Range	Rate Range
SFA 15	Restigouche River (1982-89)					
1SW	Combined	8	0.48	0.06	0.40-0.55	NA
SFA 16	Miramichi River (1985-90)					
1SW	Early	6	0.27	0.05	0.18-0.31	0.5-0.8
	Late	6	0.13	0.10	0.00-0.28	0.5-0.8
	Combined	6	0.25	0.06	0.17-0.30	0.5-0.8
SFA 18	Margaree River (1988-90)					
1SW	Late	3	0.17	0.08	0.10-0.25	0.51-0.67
MSW	Late	3	0.11	0.06	0.0.07-0.17	0.51-0.67

NA=Not Applicable.
N =Number of years.

Table 5.2.1 Estimated numbers of wild returning and spawning Atlantic salmon, egg depositions, ratios of MSW spawners to returns and fraction of target egg deposition attained in the Restigouche, Miramichi, Saint John, LaHave, Margaree, Conne rivers, and Riviere de la Trinite. Empty cells mean no prediction available. Bold numbers are target spawners and eggs.

Year	Returns (10^3)			Spawners (10^3)		Eggs (10^6)	MSW Spawners/ MSW Returns	Eggs/ Target Eggs
	1SW	MSW	Predicted	1SW	MSW			
Restigouche River								
TARGET				2.6	12.2	71.4		
1982	8.0	11.2		2.0	1.8	10.9	0.16	0.15
1983	3.3	10.2	13.5	0.6	1.4	8.7	0.14	0.12
1984	10.9	7.8	11.3	1.3	3.1	18.6	0.40	0.26
1985	7.0	9.9	12.2	2.5	6.3	37.4	0.63	0.52
1986	10.7	14.1	14.8	3.8	8.8	52.6	0.62	0.74
1987	10.0	10.1	21.9	3.5	5.9	35.0	0.58	0.49
1988	13.5	12.6	12.9	4.7	8.2	49.3	0.65	0.69
1989	7.4	11.1		2.6	6.6	39.2	0.59	0.55
1990[2]	10.3- 17.1	10.6- 16.6		4.4- 10.2	6.4- 11.4	37.8- 68.5	0.65[5]	0.53- 0.96
Miramichi River[1]								
TARGET				22.6	23.6	132.0		
1982	80.4	30.8		52.0	12.3	109.8	0.40	0.83
1983	25.2	27.9	43.0	10.8	7.5	48.1	0.27	0.36
1984	29.7	15.1	10.2	14.9	13.7	77.0	0.91	0.58
1985	60.8	20.7	18.4	37.8	19.1	130.0	0.92	0.98
1986	117.5	31.3	28.4	85.4	29.2	226.4	0.93	1.72
1987	84.8	19.4	54.2	58.8	17.1	175.9	0.88	1.33
1988	121.9	21.7	36.4	86.3	20.0	189.3	0.92	1.43
1989	75.2	17.2		50.6	14.6	124.1	0.85	0.94
1990	90.5	28.6		66.9	26.6	195.4	0.93	1.48
Saint John River[1] above Mactaquac Dam								
TARGET				3.2	4.4	29.5		
1982	7.8	6.5		4.9	2.3	16.5	0.35	0.56
1983	5.8	4.0		3.7	1.3	8.5	0.33	0.29
1984	9.8	10.9	6.2	7.2	7.2	39.5	0.66	1.34
1985	8.5	11.3	10.5	4.5	6.3	36.3	0.56	1.23
1986	8.8	6.9	8.8	5.9	3.5	26.1	0.51	0.88
1987	9.2	4.8	11.0	7.0	2.8	21.3	0.58	0.72
1988	10.2	3.5	8.0	7.5	1.5	13.1	0.43	0.44
1989	10.9	4.5	7.1	7.2	3.1	21.1	0.69	0.72
1990	8.8	4.1		5.8	2.9	20.0	0.71	0.68

Table 5.2.1 cont'd.

Year	Returns (10^3) 1SW	Returns (10^3) MSW	Predicted	Spawners (10^3) 1SW	Spawners (10^3) MSW	Eggs (10^6)	MSW Spawners/ MSW Returns	Eggs/ Target Eggs
LaHave River above Morgan Falls								
TARGET				0.6	0.1	1.7		
1983	1.1	0.2		1.1	0.2	2.0	1.00	1.18
1984	2.0	0.4	0.2[3]	2.0	0.3	3.1	0.75	1.82
1985	1.3	0.6	0.3[3]	1.3	0.4	3.4	0.67	2.00
1986	1.6	0.6	0.4[3]	1.6	0.4	4.1	0.67	2.41
1987	2.5	0.5	0.4[3]	2.5	0.4	4.9	0.80	2.88
1988	2.5	0.4	0.7[3]	2.4	0.3	4.4	0.75	2.59
1989	2.1	0.5		2.5	0.4	4.3	0.80	2.53
1990	1.9	0.4		1.8	0.3	3.3	0.75	1.94
Margaree River[1]								
TARGET				0.6	1.0	6.7		
1983	0.2	0.5		0.1	0.3	1.8	0.60	0.27
1984	0.4	0.4		0.2	0.3	2.0	0.75	0.30
1985	0.6	0.8		0.4	0.8	5.3	1.00	0.79
1986	0.8	2.0		0.5	2.0	12.9	1.00	1.93
1987	1.6	2.2		1.2	2.1	14.0	0.95	2.09
1988	2.1	1.0		1.5	1.0	6.5	1.00	0.97
1989	0.8	1.3		0.6	1.2	7.8	0.92	1.16
1990[2]	0.5-1.5	4.2-14.6		0.3-1.2	4.1-14.5	26.8-93.8	0.98[5]	4.0-14.0
Conne River								
TARGET				4.0	-	7.8		
1986	8.3	0.4		5.0	0.4	10.6	0.60[4]	1.36
1987	10.2	0.5	7.9-8.8	7.3	0.5	15.7	0.72[4]	2.01
1988	7.6	0.4	6.2-6.8	5.2	0.4	11.7	0.68[4]	1.50
1989	5.0	0.3		3.4	0.3	7.6	0.68[4]	0.97
1990	5.4	0.4		3.5	0.3	8.2	0.65[4]	1.05

Table 5.2.1 cont'd.

Year	Returns (10^3) 1SW	Returns (10^3) MSW	Predicted	Spawners (10^3) 1SW	Spawners (10^3) MSW	Eggs (10^6)	MSW Spawners/ MSW Returns	Eggs/ Target Eggs
Rivière de la Trinité								
TARGET				1.0	0.5	2.7		
1982	2.4	0.3		1.6	0.2	1.2	0.66	0.44
1983	0.9	0.5		0.7	0.5	2.5	1.00	0.93
1984	1.8	0.5		1.4	0.4	2.2	0.80	0.81
1985	1.1	0.6		0.9	0.4	2.2	0.67	0.81
1986	1.6	0.6		1.1	0.4	2.3	0.67	0.85
1987	1.3	0.6		0.8	0.4	2.6	0.67	0.96
1988	1.6	0.8		1.0	0.7	4.5	0.88	1.67
1989	1.9	0.5		1.3	0.3	2.3	0.60	0.85
1990	1.9	0.5		1.2	0.4	2.6	0.80	0.96

[1] Hatchery and wild origin.
[2] Range of estimates provided for Restigouche and Margaree Rivers in 1990.
[3] Prediction does not adjust for increased counts resulting from release of MSW fish from angling.
[4] 1SW spawners/1SW returns.
[5] Mean value.

Table 5.3.1 Carlin tag returns from 1SW salmon of Maine origin in Newfoundland and Labrador by year and salmon fishing areas.

	Salmon Fishing Area															
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Unknown	Total
1967	3	1	7	14	5	0	4	0	1	1	2	0	0	0	2	40
1968	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	3
1969	0	0	2	0	1	0	0	1	0	0	0	0	0	0	0	3
1970	5	2	13	5	1	1	0	1	0	1	0	0	0	0	0	29
1971	10	2	4	18	10	3	0	0	0	0	1	0	0	0	0	48
1972	6	1	0	0	4	0	0	0	0	0	0	1	0	0	0	12
1973	6	1	6	4	1	1	1	3	1	0	0	0	0	1	0	25
1974	0	5	19	38	13	10	5	3	3	3	0	1	0	3	0	103
1975	16	4	18	36	14	6	1	4	1	2	0	0	0	1	0	102
1976	18	6	26	14	5	5	0	0	0	3	2	0	0	1	0	80
1977	2	1	6	5	0	0	0	0	0	1	1	0	0	0	0	16
1978	4	0	1	2	1	0	0	0	0	0	0	0	0	0	0	5
1980	55	24	112	72	22	6	0	3	2	3	12	0	0	3	1	315
1981	14	0	2	10	7	5	1	0	1	0	0	0	0	1	0	41
1982	14	7	20	21	7	6	1	0	0	1	4	0	2	2	0	85
1983	8	1	11	6	0	0	0	0	0	0	0	0	0	0	0	26
1984	12	4	7	7	4	2	1	0	0	1	1	0	0	0	0	39
1985	20	3	15	36	11	1	3	2	0	0	0	0	0	2	1	94
1986	3	5	6	2	1	0	0	1	0	0	0	0	0	3	0	21
1987	14	2	16	4	6	2	0	2	1	1	0	0	0	0	1	49
1988	8	2	5	0	1	0	1	0	0	1	1	0	0	1	0	20
1989	25	5	10	6	4	1	1	1	0	1	0	0	0	0	0	54
1990	0	2	2	2	0	0	0	0	0	0	2	0	0	0	0	8
Unknown	2	0	1	1	0	0	1	1	0	0	0	0	0	0	0	6
Total	245	78	309	303	116	49	20	22	10	19	26	2	2	18	5	1224

Table 5.3.2 Estimated harvest of 1SW salmon of Maine origin in Newfoundland and Labrador by year and Salmon Fishing Area.

	Salmon Fishing Area															
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Unknown	Total
1967	14	5	43	87	31	0	25	0	6	6	12	0	0	0	12	242
1968	0	0	0	274	137	0	0	0	0	0	0	0	0	0	0	411
1969	0	0	185	0	0	0	0	92	0	0	0	0	0	0	0	277
1970	56	23	188	72	14	14	0	14	0	14	0	0	0	0	0	398
1971	51	10	26	117	65	20	0	0	0	0	7	0	0	0	0	295
1972	47	8	0	0	40	0	0	0	0	0	0	10	0	0	0	105
1973	44	7	56	38	9	9	9	28	9	0	0	0	0	9	0	220
1974	0	29	141	283	97	74	37	22	22	22	0	7	0	22	0	758
1975	129	32	187	374	135	62	10	42	10	21	0	0	0	10	0	1014
1976	418	139	777	418	149	149	0	0	0	90	60	0	0	30	0	2230
1977	95	48	368	307	0	0	0	0	0	61	61	0	0	0	0	940
1978	234	0	75	0	0	0	0	0	0	0	0	0	0	0	0	309
1980	666	291	1744	1121	343	93	0	47	31	47	187	0	0	47	16	4631
1981	330	0	61	303	212	151	30	0	30	0	0	0	0	30	0	1147
1982	217	109	399	419	140	120	20	0	0	20	80	0	40	40	0	1603
1983	441	55	779	425	0	0	0	0	0	0	0	0	0	0	0	1700
1984	350	117	262	150	75	37	0	0	37	37	0	0	0	0	0	1329
1985	400	60	386	926	283	26	77	51	0	0	0	0	0	51	26	2288
1986	67	112	172	57	29	0	0	29	0	0	0	0	0	86	0	552
1987	139	20	204	51	77	26	0	26	13	13	0	0	0	0	13	580
1988	138	34	111	0	22	0	22	0	0	22	22	0	0	22	0	393
1989	705	141	363	218	145	36	36	36	0	36	0	0	0	0	0	1717
Total	4542	1239	6528	5752	2078	857	305	388	123	390	466	17	40	349	66	23140

Table 5.3.3 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 harvests estimates are computed assuming 85 percent fish passage efficiency.

Year i	Run 1SW i	Run 2SW i+1	1/2SW Ratio	Harvest i	Harvest /2SW 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	150	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	4145	0.024	933	0.227
1978	161	1878	0.086	309	0.165
1979	251	5582	0.045	NA	NA
1980	847	5122	0.166	4607	0.902
1981	1148	6023	0.191	1137	0.189
1982	315	1930	0.163	1586	0.828
1983	271	3045	0.089	1689	0.558
1984	388	4855	0.080	1322	0.274
1985	337	5568	0.061	2274	0.409
1986	711	2397	0.297	533	0.222
1987	950	2855	0.333	584	0.204
1988	881	2946	0.299	393	0.134
1989	1267	4355	0.291	1717	0.394

NA=Not Available; no smolts were tagged in 1978.

Table 5.4.1 Quotas, closing date and landings for the commercial fisheries, SFA, 1-14 in 1990. The commercial fisheries opened June 5 in all SFAs. The landings are preliminary, landings for SFAs 1-5 and 10-14 are nominal whereas landings for SFAs 6-9 are from the quota monitoring.

SFA	Quota (t)	Date Closed	Landings (t)
1	a	Oct. 15	30
2	200	Oct. 15	151
3	155	Oct. 15	135
4	100	July 25	92
5	25	July 7	25
6	20	July 14	19
7	15	Oct. 15	13
8	10	July 21	9
9	7	Oct. 15	6
10	25	June 30	23
11	25	June 21	29
12	0	not open	0
13	35	July 3	43
14	60	July 14b	44
Total	677		619c

a Allowance of 80 t
b Southern Labrador re-opened July 20-July 30.
c Includes 30 t in SFA 1 which did not have a quota.

Table 5.4.2 Preliminary estimates of (a) small and (b) large salmon by weight which were affected by the early closure of the commercial fisheries in 8 SFAs in Newfoundland in 1990. Number in parenthesis is the percent of the harvest which would not have been caught during 1984-89 if the season was closed on the same date as in 1990. Predictions illustrate the potential consequences in 1990 of within season variations in catches for 1984-1989.

SFA	1990 Harvest (t)	Predicted weight (t) not caught		
		Min(%)	Max(%)	Mean
(a) Small Salmon				
4	61	5 (8)	19 (24)	10
5	15	4 (23)	18 (54)	9
6	11	2 (17)	11 (50)	5
8	3	<1 (3)	1 (15)	1
10	16	9 (35)	36 (69)	14
11	9	5 (35)	73 (89)	14
13	29	8 (21)	30 (51)	13
14	25	4 (15)	36 (65)	11
Total	169	37	224	77

SFA	1990 Harvest (t)	Min(%)	Max(%)	Mean
(b) Large Salmon				
4	31	5 (14)	10 (24)	6
5	10	1 (13)	5 (32)	3
6	8	1 (9)	6 (43)	2
8	6	<1 (2)	1 (14)	0
10	7	2 (18)	7 (50)	3
11	20	5 (19)	51 (72)	13
13	14	2 (12)	8 (36)	4
14	19	3 (15)	16 (46)	7
Total	115	19	104	38

Table 5.4.3 Preliminary estimates of numbers of (a) small and (b) large salmon which were affected by the early closure of the commercial fisheries in 8 SFAs in Newfoundland in 1990. Number in paranthesis is the percent of the harvest which would not have been caught during 1984-1989 if the season was closed on the same date as in 1990. Predictions illustrate potential consequences in 1990 of within season variations in catches for 1984-1989.

SFA	1990 Harvest (Numbers)	Predicted numbers not caught		
		Min	Max	Mean
(a) Small Salmon				
4	32,024	2,785 (8)	10,113 (24)	5,213
5	8,333	2,350 (22)	9,782 (54)	5,107
6	5,789	1,186 (17)	5,789 (50)	2,601
8	1,765	133 (3)	311 (15)	218
10	9,406	5,065 (35)	20,936 (69)	8,341
11	5,000	2,692 (35)	40,455 (89)	7,500
13	16,600	3,920 (21)	15,570 (49)	6,850
14	12,200	2,090 (15)	16,710 (58)	4,860
Total	91,117	20,221	119,666	40,690
(b) Large Salmon				
4	6,944	1,130 (14)	2,193 (24)	1,422
5	2,703	369 (12)	1,272 (32)	854
6	2,051	203 (9)	1,547 (43)	545
8	1,714	35 (2)	279 (14)	90
10	1,913	420 (18)	1,913 (50)	859
11	4,270	695 (14)	10,454 (71)	2,730
13	3,220	420 (12)	1,670 (34)	980
14	3,620	640 (15)	3,100 (46)	1,370
Total	26,435	3,912	22,428	8,850

Table 5.4.4 Estimates of total harvests, in numbers of 1SW salmon of Maine origin, June 5-October 15, 1984-89, and harvest and percent reduction of total harvest which would have occurred during a period similar to the period of closure in 1990, in SFAs 4, 5, and 6.

	SFA 4			SFA 5			SFA 6			SFA 4, 5, 6		
Year	June 5 to Oct 15	July 26 to Oct 15	%	June 5 to Oct 15	July 7 to Oct 15	%	June 5 to Oct 15	July 14 to Oct 15	%	June 5 to Oct 15	Closure Period	%
1984	74	37	50	111	111	100	74	37	50	259	185	71
1985	77	0	0	33	33	100	26	26	100	136	59	43
1986	58	0	0	29	0	0	0	0	0	87	0	0
1987	52	0	0	65	4	6	26	2	8	143	6	4
1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	218	0	0	109	36	33	0	0	0	327	36	11
Mean	80	6	8[1]	58	31	40[1]	21	11	26[1]	159	48	22[1]
SD	73	15	0	45	43	0	29	16	0	118	71	0

[1] Mean of percents.

Table 5.4.5 Summary of predicted reduction in total catch and reduction in numbers of Maine-origin 1SW salmon for all SFAs (2-11, 12-14) combined, 1984-89. 1 gear unit = 50 fathoms. Standard deviations of predictions are given in parentheses.

	Observed		Predicted				
				Reductions			
Year	Effort (Gear Units) x 10^3	Catch t	Duration[1] Fishery (d) (S.D.)	Catch t	Catch %	Maine No.	Maine %
84	14.3	746	54 (41)	98	13	264	41
85	12.8	794	60 (48)	226	29	131	27
86	13.0	1141	26 (13)	474	42	364	75
87	12.9	1413	32 (33)	746	53	323	58
88	12.5	908	54 (39)	252	28	130	51
89	12.4	792	55 (42)	130	16	157	16
Mean	13.0	966	47	321	30	228	45

[1] Average duration of fishery in each SFA.

Table 5.4.6 Summary of predicted mean reduction in total catch and mean reduction in numbers of Maine-origin 1SW salmon by Salmon Fishing Area, 1984-1989. 1 gear unit - 50 fathoms. Standard deviations of predictions are given in parentheses. From 1984 to 1989 the annual duration of the fishery in SFA 1-11, and 14 was 133d; in SFA 13 the fishery was 36d.

	Observed		Predicted				
				Reductions			
				Catch		Maine	
SFA	Effort (Gear Units) x 10^3	Catch t	Average duration of fishery (d)	t	%	No.	%
2	1437 (29)	255 (100)	80 (48)	70 (82)	21 (21)	22 (35)	38 (45)
3	1759 (68)	195 (90)	84 (54)	48 (83)	16 (23)	64 (82)	38 (44)
4	2814 (154)	140 (41)	51 (25)	36 (44)	21 (23)	32 (30)	42 (38)
5	1125 (114)	54 (5)	26 (13)	29 (13)	51 (13)	43 (56)	46 (45)
6	1026 (74)	42 (16)	30 (12)	22 (16)	46 (20)	15 (17)	42 (49)
7	917 (53)	20 (4)	53 (40)	5 (4)	21 (17)	13 (31)	17 (41)
8	726 (29)	23 (7)	17 (10)	13 (7)	52 (19)	9 (14)	33 (52)
9	179 (12)	9 (2)	59 (36)	2 (2)	20 (16)	0 (0)	0 (0)
10	653 (35)	35 (13)	55 (43)	12 (12)	26 (23)	6 (15)	17 (41)
11	726 (36)	52 (29)	39 (47)	27 (28)	41 (28)	6 (16)	17 (41)
13	464 (34)	57 (23)	26 (6)	23 (19)	33 (23)	0 -	0 -
14	1134 (62)	84 (35)	45 (45)	34 (35)	33 (24)	18 (34)	33 (52)

Table 6.2.1 Estimated exploitation rates (in %) of salmon in homewater fisheries. Reporting rates for external tags assumed to be: North Esk area 100%, elsewhere in Scotland 75%, Norwegian coastal fisheries 50%. (HR = hatchery-reared).

	Iceland	Ireland	Norway						Sweden		UK(Engl.+ Wales)			UK (N.Ireland)		UK (Scotland)	
	R.Ellidaar wild	Burrishoole wild all ages	R.Drammen HR[2]		R.Imsa Wild		R.Imsa HR[2]		Lagan HR(2+)		Itchen Wild all ages		Test	R. Bush Wild	R. Bush Wild/HR	North Esk[3] Wild	
Year	1SW		1SW	2SW	1SW	2SW	1SW	2SW	1SW	2SW	net	rod	rod	1SW	2SW	1SW	2SW
1985		82	57	-	73	94	81	100	77							23	35
1986	34	85	81	50	79	82	78	90	92	82						40	29
1987		75	64	52	56	95	83	95	66	25				69	46	29	37
1988		76	70	47	51	80	78	91	73	82				65	36	35	37
1989	41	82	40	59	65	74	44	65	76	84	9	45	29	89	60	25	26
1990[1]	44	54	5	40	22	42	68	68	45[1]	22[1]	19	49	37	61	38	37	37
Average	40	76	53	50	58	78	72	85	72	49	14	47	33	71	45	32	34

[1] Provisional figures.
[2] HR in R. Drammen and R. Ims are pooled groups of 1+ and 2+ smolts.
[3] In-river netting only.

Table 6.2.2 Wild smolt counts and estimates on various index streams in the NE Atlantic Area including juvenile counts in the River Bush catchment.

Year	Iceland R. Ellidaar	Ireland R. Burrishoole	N.Ireland R. Bush	Norway R. Imsa	Scotland N.Esk	N. Ireland R. Bush
	Estimate	Total count	Total count	Total count	Estimate	juvenile surveys[2]
1981		11,208	14,509	3,214	195,000	-
1982		9,434	10,694	736	160,000	-
1983		10,381	26,804	1,287	-	32.6
1984		9,383	30,009[1]	936	220,000	19.5
1985	29,000	7,270	30,518[1]	892	130,000	7.6
1986		6,268	18,442	477	-	11.3
1987		5,376	21,994	480	199,000	10.3
1988	23,000	3,817	22,783	1,700	-	8.9
1989	22,500	6,554	17,644	1,194	141,000	16.2
1990		6,563	17,133	1,822	175,000	5.6

[1] These smolt counts show effects of enhancement.
[2] Juvenile surveys represent index of fry (0+) abundance (number per 5 minutes electrofishing) at 137 sites, based on natural spawning in the previous year.

Table 6.2.3 Wild adult counts to various rivers in the NE Atlantic Area.

Year	England R. Severn	Iceland R. Ellidaar	Ireland R. Burrishoole	N. Ireland R. Bush	Norway R. Imsa	Scotland N. Esk	Sweden R. Högvadsån	USSR R. Tuloma
	Counter	Estimate	Total Trap	Total Trap	Total Trap	Counter	Total Trap	
1981	3,884		831	1,538		8,731	512	3,467
1982	1,875		347	1,492	66	7,764	572	4,252
1983	1,232		509	966	14	8,434	447	9,102
1984	1,711		602	592[2]	32	6,597	629	10,971
1985	3,257		319	2,376	31	9,036	768	8,067
1986	2,129	2,726	567	2,836	22	6,326	1 632	7,074
1987	1,206	-	495	2,386	9	6,240	1 475	5,470
1988	1,958		467	3,005	44	10,208	1 238	6,069
1989	5,207	2,921	458	993	83	10,215	480	-
1990	1,006	1,822	655	1,843	67	4,000[1]	879	-

[1]Provisional.
[2]Partial count.

Table 6.2.4 Estimated survival of wild smolts (%) into freshwater in various rivers in the NE Atlantic area. R. Bush and R. Imsa data are actual counts.

Smolt migration year	Iceland[1]				Ireland[1]	N. Ireland		Norway[2]		UK (Scotland)		
	R.Ellidar	R.Midfjardara[5]		R. Vesturdalsa	R.Burrishoole	R.Bush		R.Imsa		North Esk[4]		
	1SW	1SW	2SW	1SW	1SW	1SW	2SW	1SW	2SW	1SW	2SW	3SW
1981					5.4	9.5	0.9	2.0	0.3	2.9	1.4	0.1
1982					5.8	7.8	0.8	0.7	0.1	4.1	1.3	0.1
1983				Ca 2.0	3.4	1.9[3]	1.7	2.4	0.1	-	-	-
1984					7.8	6.4	1.4	3.2	0.3	3.0	1.5	0.1
1985	9.4				7.9	7.9	1.9	2.1	0.1	3.6	1.8	0.2
1986					8.7	9.7	1.9	1.6	0.4	-	-	-
1987		4.6	2.6		12.0	12.0	0.4	8.3	1.5	4.4	1.5	0.1
1988	12.7	1.0	2.0		10.1	3.9	0.8	4.3	0.6	-	-	-
1989	8.1	0.4	-	1.1	3.5	9.3	-	4.7	-	2.1	-	-

[1]Microtags.
[2]Carlin tags.
[3]Minimum estimate.
[4]Before in-river netting.
[5]Assumes 50% exploitation in rod fishery.

Table 6.2.5 Survival (%) of hatchery smolts (1+, 2+) into freshwater, released into various rivers in the NE Atlantic area. Included are exact counts and estimates.

Smolt migration year	Iceland[1]				Ireland[1]	N. Ireland[1]		Norway[2]			
	Kollafjordur		R. Midfjordara[4]		R. Burrishoole	R. Bush		R. Imsa		R. Drammen	
	1SW	2SW	1SW	2SW	1SW	1SW 1+ smolts	1SW 2+ smolts	1SW	2SW	1SW	2SW
1981	5.6	3.1			1.3	-	-	2.0	0.1		
1982	8.7	1.6			1.6	-	-	0.2	0.03		
1983	1.2	0.9	0.04	0.15	0.5	0.1	0.4	0.1	0.0		
1984	4.5	0.5	0.45	0.18	3.0	0.9		0.6	0.03	1.5	1.2
1985	ca 7.3	ca 0.7	0.77	0.15	3.7	2.8	4.3	1.3	0.13	0.6	0.9
1986	0	0	0.34	0.66	1.7	0.1	2.1	1.1	0.07	2.2	1.1
1987	7.0	0.5	2.68	0.68	3.5	1.8	8.2	2.1	0.3	0.4	0.3
1988	ca 1.0	ca 0.7	0.88	0.10	3.3	0.4	1.0	4.8	0.2	0.3	0.2
1989	ca 1.0	-			2.5	2.9	6.8	0.5	-	1.1	
1990	-	-				-	-	-			

[1] Microtagged.
[2] Carlin tagged.
[3] Minimum estimate.
[4] Return rates to rod fishery with constant effort.

Table 6.2.6 Summary of estimates of the incidence of fish farm escapees in catches and spawning stocks by country in the North-East Atlantic.

Country	Location	No. sites examined	Net catch	Rod catch	Spawning stock
Iceland	Southwest	5	-	9.6-25.3	-
Ireland	Donegal	1	0.03%	-	-
	Galway	2	<3%		
Norway	Outer coast	9	16-64%	-	-
	Fjords	5	6-36%	-	-
	Fresh water[2]	23	-	0-55%	8-65%
UK (Engl.+ Wales)		10	0	0	0
UK (N. Ireland)	Bush	1	-	-	0.1%
UK (Scotland)	R. Polla	1	10%[1]	5%	-
	West coast	1	21%	-	-
	Northwest coast	1	4.7%	-	-
	North coast	1	3.8%	-	-
	Kyle of Sutherland	1	0	-	-

[1] Experimental netting.
[2] Provisional data.

Table 6.2.7 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	1990
Drift nets	590	826	866	667	795	552	527	0	0
Other nets	469	418	458	572	497	461	314	488	504
Freshwater	289	306	299	322	306	372	235	417	404
Proportion in freshwater	0.21	0.20	0.18	0.21	0.19	0.27	0.22	0.46	0.44
Total	1,348	1,550	1,623	1,561	1,598	1,385	1,076	905	908

Table 6.2.8 Exploitation of River Lagan stock in Norway. Reporting rates assumed to be 50%.

Year of fishery	1SW	2SW
1985	5%	-
1986	6%	0%
1987	5%	11%
1988	12%	0%
1989	0%	0%
1990	4%	0%

Table 6.2.9 Frequency of net marks on Atlantic salmon in 10 Norwegian rivers sampled during 1978-1988 (unweighted mean) and in 1990.

	1978-1988 (Data from Lund and Heggberget, 1991)				1990	
River	Number of sampling years	Total number of fish examined	Net marks %	Range %	Number of fish examined	Net marks %
R. Malselv	9	2,590	44	12-75	206	31
R. Vefsna	8	2,220	33	16-68	102	12
R. Namsen	9	4,036	25	12-36	239	4
R. Stjordal	4	889	43	32-63	69	6
R. Orkla	2	132	71	66-76	73	19
R. Orsta	7	2,094	73	48-90	78	17
R. Gaular	5	1,522	37	23-56	77	27
R. Suldal	7	1,025	18	8-43	425	1
R. Imsa	11	2,886	16	6-47	2,324	5
R. Figgjo	4	950	24	12-38	305	9

Table 7.3.1 Proportion of reported catches of 2SW (MSW) stocks of North American Origin caught at West Greenland.

Year[1]	Numbers of salmon reported from WG	% of NA origin	Numbers of NA 2SW salmon caught in WG	Reported NA home-water catch of 2SW	Total	% of total catch in WG
1981	421	59	248	240	488	51%
1982	336	62	208	201	409	51%
1983	100	40	40	143	183	22%
1984	90	50	45	123	167	27%
1985	311	50	156	163	319	49%
1986	320	57	182	204	386	47%
1987	306	59	181	138	319	57%
1988	288	43	124	142	266	47%
1989	118	56	66	103	169	39%

(All numbers are given in '000)
[1]Refers to year of capture in West Greenland.

Table 7.3.2 Distribution of 2SW (MSW) salmon of NE Atlantic stocks by cohort.

Year[1]	Catches in W. Greenl. No.	%	Catches in Faroes No.	%	Catches in Homewaters No.	Total	% in W.Greenl. and Faroes
1982	128	18%	123	17%	459	710	35%
1983	60	10%	153	24%	418	631	34%
1984	45	7%	150	25%	409	604	32%
1985	156	19%	175	21%	491	822	40%
1986	138	21%	131	20%	377	646	41%
1987	125	22%	59	10%	380	564	32%
1988	164	29%	92	17%	301	557	46%
1989	52	12%	109	26%	264	425	38%

(All numbers are given in '000)
[1]Refers to year of capture in West Greenland.

Table 7.3.3 Summary of input data and constraints for regional run reconstruction model.

Catch Data	Values	
Year of Fishery (i)	1986	1989
Greenland Catch of NA 1SW (i)	182	66
Canadian Comm. Catch of MSW (i+1)	190.7	83.8
Can 1SW Comm (Lab+SFA 3,4,5) (i)	203	159.5
Can MSW Comm (Lab+SFA 3,4,5) (i)	100.2	80.4

Input Parameters	Value
Instan. Natural Mort Rate (1/yr)	0.12
Time btw HW Cat. & Ret. to Riv (yr)	0.083
Time btw Grld Cat & HW Cat. (yr)	0.833
Fract of Stock Elsewhere (FU)	{0, 0.15, 0.3}
Fract of 1SW in Large Category	{0.1, 0.2}

Constraints	Values	
Year of 2SW Return to River	1987	1990
Low No. MSW Returns to Can Rivers (i+1) (in millions of fish)	0.043	0.069
High No. MSW Returns to Can Rivers (i+1) (in millions of fish)	0.142	0.166

Range of Estimates for Non-maturing Salmon (1000s) in 1986

Fraction 1SW Immature	Fract non mat 1SW in Large Size Catch		
	0.1	0.2	0.3
0.1	21.3	22.3	23.3
0.15	32.0	33.5	35.0
0.2	42.6	44.6	46.6

Range of Estimates for Non-maturing Salmon (1000s) in 1989.

Fraction 1SW Immature	Fract non mat 1SW in Large Size Catch		
	0.1	0.2	0.3
0.1	16.8	17.6	18.4
0.15	25.1	26.3	27.5
0.2	33.5	35.1	36.7

Pred No. Non Mat = f_imm x (obs small + q x obs large)

Table 7.3.4 Example application of the regional run-reconstruction model to the 1986 fishery in Greenland. The fraction of 1SW salmon in the Canadian "large" market category was assumed to be 0.1; the fraction of the population unavailable to any fishery was assumed to be 0.15. Catch data and other parameter values are given in Table 7.3.3.

(A) Estimated fishery area exploitation rates (Eq. 7) in West Greenland for values of exploitation rates in homewaters and for fraction of the 2SW population returning from Greenland.

Fraction in W.Grl. (1-P)	Fishery Area Exploitation Rate in Homewater								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0.1	0.49	0.66	0.74	0.79	0.83	0.85	0.87	0.88	0.90
0.2	0.32	0.49	0.59	0.66	0.71	0.74	0.77	0.79	0.81
0.3	0.24	0.39	0.49	0.56	0.62	0.66	0.69	0.72	0.74
0.4	0.19	0.32	0.42	0.49	0.55	0.59	0.63	0.66	0.68
0.5	0.16	0.28	0.37	0.43	0.49	0.54	0.57	0.61	0.63
0.6	0.14	0.24	0.32	0.39	0.44	0.49	0.53	0.56	0.59
0.7	0.12	0.22	0.29	0.35	0.41	0.45	0.49	0.52	0.55
0.8	0.11	0.19	0.26	0.32	0.37	0.42	0.46	0.49	0.52
0.9	0.10	0.18	0.24	0.30	0.35	0.39	0.43	0.46	0.49
Predicted MSW Retrns	1.529	0.680	0.396	0.255	0.170	0.113	0.073	0.042	0.019

Likely range of MSW Returns to Canada in 1987: (0.043,0.142) million

(B) Predicted number of non-maturing 1SW catch in Canada in 1986.

Fraction in W.Grl. (1-P)	Fishery Area Exploitation Rate in Homewater								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0.1	17.2	38.6	66.2	103.0	154.5	231.7	360.4	617.9	******
0.2	14.9	33.5	57.4	89.2	133.9	200.8	312.4	535.5	******
0.3	12.6	28.3	48.5	75.5	113.3	169.9	264.3	453.1	******
0.4	10.3	23.2	39.7	61.8	92.7	139.0	216.3	370.7	834.1
0.5	8.0	18.0	30.9	48.1	72.1	108.1	168.2	288.3	648.8
0.6	5.7	12.9	22.1	34.3	51.5	77.2	120.1	206.0	463.4
0.7	3.4	7.7	13.2	20.6	30.9	46.3	72.1	123.6	278.0
0.8	1.1	2.6	4.4	6.9	10.3	15.4	24.0	41.2	92.7
0.9	-1.1	-2.6	-4.4	-6.9	-10.3	-15.4	-24.0	-41.2	-92.7

(C) Range of Estimates for Non-maturing Salmon (1000s) in Canada, 1986

Fraction 1SW Immature	Fract non mat 1SW in Large Size Catch		
	0.1	0.2	0.3
0.1	21.3	22.3	23.3
0.15	32.0	33.5	35.0
0.2	42.6	44.6	46.6

Tablel 7.3.5 Example application of the regional run-reconstruction model to the 1989 fishery in Greenland. The fraction of 1SW salmon in the Canadian "large" market category was assumed to be 0.1; the fraction of the population unavailable to any fishery was assumed to be 0.15. Catch data and other parameter values are given in Table 7.3.3.

(A) Estimated fishery area exploitation rates (Eq. 7) in West Greenland for values of exploitation rates in homewaters and for fraction of the 2SW population returning from Greenland.

Fraction in W.Grl. (1-P)	Fishery Area Exploitation Rate in Homewater								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0.1	0.44	0.61	0.70	0.76	0.80	0.83	0.85	0.86	0.88
0.2	0.28	0.44	0.54	0.61	0.66	0.70	0.73	0.76	0.78
0.3	0.21	0.35	0.44	0.51	0.57	0.61	0.65	0.68	0.70
0.4	0.17	0.28	0.37	0.44	0.50	0.54	0.58	0.61	0.64
0.5	0.14	0.24	0.32	0.39	0.44	0.49	0.53	0.56	0.59
0.6	0.12	0.21	0.28	0.35	0.40	0.44	0.48	0.51	0.54
0.7	0.10	0.18	0.25	0.31	0.36	0.40	0.44	0.48	0.50
0.8	0.09	0.17	0.23	0.28	0.33	0.37	0.41	0.44	0.47
0.9	0.08	0.15	0.21	0.26	0.31	0.35	0.38	0.41	0.44
Predicted MSW Retrns	0.672	0.299	0.174	0.112	0.075	0.050	0.032	0.019	0.008

Likely range of MSW Returns to Canada in 1990: (0.069,0.166) million

(B) Predicted number of non-maturing 1SW catch in Canada in 1986.

Fraction in W.Grl. (1-P)	Fishery Area Exploitation Rate in Homewater								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0.1	7.5	17.0	29.1	45.3	67.9	101.8	158.4	271.5	610.9
0.2	6.5	14.7	25.2	39.2	58.8	88.2	137.3	235.3	529.4
0.3	5.5	12.4	21.3	33.2	49.8	74.7	116.1	199.1	448.0
0.4	4.5	10.2	17.5	27.2	40.7	61.1	95.0	162.9	366.5
0.5	3.5	7.9	13.6	21.1	31.7	47.5	73.9	126.7	285.1
0.6	2.5	5.7	9.7	15.1	22.6	33.9	52.8	90.5	203.6
0.7	1.5	3.4	5.8	9.1	13.6	20.4	31.7	54.3	122.2
0.8	0.5	1.1	1.9	3.0	4.5	6.8	10.6	18.1	40.7
0.9	-0.5	-1.1	-1.9	-3.0	-4.5	-6.8	-10.6	-18.1	-40.7

(C) Range of Estimates for Non-maturing Salmon (1000s) in Canada, 1989

Fraction 1SW Immature	Fract non mat 1SW in Large Size Catch		
	0.1	0.2	0.3
0.1	16.8	17.6	18.4
0.15	25.1	26.3	27.5
0.2	33.5	35.1	36.7

Table 7.3.6 Summary of the derived range of fishery area exploitation rates for West Greenland for the range of model parameters examined for the 1986 and 1989 fishery years. Exploitation rates are approximate because they do not represent analytical solutions to the constrained model. Instead rates are obtained simply from the spreadsheet solutions.

Year	Fraction of 1SW in "Large" Size Catch	Fraction Unavailable	Constrained Fishery Area Exploitation Rate Interval	
			Min	Max
1986	0.1	0.0	0.35	0.43
		0.15	0.41	0.45
		0.30	0.44	0.49
	0.2	0.0	0.42	0.46
		0.15	0.40	0.49
		0.30	0.52	0.56
1989	0.1	0.0	0.33	0.70
		0.15	0.40	0.70
		0.30	0.44	0.70
	0.2	0.0	0.36	0.73
		0.15	0.43	0.73
		0.30	0.47	0.73

Table 9.2.1 Mean and mean squared error of estimated North American contribution of Atlantic salmon at West Greenland. One hundred simulations were performed in each run. Each simulation constructed a mixed-fishery sample of size 100 (a) and 400 (b) from a mixed fishery with true composition (0.5,0.5).

(a)

1985

	Classification correction unstratified	Classification correction stratified	Maximum likelihood unstratified	Maximum likelihood stratified
fixed learning sample	.515 .0146	.518 .0183	.466 .0093	.453 .0103
random learning samples	.512 .0211	.517 .0234	.464 .0130	.448 .0134

1989

	Classification correction unstratified	Classification correction stratified	Maximum likelihood unstratified	Maximum likelihood stratified
fixed learning sample	.500 .0153	.500 .0130	.570 .0117	.579 .0130
random learning samples	.491 .0307	.516 .0228	.556 .0228	.576 .0217

(b)

1985

	Classification correction unstratified	Classification correction stratified	Maximum likelihood unstratified	Maximum likelihood stratified
fixed learning sample	.493 .0028	.502 .0039	.448 .0047	.445 .0046
random learning samples	.485 .0078	.502 .0081	.459 .0068	.446 .0071

1989

	Classification correction unstratified	Classification correction stratified	Maximum likelihood unstratified	Maximum likelihood stratified
fixed learning sample	.502 .0031	.503 .0024	.574 .0071	.585 .0085
random learning samples	.492 .0149	.545 .0108	.578 .0123	.604 .0156

Table 12.1 Number of microtags, external tags, and finclips applied to Atlantic SALMON by countries, for 1990.

Country	Stock	Micro-tags	External tags	Finclips (only)	Comments
Canada	Hatchery	74,329	66,047	842,938	33,004 externally tagged were
	Wild	30,384	8,263	1,589	adipose clipped
Faroes	Hatchery	11,820	-	-	
	Wild	-	-	-	
France	Hatchery	18,682	20,477	101,701	
	Wild	-	-	-	
Iceland	Hatchery	405,350	250	-	
	Wild	6,000	-	-	
Ireland	Hatchery	151,469	-	-	
	Wild	16,789	-	-	
Norway	Hatchery	-	100,580	-	
	Wild	-	2,822	-	
Sweden	Hatchery	-	8,841	45,510	1,191 externally tagged were
	Wild	-	-	-	adipose clipped
UK (Engl.& Wales)	Hatchery	241,361	8	25,613	microtag releases include
	Wild	8,663	511	-	7,937 without adipose clips
UK (Scotland)	Hatchery	33,460	510	7,219	9,224 externally tagged were
	Wild	7,930	18,067	-	adipose clipped
UK (N. Ireland)	Hatchery	27,076	-	9,362	
	Wild	2,799	-	-	
USA	Hatchery	857,306	50,807	207,646	
	Wild	-	-	-	
USSR	Hatchery	-	4,007	489,174	3,000 externally tagged were
	Wild	-	617	-	adipose clipped
Total	Hatchery	1,820,853	251,527	1,729,163	
	Wild	72,565	30,280	1,589	
Grand Total		1,893,418	281,807	1,730,752	

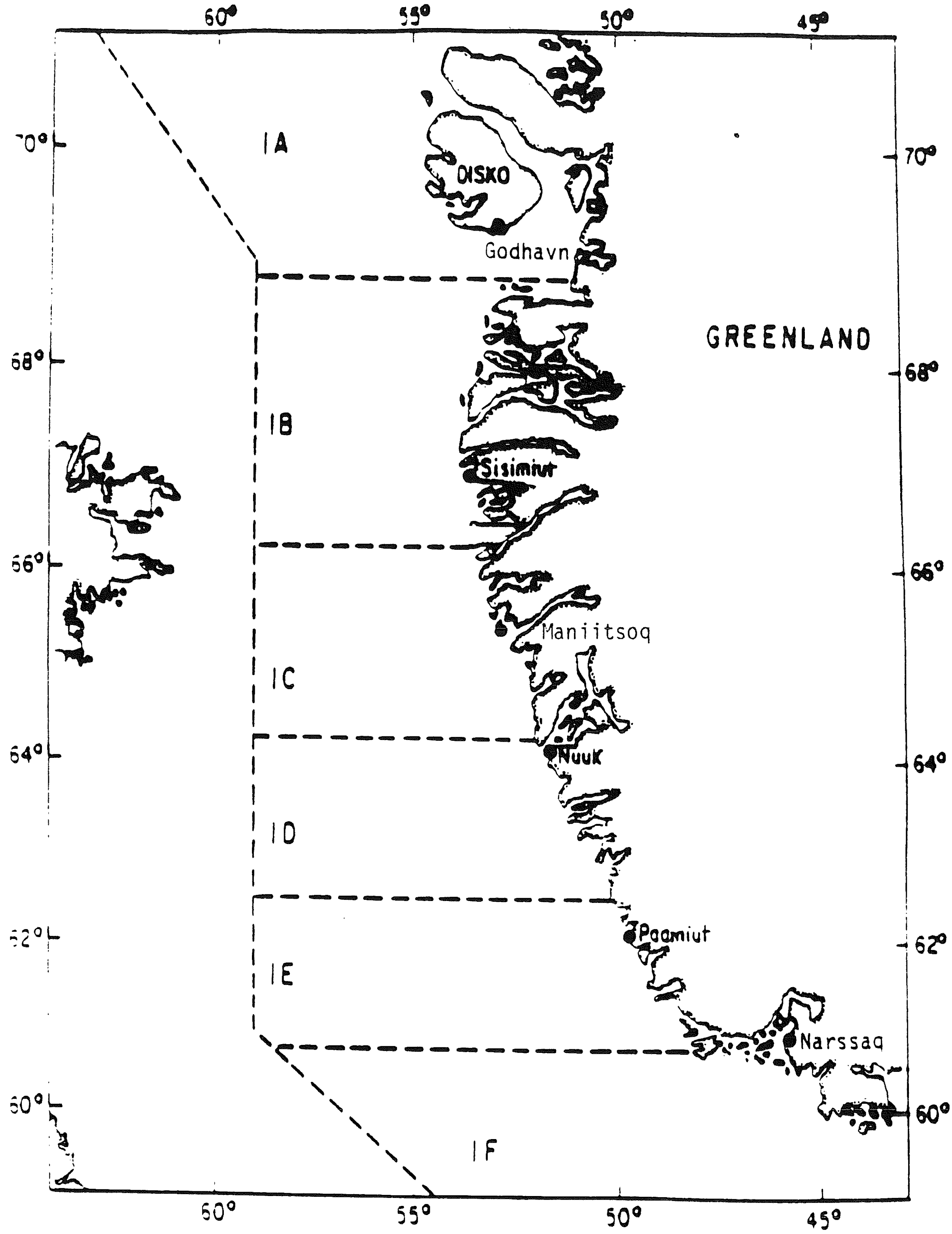
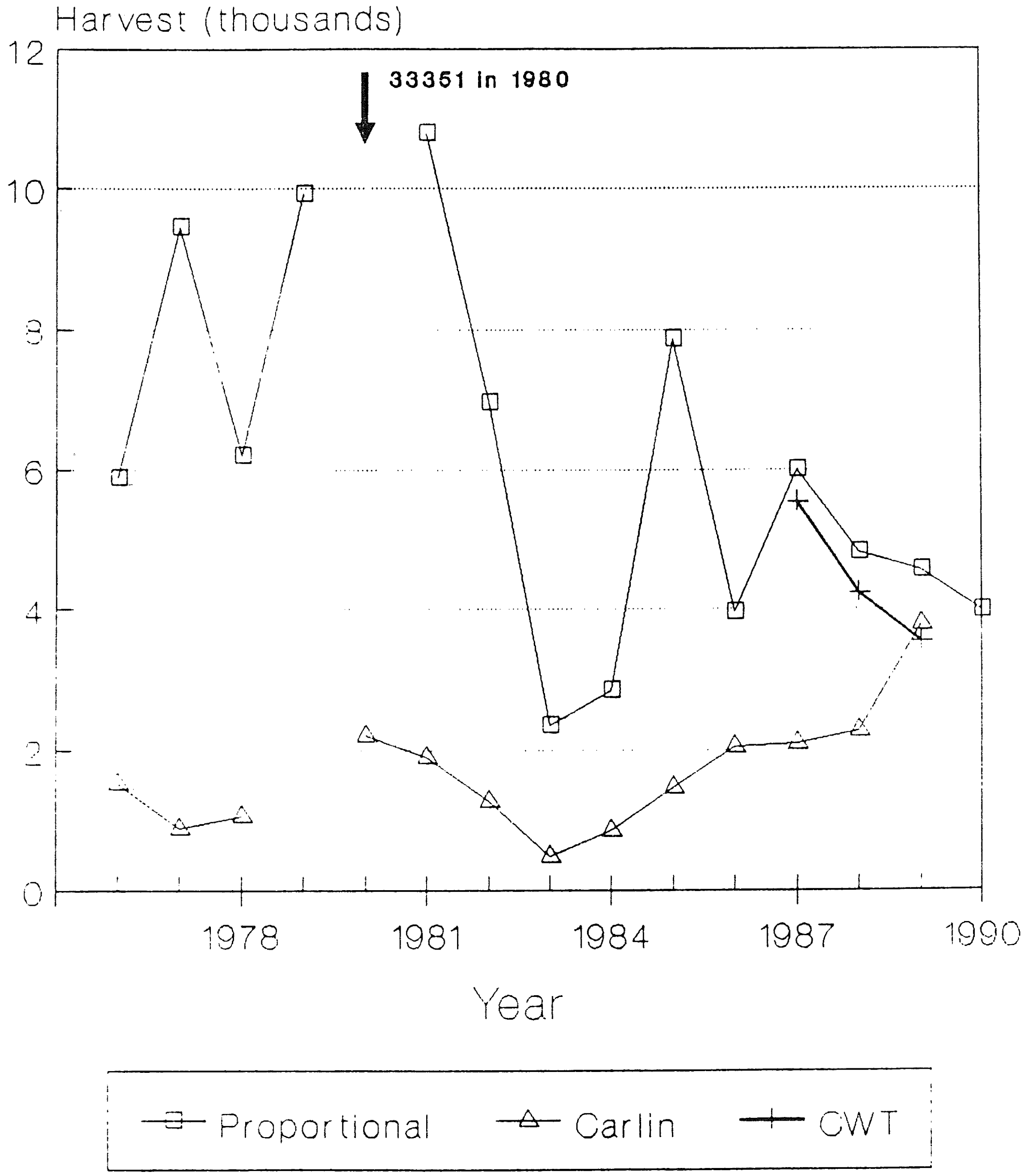


Figure 3.1.1 The coast of Greenland showing NAFO Divisions.

Figure 3.2.1

Comparison of Harvest Estimates of Maine-origin Salmon at West Greenland



Note:No USA Carlin tags released in 1978

Figure 3.2.2 Estimated reporting rates for Carlin tags (1976-1989) based on comparison of Carlin-based harvest estimated and estimates based on CWT recoveries and the proportional harvest model (1987-1989).

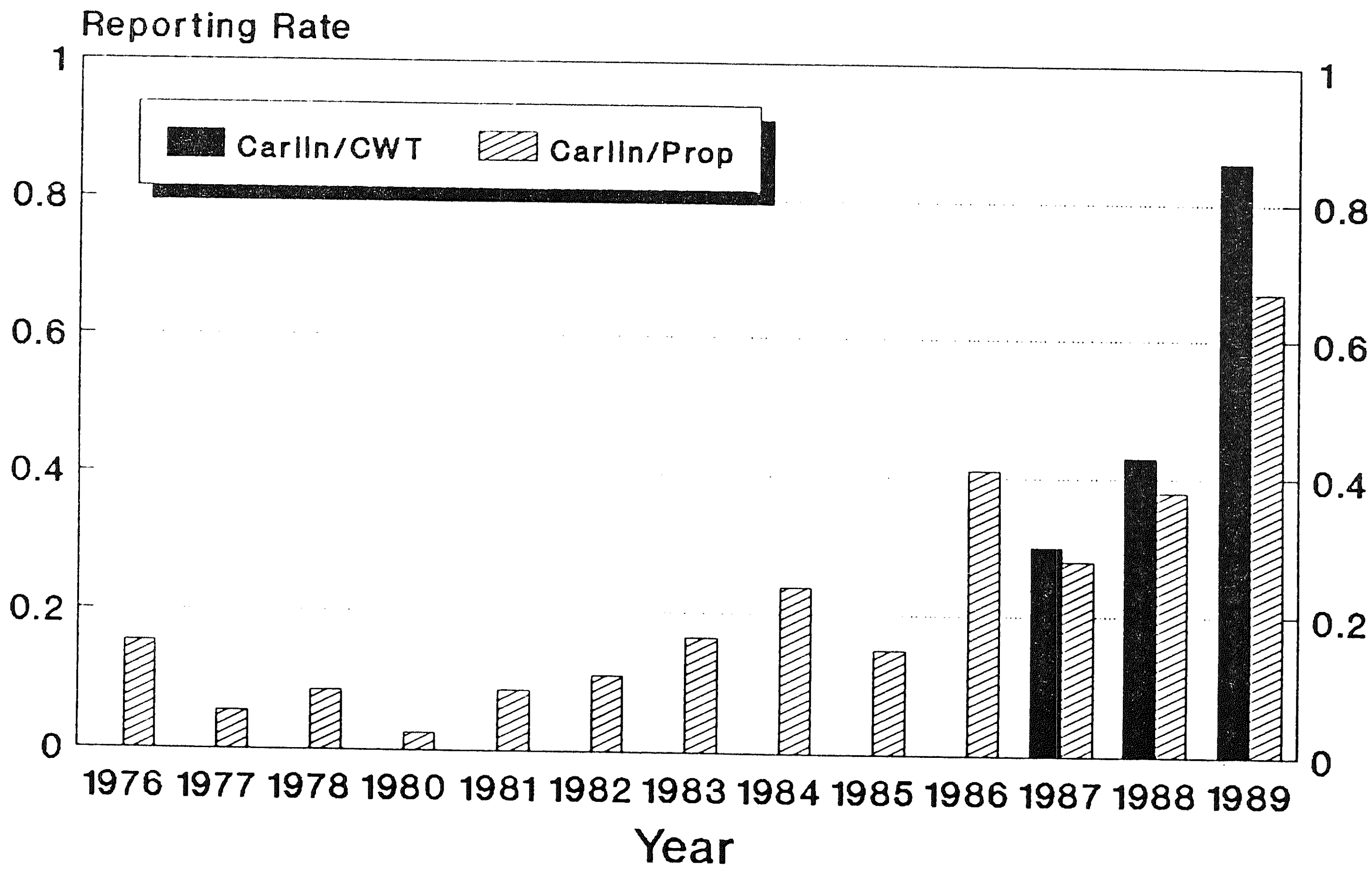


Figure 3.2.3 Comparison of estimated harvest of Maine-origin salmon in West Greenland based on recovery of Carlin tags, (CARLIN) coded wire tags, (CWT), and the age composition of the North American salmon at West Greenland (i.e., the proportional harvest model (PROP).

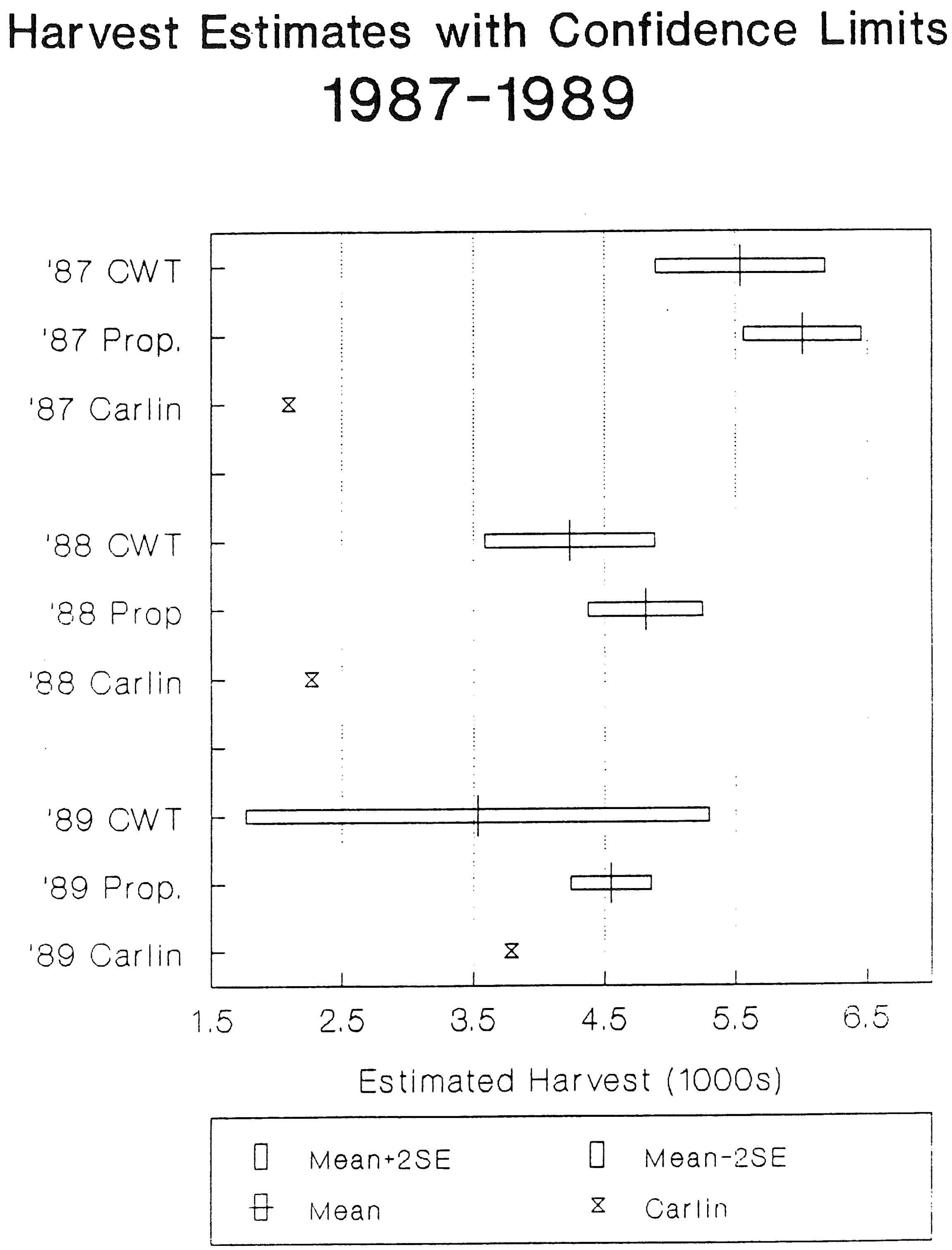


Figure 3.2.4 Effects of catch/day (mt) during the first 2 weeks on reporting rate(1980-1989) at West Greenland.

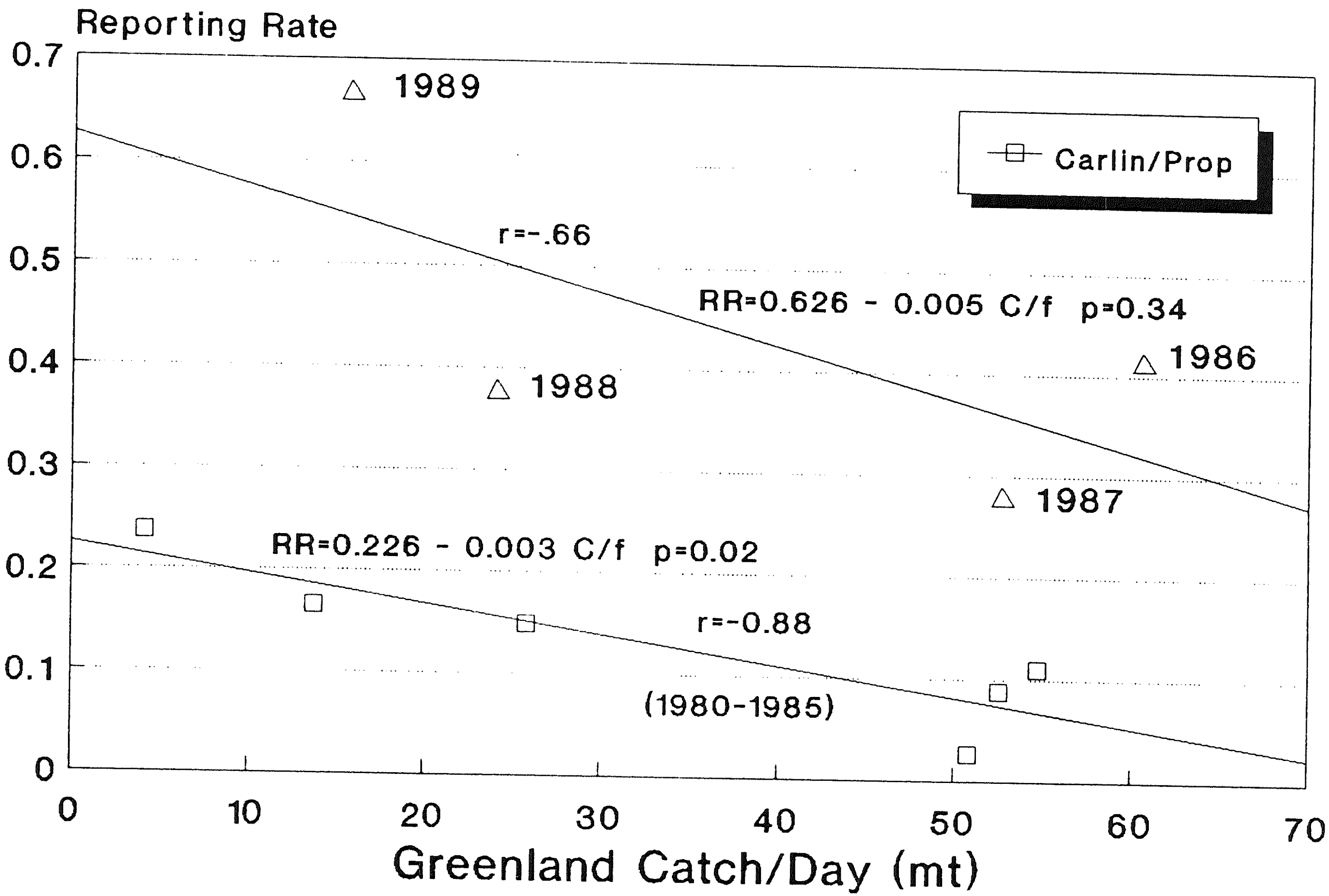
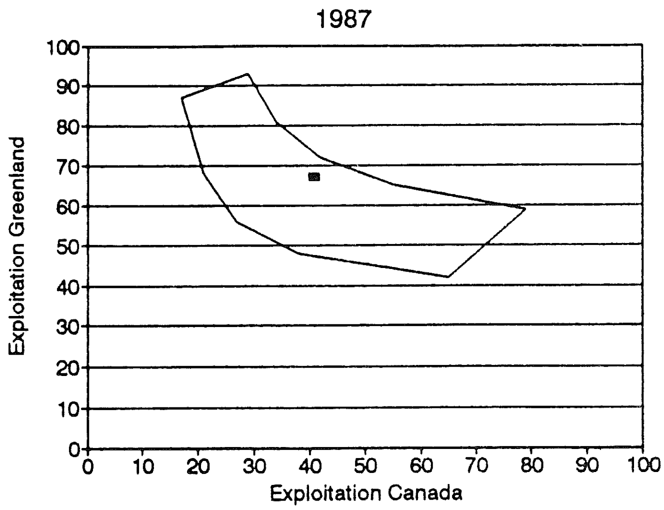


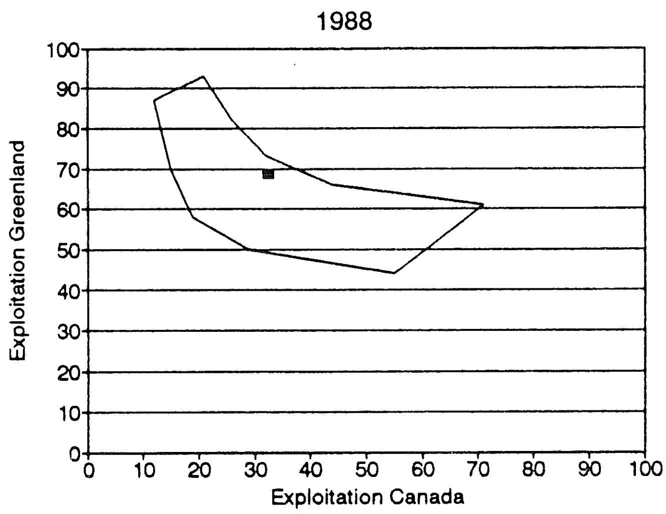
Figure 3.3.1 Effects of Carlin tag reporting rate and proportion of Maine salmon stocks available to the fisheries in Greenland and Canada.

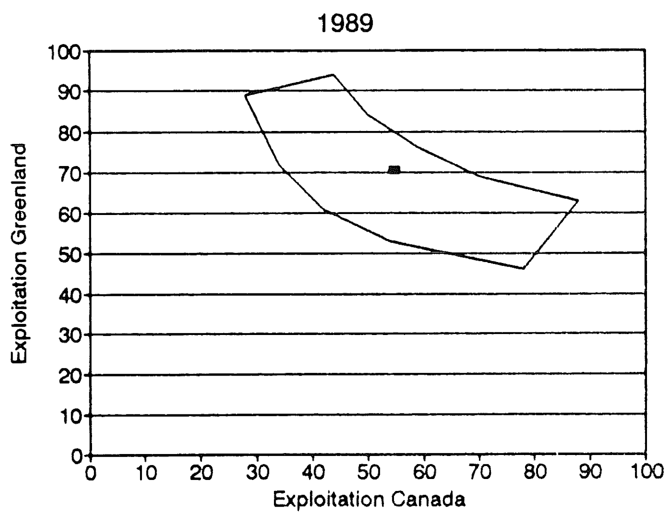


The upper line of each figure represents the levels of exant exploitation when the Carlin-based harvest estimates are multiplied by 2.0.

The lower line represents the level of extant exploitation for unadjusted Carlin tag estimates.

The midpoint represents the average of the values defining the perimeter of the two Carlin adjustment factors.





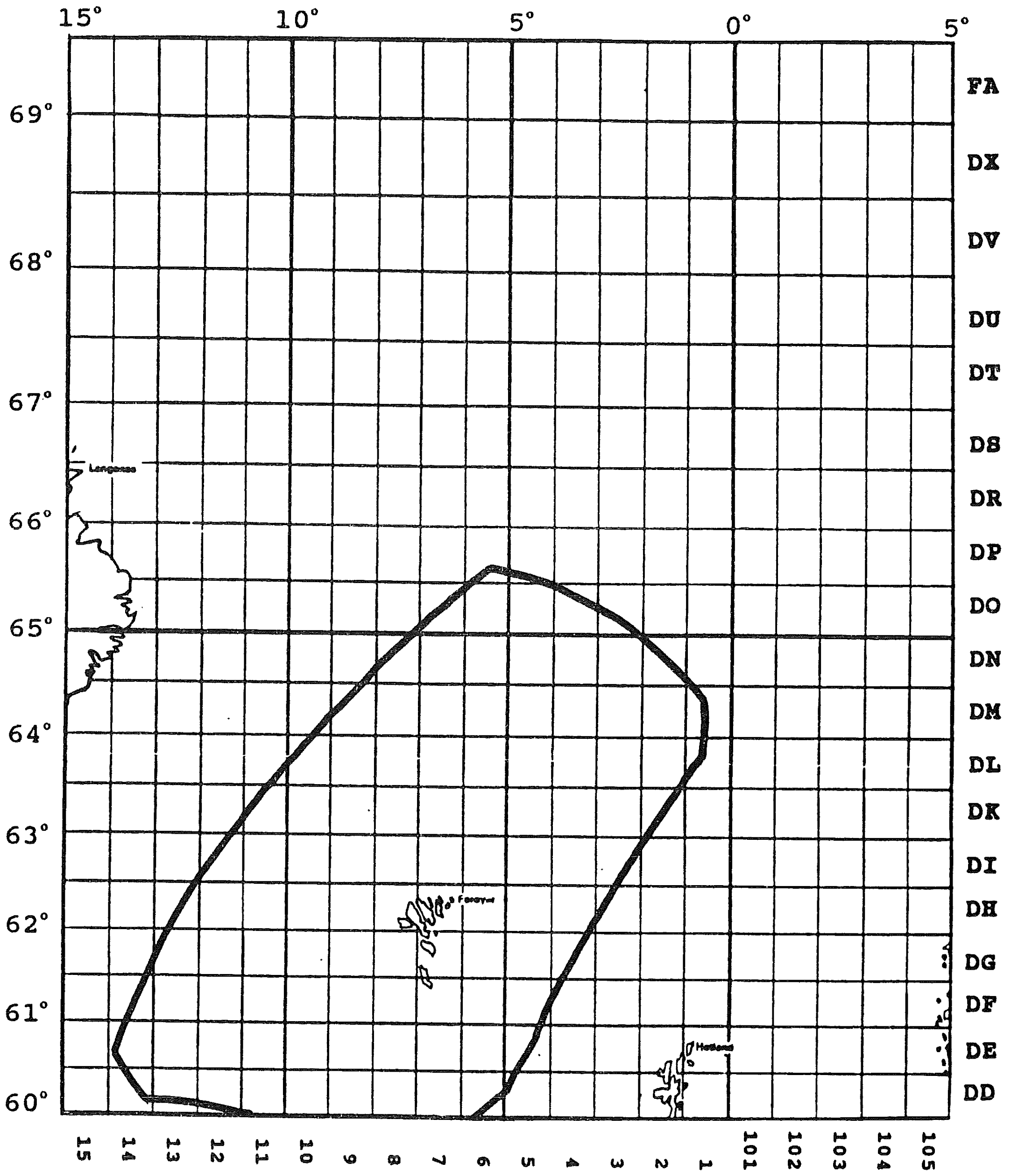


Figure 4.1.1 The Faroese Exclusive Economic Zone (EEC).

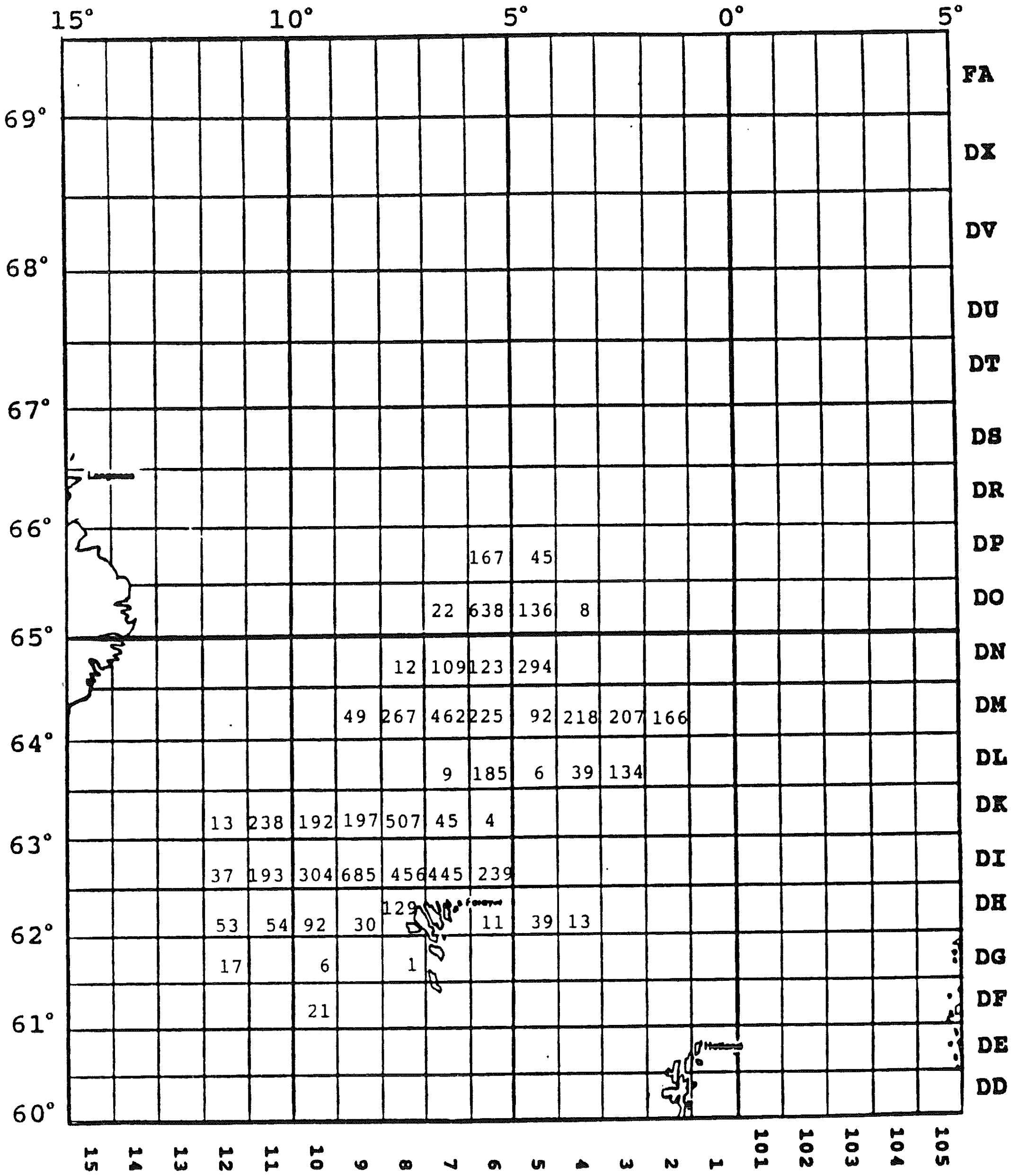


Figure 4.1.2 Catch in number x 10^{-1} by statistical rectangle from logbooks, 1989/90 season.

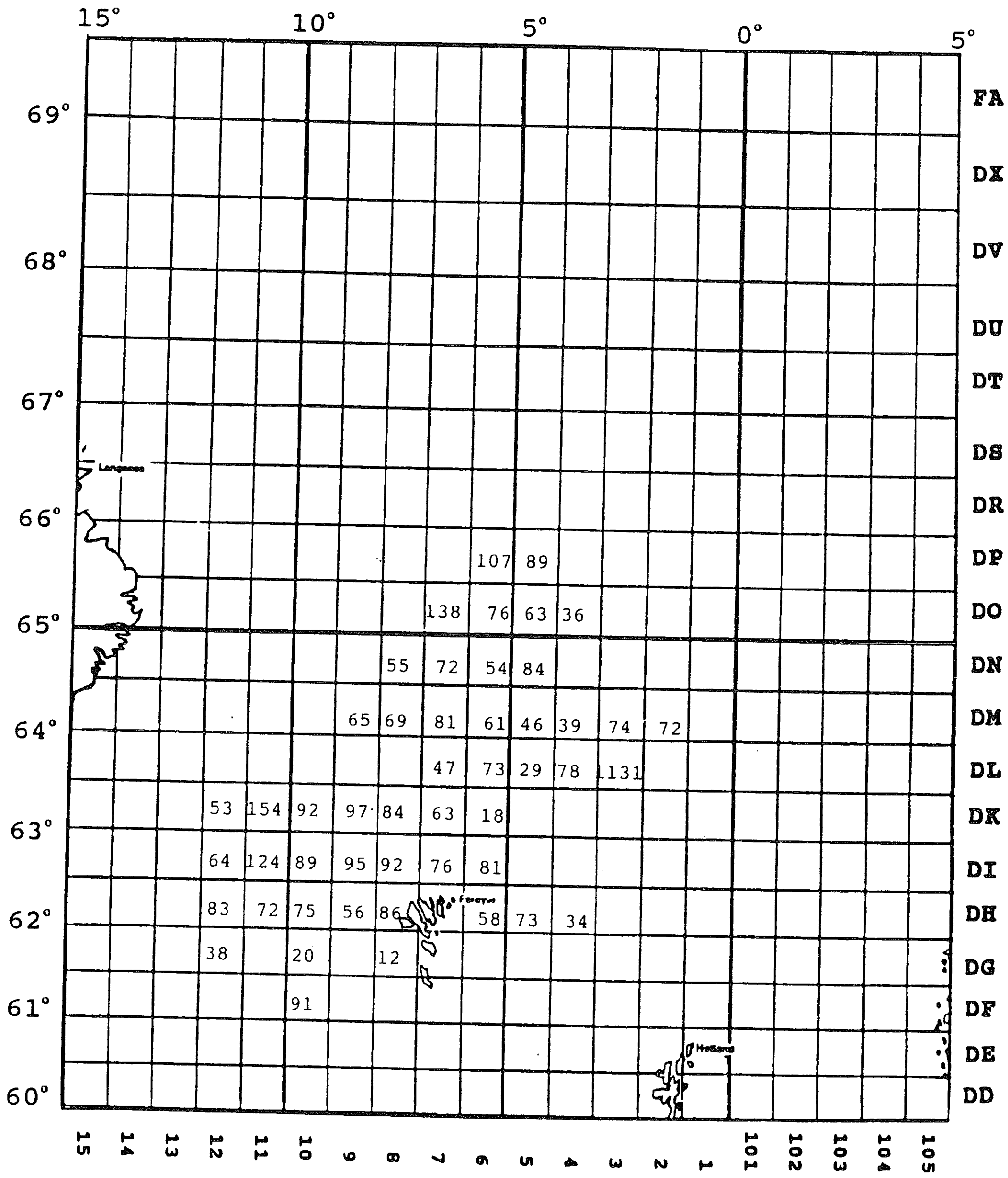


Figure 4.1.3 Catch per unit effort (1000 hooks) by statistical rectangle from logbooks, 1989/1990 season.

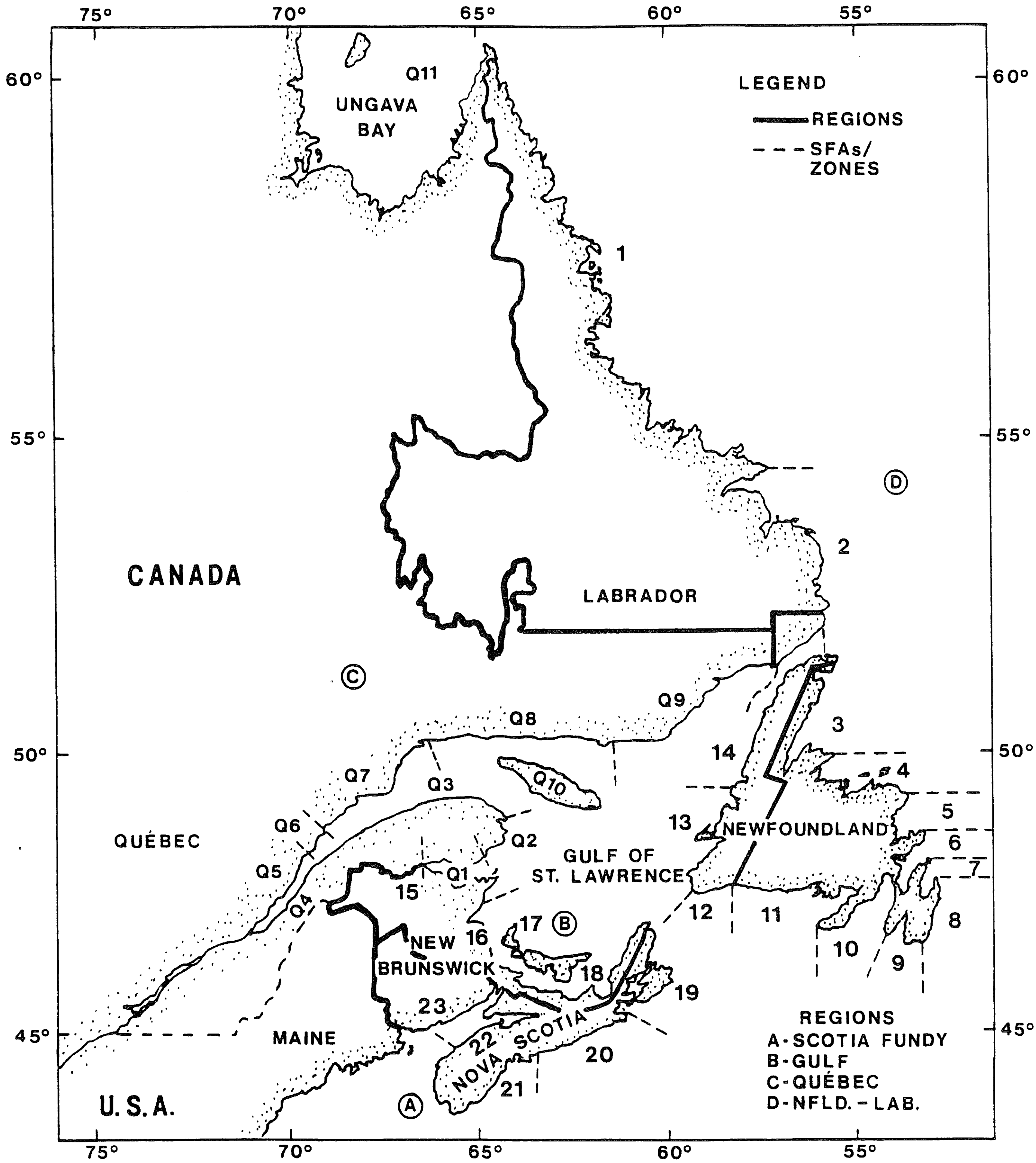


Figure 5.1.1 Map of Eastern Canada showing Salmon Fishing Areas.

Figure 5.1.2 Canadian landings of Atlantic salmon, 1974-1990.

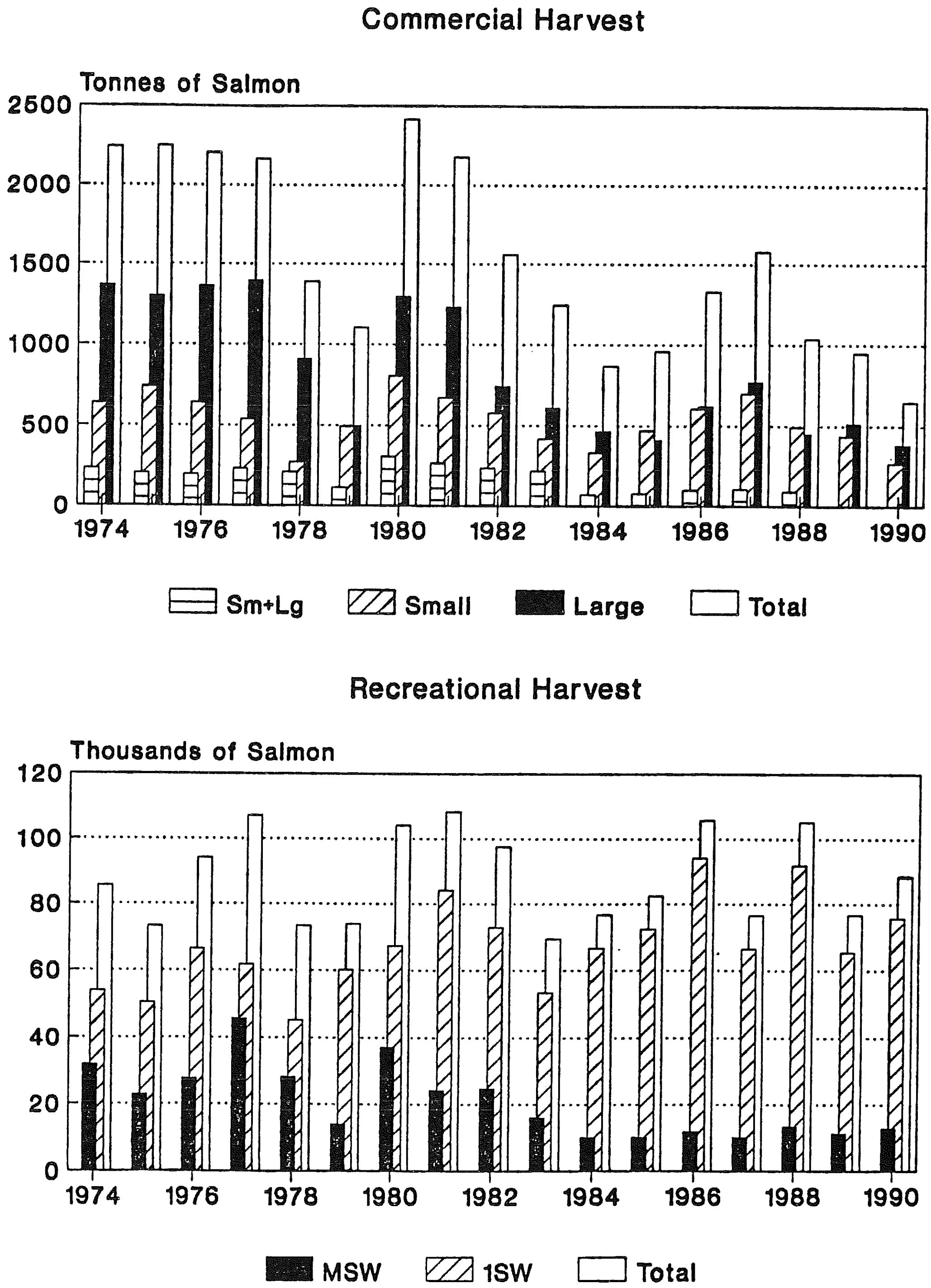


Figure 6.2.1 Relationship between the proportion of reared salmon in marine sampling sites and the number of smolts stocked in cages in the same county the previous year in Fjord locations (A) and coastal sites (B). Data from 1986-1989 pooled. (Økland *et al*., 1991).

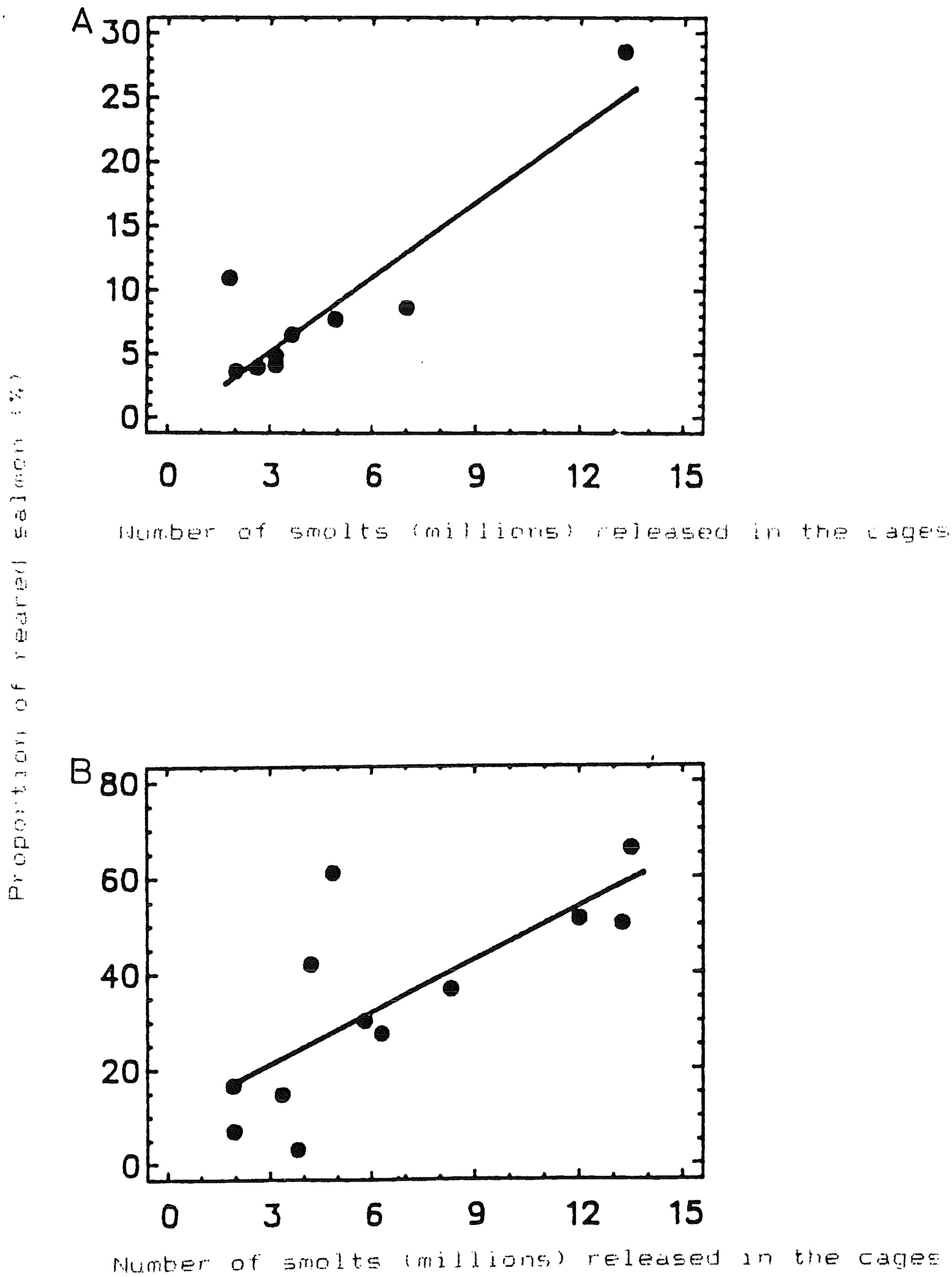


Figure 6.2.2 Relationship between the proportion of reared salmon in marine sampling sites on the coast and the mean distance to the nearest 5 (A) and 10 (B) fish farms. Data are from 1989 (Økland *et al.*, 1991).

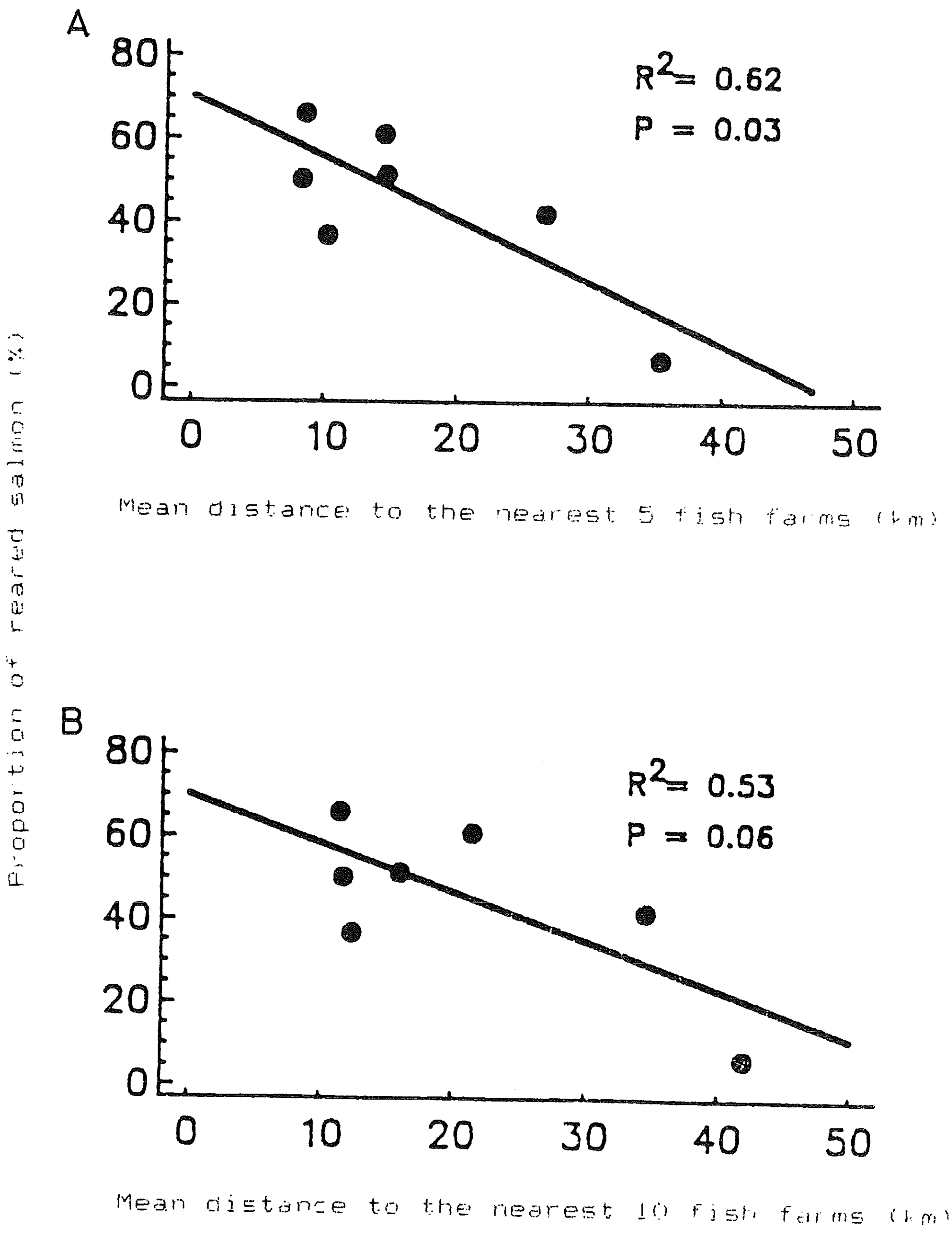


Figure 7.2.1 Percentage of maturing and immature salmon, 1985-1988.

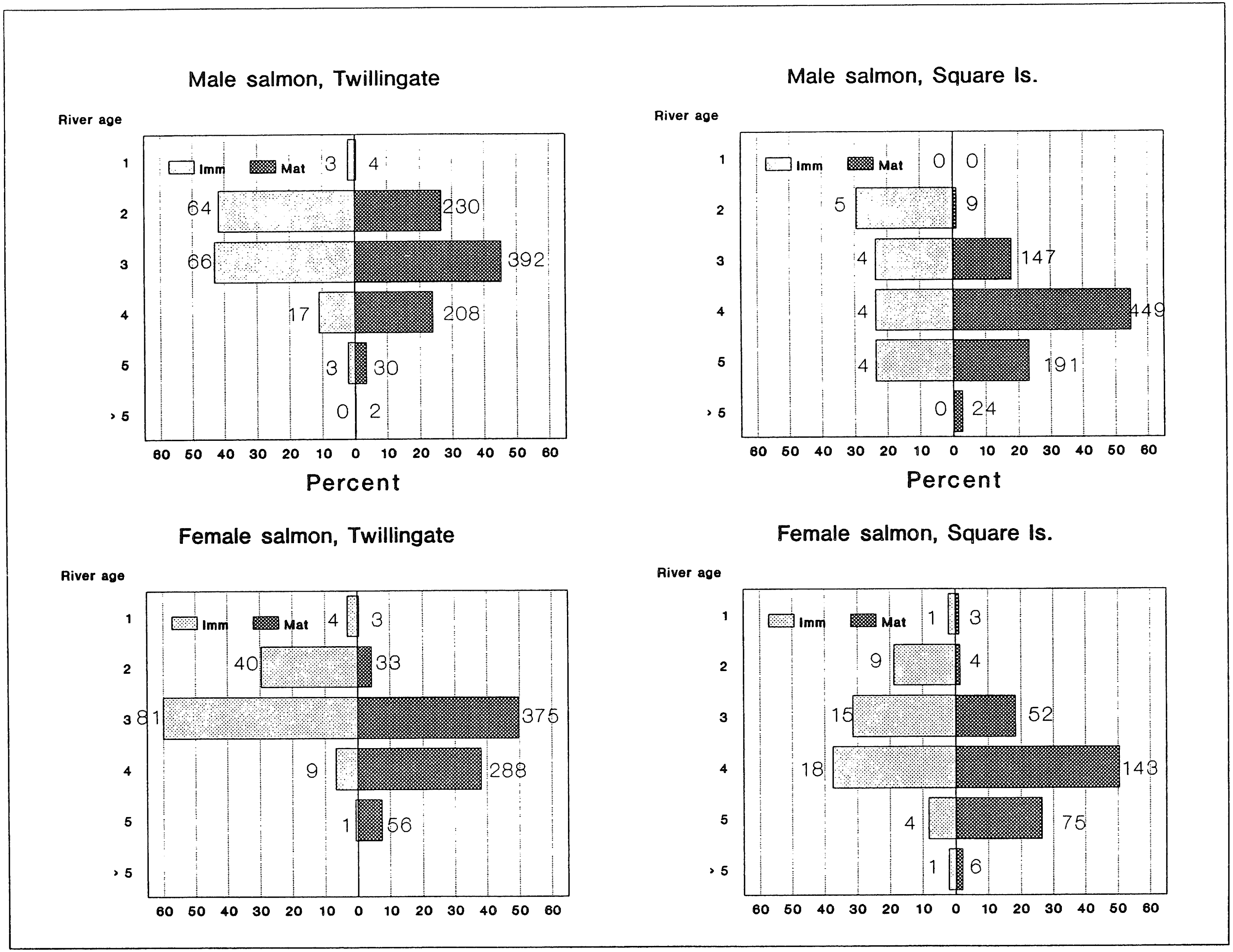


Figure 7.2.2 Percentage for each river age of mature and immature 1SW salmon, 1985-1989.

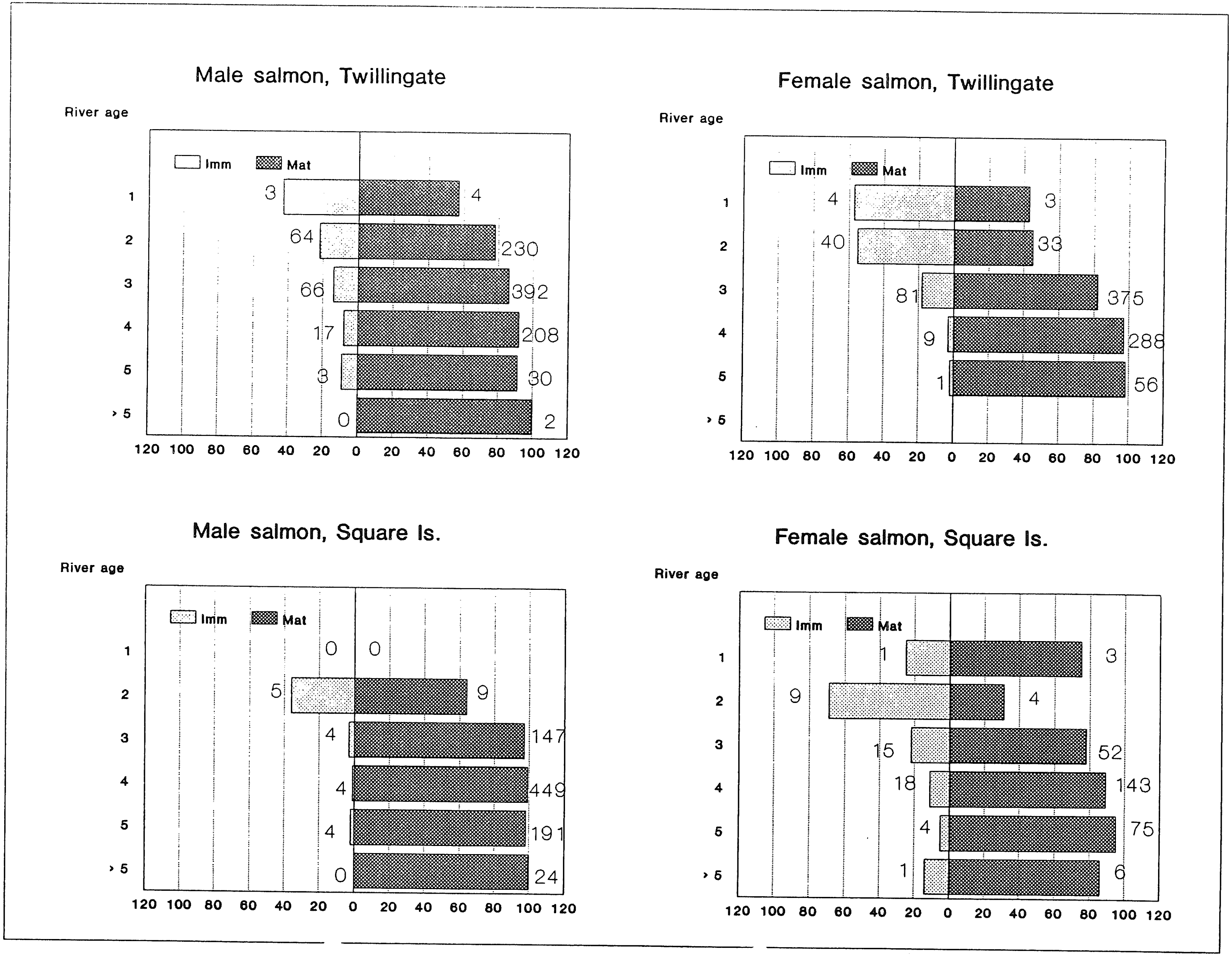


Figure 7.3.1

Proportion of reported catches of 2SW stocks caught at West Greenland.

(Year = Year of catch at West Greenland).

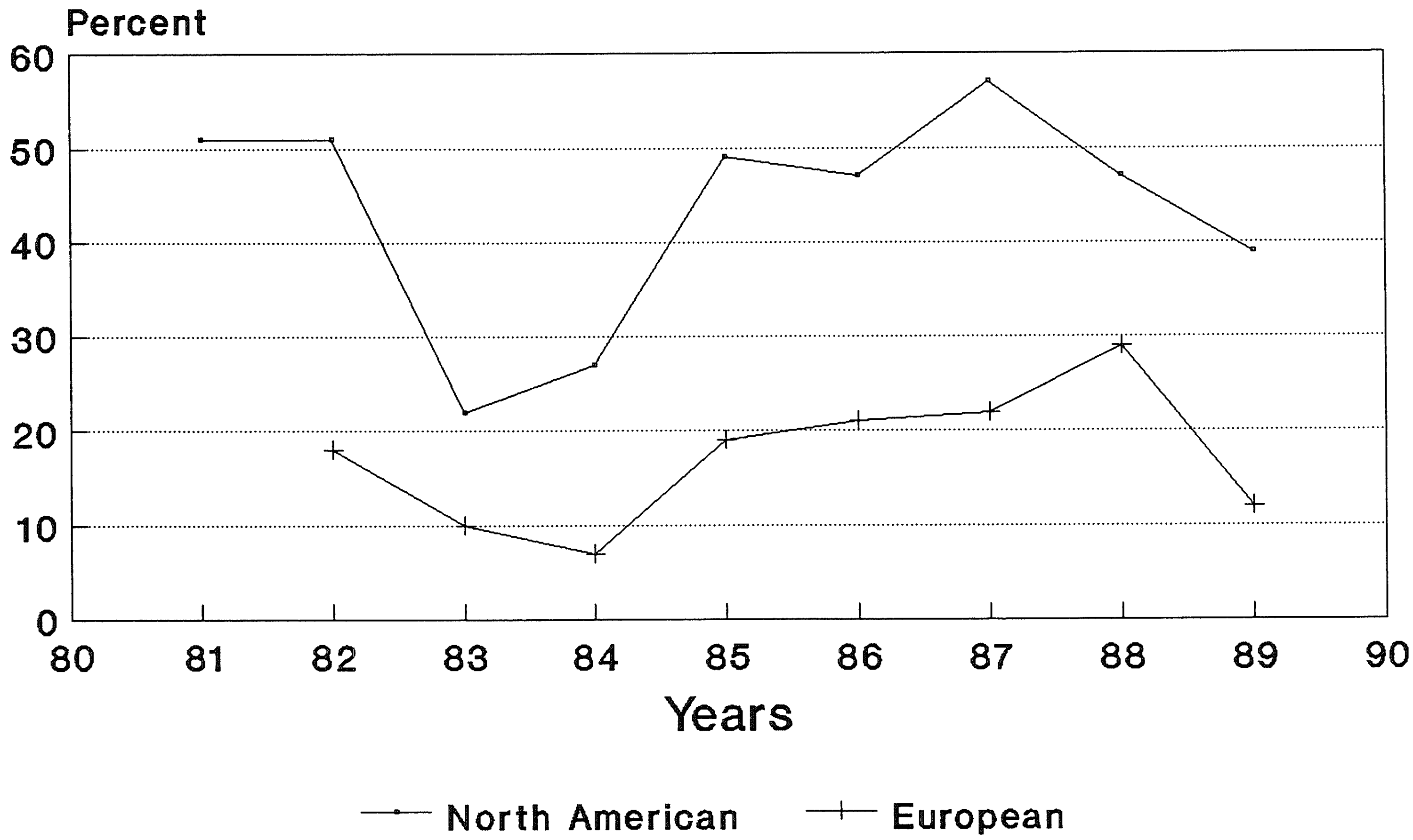
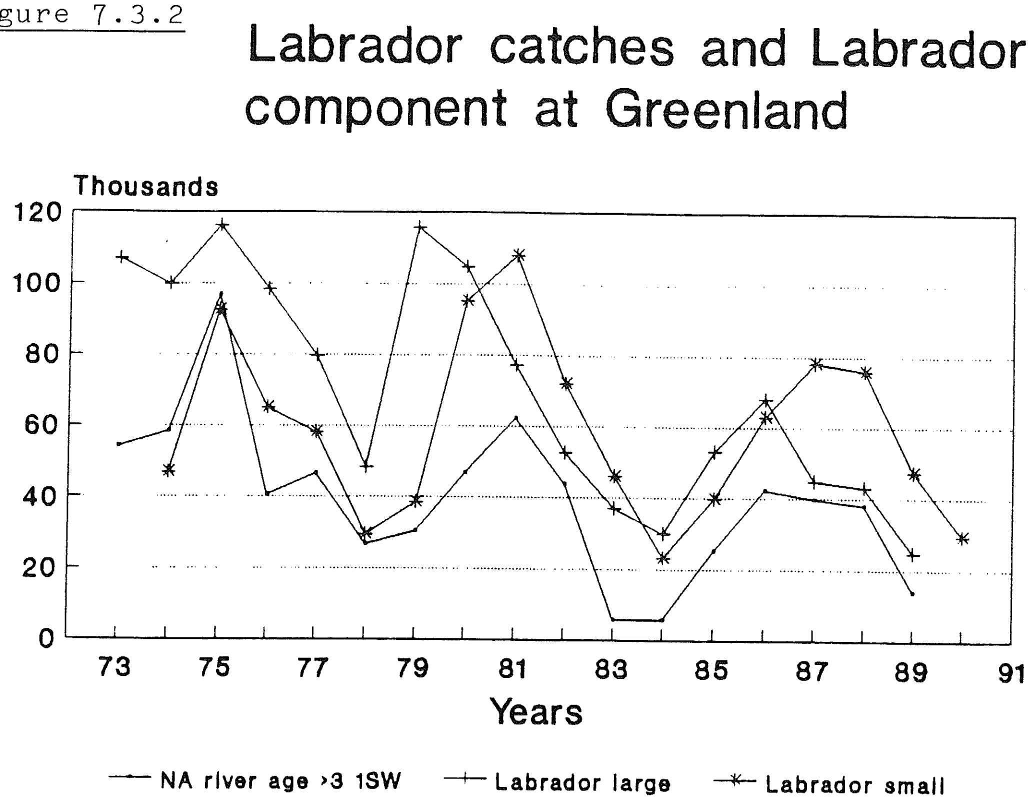


Figure 7.3.2


Labrador catches and Labrador component at Greenland
Thousands
120
100
80
60
40
20
0
73
75
77
79
81
83
85
87
89
91
Years
NA river age >3 1SW
Labrador large
Labrador small

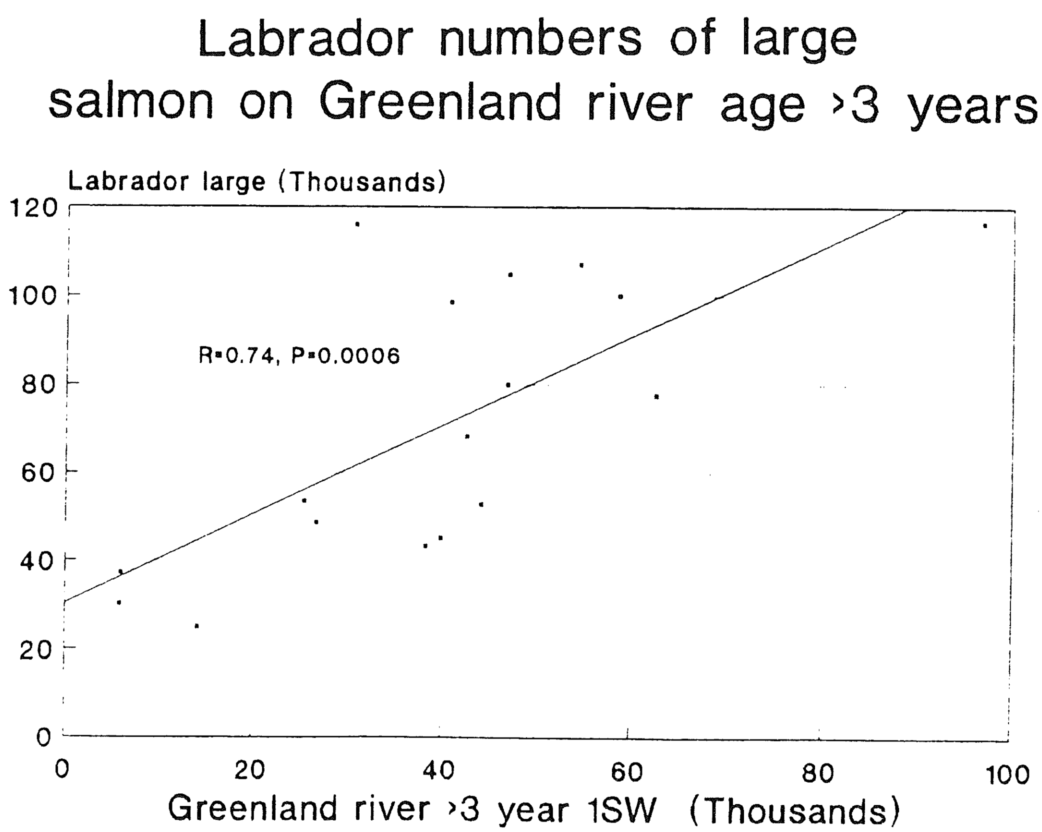
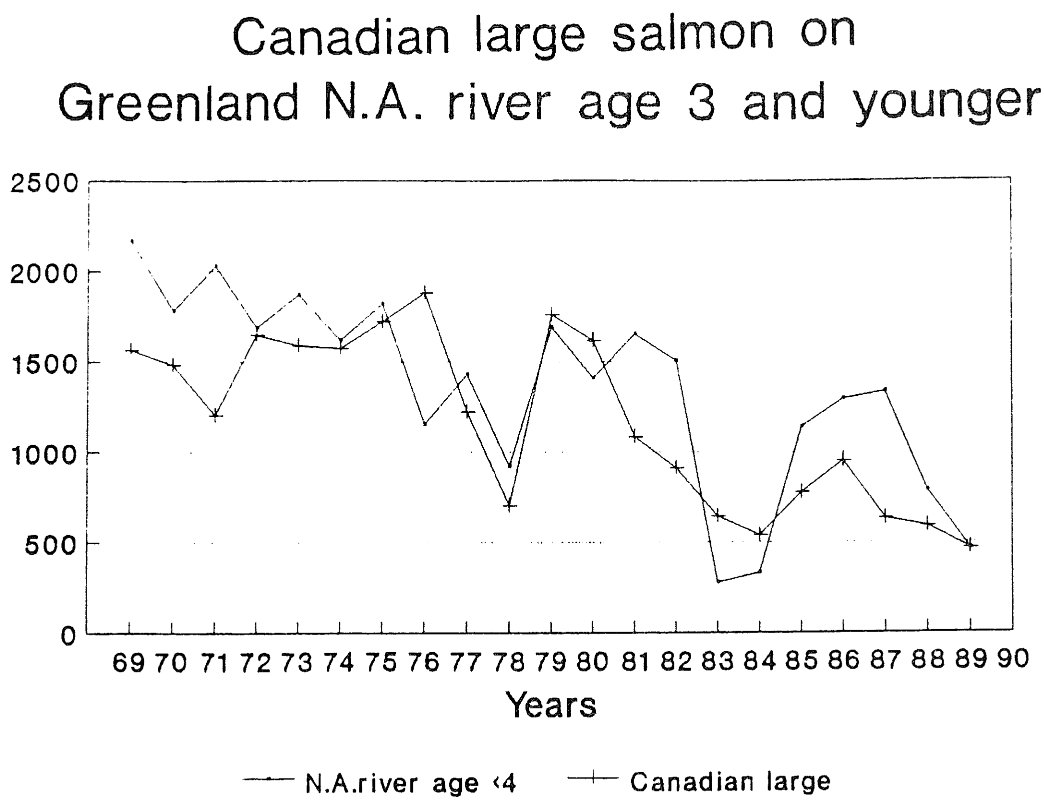

Labrador numbers of large salmon on Greenland river age >3 years
Labrador large (Thousands)
120
100
80
60
40
20
0
R=0.74, P=0.0006
0
20
40
60
80
100
Greenland river >3 year 1SW (Thousands)

Figure 7.3.3


Canadian large salmon on
Greenland N.A. river age 3 and younger
2500
2000
1500
1000
500
0
69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90
Years
N.A.river age <4
Canadian large

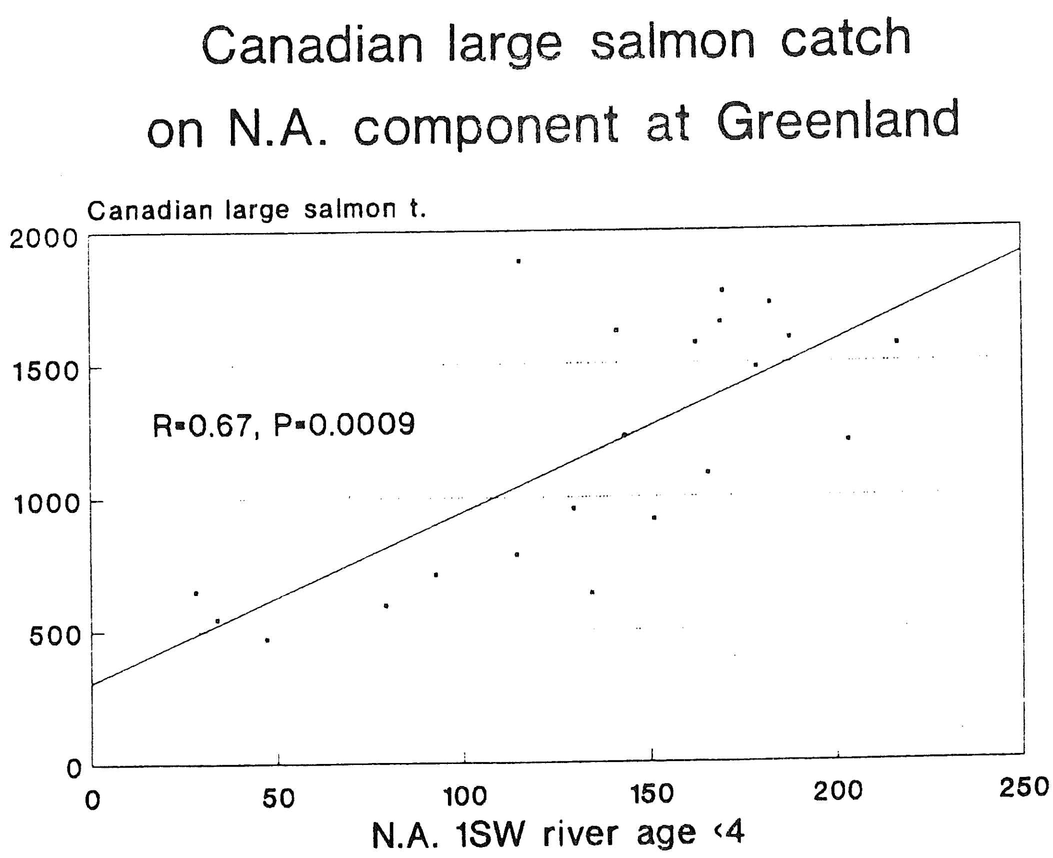
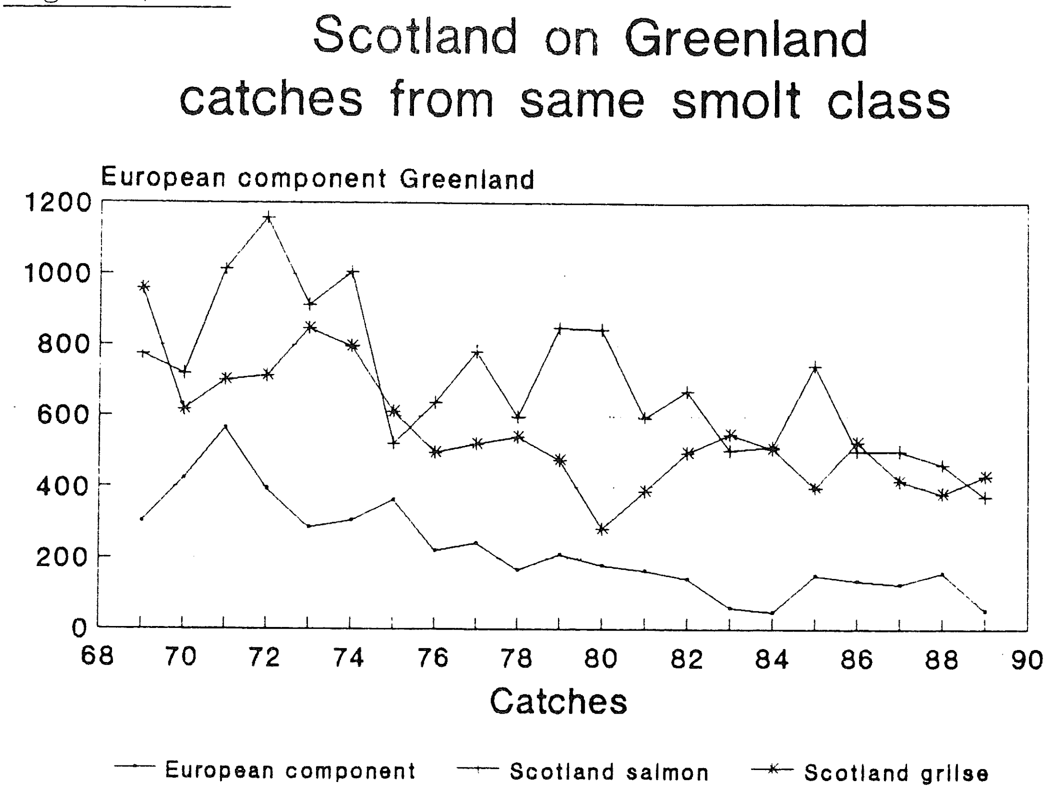

Canadian large salmon catch
on N.A. component at Greenland
Canadian large salmon t.
2000
1500
1000
500
0
R=0.67, P=0.0009
0
50
100
150
200
250
N.A. 1SW river age <4

Figure 7.3.4


Scotland on Greenland
catches from same smolt class
European component Greenland
1200
1000
800
600
400
200
0
68
70
72
74
76
78
80
82
84
86
88
90
Catches
European component
Scotland salmon
Scotland grilse

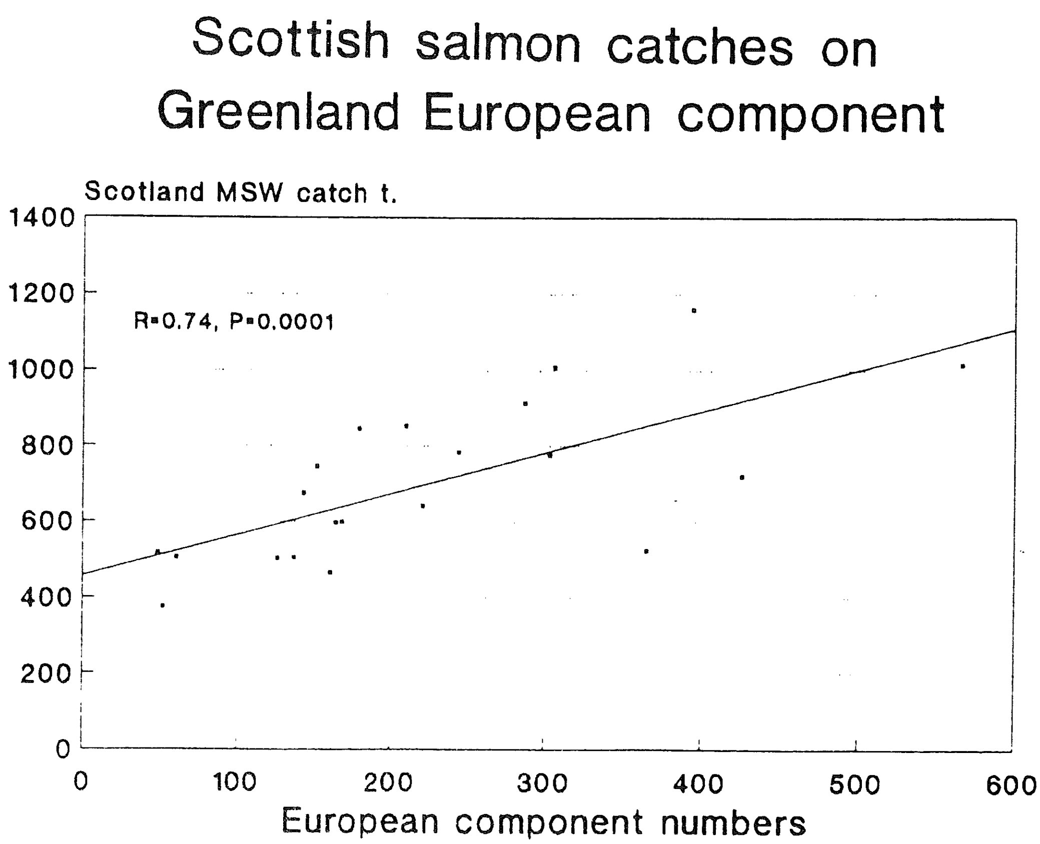
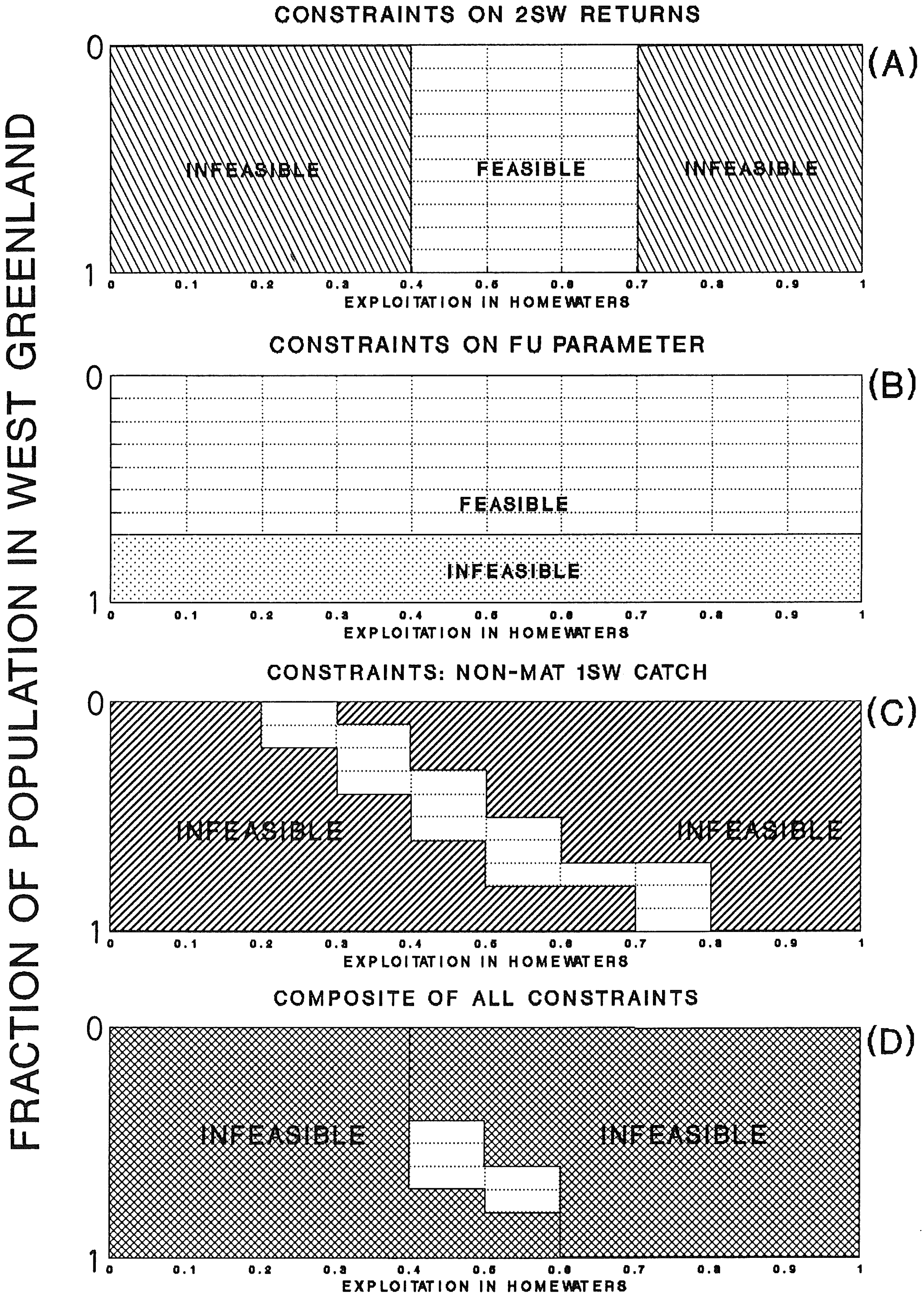
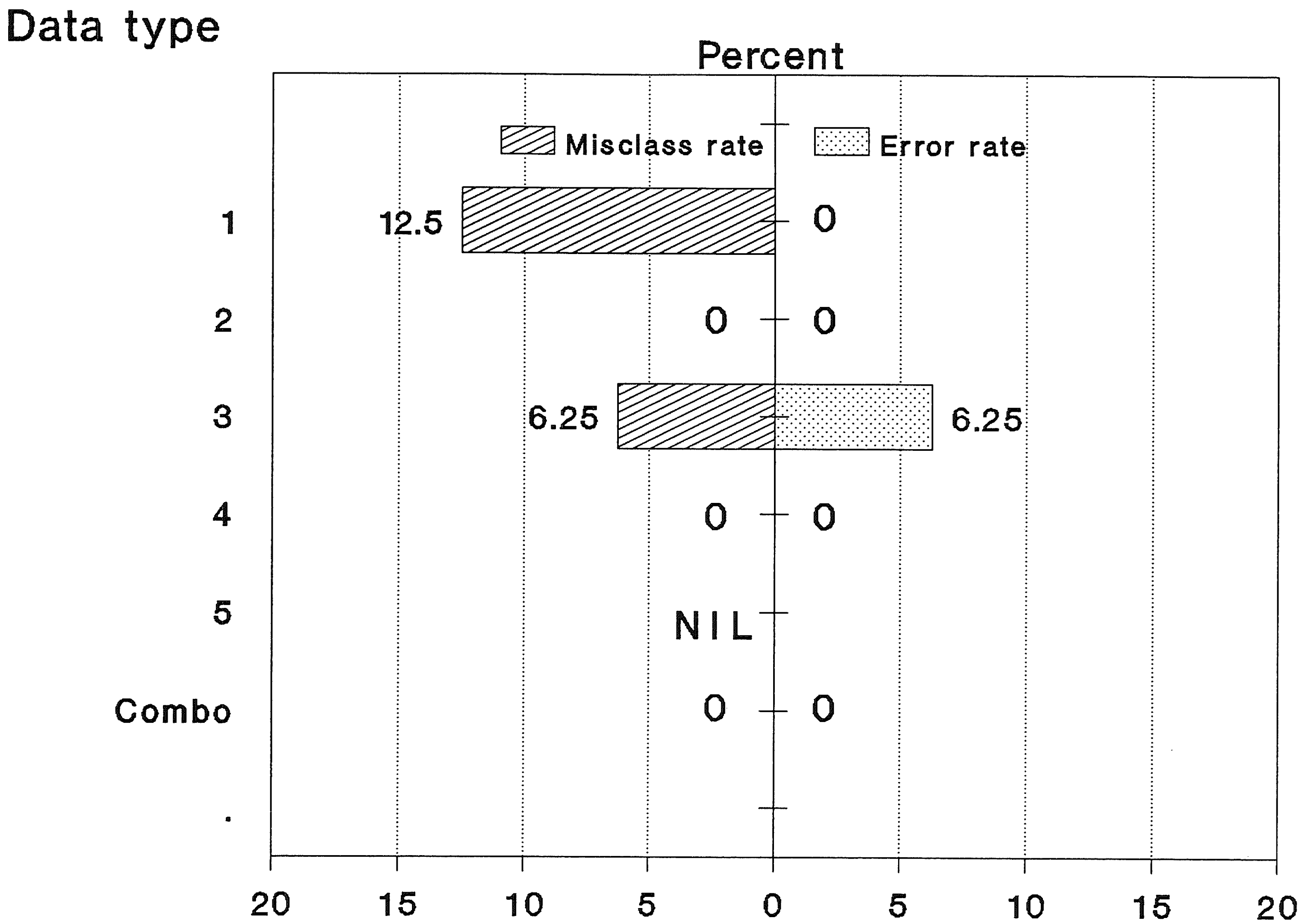

Scottish salmon catches on
Greenland European component
Scotland MSW catch t.
1400
1200
1000
800
600
400
200
0
R=0.74, P=0.0001
0
100
200
300
400
500
600
European component numbers

Figure 7.3.5 Schematic diagram of the effects of constraints on the estimation of feasible fishery area exploitation rates for West Greenland.



(A) Constraints on 2SW returns
(B) Constraints on fraction of population outside the West Greenland area and Canada
(C) Constraints on fraction of non-maturing 1SW catch
(D) Composite of all constraints.

Figure 9.1.1 Summary of misclassification rate



APPENDIX 1

TERMS OF REFERENCE FOR NORTH ATLANTIC SALMON WORKING GROUP

The Working Group on North Atlantic Salmon (Chairman: Dr K. Friedland, USA) will meet at ICES Headquarters from 14-21 March 1991 to:

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

   a) describe events of the 1990 fisheries with respect to gear, effort, composition, and origin of the catch;

   b) continue the development of run-reconstruction models of national stocks for input to a North Atlantic salmon model to describe fisheries interactions and stock dynamics;

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

   d) evaluate the effects of the management measures in the salmon fisheries at Faroes and West Greenland on stocks occurring in the Commission area;

   e) evaluate the effects of the newly-introduced quotas in the commercial salmon fishery of Newfoundland and Labrador and the regulations introduced into Norwegian salmon fisheries in 1989 on stocks occurring in the Commission area;

   f) specify data deficiencies and research needs;

   g) provide quantitative estimates of the effect of fish farm escapees on salmon stocks and catches.

2. With respect to Atlantic salmon in the North-East Atlantic Commission and West Greenland Commission areas, describe the distribution of parasites and diseases that are harmful to Atlantic salmon and assess their effects on wild salmon stocks.

3. With respect to Atlantic salmon in the NASCO area, provide a compilation of microtag, finclip, and external tag releases within ICES Member Countries in 1990.

4. With respect to Atlantic salmon in the NASCO area, provide a definition of the term "Index Rivers" and provide a commentary on how they could be used to assess the status of salmon stocks.

5. With respect to Atlantic salmon in the NASCO area, meet jointly with the Study Group on Genetic Risks to Atlantic Salmon Stocks to discuss the experimental design for a research programme to evaluate the possible effects (including genetic, ecological, and behavioural interactions) of fish farm escapees of Atlantic salmon on wild stocks.

APPENDIX 2

DOCUMENTS SUBMITTED TO THE WORKING GROUP

1. Millar, R.B. and D.G. Reddin. Improving the Performance of Classification and Composition Methodology for Salmon of Mixed Continental Origin at West Greenland.

2. Reddin, D.G. and P.B. Short. Identification of North American and European Atlantic Salmon (Salmo salar L.) caught at West Greenland in 1990.

3. 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 1990.

4. Reddin, D.G. and P.R. Downton. 1990. Database for Discrimination at Greenland.

5. Reddin, D.G., P.B. Short and T. Bowdring. Update of Discriminating Variables for Greenland.

6. 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 1990.

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

8. Friedland, K.D., L.G. Stolte, T.F. Meyers and E.T. Baum. Estimated Harvest of USA-Origin 1SW Salmon in Greenland in 1989.

9. Friedland, K.D., P.J. Rago and E.T. Baum. Carlin Tag Returns and Harvest Estimates of US-Origin Salmon in Greenland, 1967-1990.

10. Økland, F., R.A. Lund and L.P. Hansen. Escapes of Reared Salmon in Marine Fisheries in Norway.

11. Møller Jensen, J. The Exploitation Rate at Angmagssalik District (East Greenland including Labrador and Irminger Seas).

12. Møller Jensen, J. The Salmon Fishery at West Greenland 1990.

13. Anon., 1991. Report of the Workshop on Identification of Fish Farm Escapees and Wild Salmon.

14. Anon., 1991. Extract from the Report of the Working Group on Pathology and Diseases of Marine Organisms.

15. Thibault, M. and P. Prouzet. Atlantic Salmon in France for 1990.

16. Dunkley, D.A. Report for the United Kingdom (Scotland) for 1990.

17. Dunkley, D.A. Scottish Atlantic Salmon Catch Data for ICES Database.

18. Dunkley, D.A. The Seasonal Distribution of Atlantic Salmon Returning to the North Esk.

19. MacLean, J.C. A Comparison Between two Methods for Determining the Sex of Adult Atlantic Salmon Returning to the North Esk.

20. Crozier, W.W. Homewater Exploitation Rates on Microtagged Salmon Returning to the R. Bush in 1990.

21. Davidson, W.S., M. Seligy, S.E. Bartlett and D.G. Reddin. Analysis of the West Greenland Atlantic Salmon Fishery Using a Polymorphism in the Ribosomal RNA Gene Complex.

22. Mortensen, S.H., P. Hopp, B.K. Hjeltnes and M. Holm. Health Screening of Wild Atlantic Salmon (Salmo salar) from the Osterfjorden-Area, Western Norway.

23. Potter, E.C.E., L. Kell and D.G. Reddin. The Use of a Neural Network to Distinguish North American and European Salmon from Scale Characteristics.

24. Reddin, D.G. Environmental Conditions in the Northwest Atlantic.

25. 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.

26. Rago, P.J. and K.D. Friedland. Exploitation Rates of Maine-Origin Salmon in the Fisheries of Canada and West Greenland, 1967-1989.

27. Zubchenko, A. USSR Homewater Fishery (Overview of Fishery for 1990).

28. Anon., 1991. Report of the Study Group on the Norwegian Sea and Faroes Salmon Fishery.

29. Anon., 1991. Report of the Study Group on the North American Salmon Fisheries.

30. Anon., 1991. Report of the Study Group on Genetic Risks to Atlantic Salmon Stocks.

APPENDIX 3

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 the 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 Working Group on North Atlantic Salmon. Copenhagen, 15-22 March 1990. ICES, Doc. C.M.1990/Assess:11.

Anon. 1990b. 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. 1990c. 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. 1991a. Report of the Study Group on the North American Salmon Fishery, Leetown, West Virginia, USA, 25 February - 1 March 1991. ICES, Doc. C.M. 1991/M:6

Anon. 1991b. Report of the Study Group on the Norwegian Sea and Faroes Salmon Fishery, Dublin, 4-7 March 1991. ICES, Doc. C.M.1991/M:4.

Anon. 1991c. ICES compilation of microtag, finclip and external releases in 1990. ICES, Doc.C.M.1991/M:5.

Anon. 1991d. Report of the Workshop on identification of fish farm escapees and wild salmon, Trondheim, Norway, 11-13 February 1991. ICES, Doc.C.M.1991/M:2.

Anon. 1991e. Report of the Study Group on Genetic Risks to Atlantic Salmon Stocks, Copenhagen 13-15 March 1991. ICES, Doc.C.M.1991/M:3.

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APPENDIX 4

RECOMMENDATIONS FROM STUDY GROUPS AND WORKSHOPS

THE WORKSHOP ON IDENTIFICATION OF FISH FARM ESCAPEES AND WILD SALMON

Recommendations

1. Having considered all the methods currently available to distinguish wild salmon from farmed escapees, the Workshop considers that morphological characters, scale characters and otolith structure, used alone or in combination, are the least expensive and most discriminatory methods available. The Workshop notes that these methods will almost certainly underestimate the true numbers of escaped farmed fish in mixed groups of farmed and wild salmon. It is recommended that these methods continue to be used as widely as possible and that the methods continue to be developed. In particular, the Workshop recommends that automated, passive methods for scale analysis be developed to reduce subjectivity of interpretation and to speed analysis. Particular attention should be given to achieving discrimination between wild fish and escapees or releases made early in freshwater life. The Workshop also recognises a requirement for the development and use of regional and local keys to scale characters since these vary markedly in relation to environment and stock.

2. In some circumstances, tissue pigment analysis is diagnostic for farmed escapees. The technique can be used to support non-chemical methods. It is of particular use in some situations for distinguishing the progeny of escaped farmed females (but not males) from those of wild females, although only through the egg stage and for the first few weeks of free swimming life. The Workshop recommends that these methods continue to be developed because of their special usefulness and power. In particular, HPLC methods for detecting the isomers of astaxanthin should be further developed. Using available methods the kinetics of the isomers, in relation to time, growth, assimilation and transfer between tissues should be fully explored. The intended withdrawal of canthaxanthin as a feed pigment makes development of methods for examining isomeric ratios of astaxanthin of special importance.

3. In some circumstances, fortuitously or by experimental design, genetic methods may be used to distinguish wild salmon from farmed escapees. In exceptional circumstances only, existing genetic methods may be sensitive enough to follow the progeny of wild and farmed fish by examining the introgression of genes (rather than fish) from farmed escapees of both sexes into natural populations. In the same way, the subsequent spread of the same genes within and between populations and their propagation through later geneerations might be assessed. The Workshop recommends that genetic methods continue to be developed with a particular view to following gene flow in natural populations exposed to farmed escapees because of the potential, biological importance of gene flow for natural populations. The Workshop also recommends further development of genetic tags, because of their special power, for use locally in the field or in experimental situations.

4. The Workshop understands that canthaxanthin and astaxanthin are used widely as colourants in the food industry. In the past, both colourants have been widely used in aquaculture. The Workshop is aware of consumer pressure on aquaculture to cease usage of canthaxanthin and of the intention of the industry to comply. The Workshop is not aware of the scientific basis on

which synthetic astaxanthin is preferred to canthaxanthin but expects the use of synthetic astaxanthin alone, to become general in fish-farming. However, the Workshop is aware of the advantages to fisheries management which would follow from the continued inclusion of canthaxanthin in fish-feeds by all feed compounders, at low levels and in combination with synthetic astaxanthin which will continue to be used. The Workshop recommends that the advantages for fishery managers of the continued use of canthaxanthin should be noted and reserved.

THE STUDY GROUP ON THE NORWEGIAN SEA AND FAROES SALMON FISHERY

Recommendations

1. The Study Group should meet for 3 days, prior to the Working Group meeting unless additional questions are asked in which case they should again meet at Lowestoft (UK) for 4 days at least one full week prior to the Working Group.

2. Discard samples should be collected throughout the fishing season in the Faroes fishery.

3. All countries should attempt to collect effort data from net and rod fisheries wherever possible.

4. Members should review the data used in their models of national stocks and consider what new data are required in order to refine the NE Atlantic model in 1992.

5. The Faroes Fisheries Laboratory should provide a check list of external tag recoveries for each country from their data base in order that national records can be validated.

The Study Group recommended that further attempts be made to refine each national model before 1992. Further, it was agreed that all members should review their tagging experiments and consider what additional data were required to improve the reliability of their national model.

THE STUDY GROUP ON THE NORTH AMERICAN SALMON FISHERIES

Recommendations

1. Investigate stock recruitment relationship for naturally-spawning fish in the Penobscot and Saint John Rivers.

2. Examine forecast models for MSW salmon in an attempt to explain observed recent decreases in the numbers of MSW salmon and increases in the numbers of 1SW salmon returning to some Canadian and USA rivers.

3. Evaluate relationships between redd counts and spawning populations and its applicability for North American rivers.

4. Estimate abundance of returning salmon which remain below Veazie dam on the Penobscot River and continue evaluation of passage efficiency.

5. Consideration should be given to stratifying sampling for CWTs in the commercial fisheries in Newfoundland-Labrador into size categories.

6. Catches by week for the commercial fisheries in SFAs 13 and 14 are to be provided for missing years (1984-1988).

7. Provide updated estimates of exploitation rates, where available, on an annual basis.

8. Maintain an inventory of production by area, and escapes from aquaculture sites, as well as estimates of escapees found in rivers and fisheries.

9. With respect to the estimation of maturation rates in salmon in the Newfoundland-Labrador salmon fishery (Section 4.3), the following recommendations were noted:

   a) Samples be obtained to test the hypothesis of equivalent rates between gonadal and somatic growth.

   b) Samples of known maturity be obtained to determine histologically or biochemically the state of maturity.

   c) Test the hypothesis of no stock differences in GSIs between the Conne River estuary and the Labrador Sea by contrasting these GSIs with samples obtained from the Miramichi River.

   d) Further studies should investigate temporal trend in maturity over the entire fishery.

10. It is recommended that the Study Group meet in 1992 in St. John's, Newfoundland at an appropriate time before the meeting of the Working Group on North Atlantic Salmon.

THE STUDY GROUP ON GENETIC RISKS TO ATLANTIC SALMON STOCKS

Recommendations

1. That research on the effects of farmed escapes on natural populations of Atlantic salmon (particularly relative reproductive success and gene introgression) should be encouraged in the context of more general studies of local adaptation in salmon populations.

2. That these studies should be undertaken co-operatively and integrated by the parties involved to maximise the information gained given the many variables involved and the likely costs of the research.

3. That the occurrence of escapes should be exploited as unplanned experiments to explore the mechanisms which segregate natural populations.

4. That future research should aim to give direction to management, with a view to tempering any effects which escapes from culture may be shown to have on wild populations - when this is considered necessary.

5. That management decisions, designed to reduce the risk of genetic impacts by farmed fish, be based on the body of information which exists, since scientific understanding has increased less rapidly than aquaculture has grown.

6. That the use of sterile, triploid salmon in the aquaculture industry be encouraged, as widely as possible, to reduce the genetic risks which farmed escapees may pose to wild salmon populations.