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Evaluation of the status of the Atlantic salmon population of Conne River, Newfoundland, in 1992

by

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Abstract

Results obtained from a fish counting fence provided the basis for the assessment of the Conne River Atlantic salmon stock in 1992. Returns to home waters (river and estuary) were 2523 salmon < 63 cm in length and 159 salmon ≥ 63 cm in size. This represented an increase of 5% for small salmon and 79% for large salmon from 1991. Sea survival was estimated to be only 3.4% (3.9-4.6%), the lowest recorded to date. Estimated egg deposition from small and large salmon was 3.970 x 10^6 eggs; 51% of the target requirement. Condition factor of adults appears to be related to condition of smolts that migrated in the previous year. Higher sea survival is also associated with years in which smolt condition values were greater. A mark-recapture study suggested a smolt run in 1992 of 68208 (61334-75052). Using a simulation approach, expected returns of 1SW salmon in 1993 could be 4469 (4044-4901, 5th and 95th percentiles) salmon with a high probability that returns in 1993 should be higher than those observed in 1991 and 1992. The lower forecast for 1993 relative to previous values reflects the influence of decreased smolt to adult survival in recent years.

Résumé

L'évaluation de la population de saumons de l'Atlantique dans la rivière Conne (T.-N.) en 1992 est fondée sur les résultats obtenus à un barrage de dénombrement du poisson. Quelque 2 523 saumons < 63cm et 159 saumons ≥ 63 cm ont remonté dans les eaux d'origine (rivière et estuaire), ce qui représentait un accroissement de 5 % pour le petit saumon et de 79 % pour le gros saumon par rapport aux montaisons de 1991. Le taux de survie en mer n'atteignait que 3,4 % (3,9-4,6 %); c'était le plus bas de tous ceux enregistrés jusqu'ici. La ponte estimée des petits et des gros saumons était de 3,970 x 10^6 oeufs, soit 51 % de la cible. Le coefficient de condition des adultes semble relié à celui des saumoneaux qui ont migré l'année précédente. Le taux de survie en mer apparaît supérieur les années où les coefficients de condition des saumoneaux sont plus grands. D'après une expérience de marquage-recapture, 68 208 saumoneaux (61 334-75 052) auraient remonté la rivière en 1992. On a déterminé, par simulation, que les montaisons de saumons unibermarins pourraient être de 4 469 (4 044-4 901, 5^e et 95^e percentiles) poissons en 1993 et qu'il était fort probable que les montaisons totales soient supérieures à celles de 1991 et 1992. Les prévisions pour 1993, plus basses par rapport aux valeurs antérieures, relètent l'influence d'une baisse de survie dans le passage du stade de saumoneau à celui d'adulte ces dernières années.

Introduction

Conne River, SFA 11 (Fig. 1) flows into Bay D'Espoir on the south coast of insular Newfoundland. It is a sixth-order river with a drainage area of 602 km^2 and a total length of 193 km. Since 1986, a fish counting fence has been operated to enumerate the upstream migrating population of Atlantic salmon. Mark-recapture studies were initiated in 1987 to survey the number of migrating smolts. Both of these operations continued in 1992. This paper summarizes returns of adult salmon to Conne River in 1992 and provides a forecast of one-sea-winter (1SW) returns for 1993.

Background

In contrast with past years, Atlantic salmon stocks of the Conne River could contribute only to recreational and native food fisheries during 1992. The opening and closing dates for these fisheries are summarized in Table 1. A recreational fishery quota of 330 small salmon was set for 1992 in recognition of the potential for low returns as a result of analomous oceanic environmental conditions that prevailed in 1991. Regulations on the native food fishery were as in past years: 1) a total quota of 1200 salmon; 2) fishing was restricted to the Conne River estuary and the use of two trap nets or a combination of one trap net and two gillnets; 3) mesh size of the gillnets was restricted to 127 mm or larger; 4) maximum weekly harvest levels were 200 fish from June 1-7, 400 fish from June 8-21, with the remainder of the quota during the other weeks of the fishery. The food fishery was allowed to open June 1, 1992. Both recreational and food fisheries were prohibited from retaining salmon $\geq$ 63 cm, although salmon of this size found dead in the food fishery gear could be retained and counted against the quota.

Methods

1. Landings in 1992

Data on landings in the recreational fishery were collected by Department of Fisheries and Oceans (DFO) Fisheries Officers and guardians and processed by DFO Science Branch personnel. Landings in the native food fishery were obtained from the Conne River Native Band Council.

2. Biological characteristics

Biological characteristic information on adult salmon, including fork length, whole weight, age and sex, was obtained from sampling salmon caught in the recreational fishery. Additional data were also obtained from sampling salmon at the fish counting fence (N = 44) or from mortalities in the river. The Conne River Indian Band Council provided length, weight, and sex data along

with representative scale samples from 211 adult salmon caught in the food fishery. Biological data from Atlantic salmon smolts (N = 169) were obtained from specimens sampled at the downstream counting trap. Comparisons of the river age distribution of smolts in year i with grilse in year i+1 were carried out using likelihood ratio statistics (G^2 - test). The G^2 - test was also used in comparisons of the river age distribution of fish caught in the estuarine food fishery with those fish sampled directly from Conne River.

Analyses of smolt and adult condition factor were done following the methods outlined by Patterson (1992). Here a single model is used to examine the response of fish weight to a number of factors. In current analyses, the model includes week and year effects with length as a covariate. Coefficients correspond to the natural log of the geometric means of the deviation of the condition from unity (Patterson 1992). Analyses were done using SAS GLM procedures (SAS 1985). Comparisons of whole weight and fork length between small salmon caught in the food fishery with those sampled directly from the river were performed on rank transformed data (Conover 1980; Conover and Iman 1981).

3. Estimated returns and spawning escapement

Adult Atlantic salmon migrants were enumerated at a fish counting fence, located about 1 km upstream from the mouth of the Conne River (Fig. 1), which operated from May 26 to August 10, 1992 (Table 2). Total returns (TR) were estimated from:

$$TR = Fc + Mb + Rb + Cn$$

where,
- Fc is the count of fish at the counting fence
- Mb is the known mortalities below the counting fence
- Rb is the estimated recreational catch below the fence
- Cn is the estimated number of Conne River origin salmon caught in the native food fishery.

Spawning escapement (SE) was estimated as:

$$SE = Fr - Ma - Ra$$

where,
- Fr is the number of fish released at the counting fence
- Ma is the known number of mortalities above the fence
- Ra is the estimated recreational catch above the fence.

Consistent with the practise established last year, estimated egg deposition refers to the 'potential' deposition relative to the target. As in past years, egg deposition was calculated separately for salmon < 63 cm and salmon ≥ 63 cm and then totaled.

Egg deposition = spawners x % female x fecundity at size.

An estimate of fecundity was obtained from the relationship derived in 1987 (October 27-30) from ripe salmon (Dempson et al. 1987):

$$\text{Fecundity} = 0.1988(\text{fork length, cm})^{2.3942} \quad (r^2 = 0.48,\ P < 0.001)$$

where length is the mean length of female salmon < 63 cm in size sampled in 1992.

An estimate of the egg deposition from salmon ≥ 63 cm in size was obtained using the same length-fecundity relationship for salmon < 63 cm, with the same data for mean length (67.8 cm) and percent females (71%) as used in past years (Dempson 1989, 1990).

The target spawning requirements were the same as in past years at 7.8 million eggs, equivalent to about 4000 salmon < 63 cm in size.

4. Forecast of 1993 returns

A mark-recapture study was carried out to estimate the smolt production in 1992. The study was similar to those carried out in 1987-91, the design of which is summarized in Dempson and Stansbury (1991) and uses the estimator described in Schwarz and Dempson (1993).

During 1992, 3758 smolts were tagged and released at the upstream partial counting fence site (Fig. 1). At the downstream recapture site, 10229 smolts were caught including 529 tagged smolts. From the estimate of the number of smolts obtained, a forecast of 1SW returns in 1993 was derived using a simulation approach. The simulation approach incorporates into the forecast the uncertainty in the number of smolts migrating in 1992, and the variation in smolt to adult survival rates as derived during the past five years. The approach to forecast 1993 returns was as follows:

- estimate the smolt to adult survival rate where the number of smolts are drawn randomly from a normal distribution using data from the smolt mark-recapture estimate from the past five years (1987/88 to 1991/92);

- apply the survival rate from above to the 1992 mark-recapture estimate of the number of smolts which is also drawn randomly from a normal distribution;

- repeat the above steps a large number of times (say 5000) and generate a distribution of expected 1SW returns for 1993.

Results and Discussion

1. Landings in 1992

Table 3 summarizes the commercial landings of small and large salmon from Statistical Section 36, SFA 11, from 1974-91. Over the 10-year period 1982-91, landings of small and large salmon averaged 16.6 t per year. No commercial fishery occurred in 1992.

Landings in the recreational fishery are summarized in Table 4 and Figure 2. Native food fishery catches are also summarized in Table 4. A total of 329 small salmon were reportedly caught in the 1992 sport fishery (quota = 330) which closed on July 5. Despite the low angling catch, angling exploitation rate to July 4 (river closed as of July 5) was 0.268, indicating that about one of every four fish that had returned to the river by this date was removed by the sport fishery. Overall, the recreational fishery removed 13% of the estimated total number of small salmon returns to home waters in 1992. Past estimates of angling exploitation rates, adjusted in some years for the period that the fishery was open, are:

Year	Exploitation rate
1986	0.275
1987	0.181
1988	0.217
1989	0.223
1990	0.285
1991	0.245
1992	0.268

The native food fishery reported a catch of 484 small salmon and 5 large salmon (67% females, N = 209). Of the small salmon, 403 (83.3%) were estimated to be of Conne River origin. The food fishery removed 16% of the estimated total number of small salmon returns to home waters in 1992.

2. Biological characteristics

Biological characteristic information was obtained from 169 smolts and 68 1SW fish during 1992. Sixteen previous spawners and one 2SW salmon were also sampled (Table 5) from fish caught in the river. Small salmon caught in the food fishery in 1992 averaged 515 mm in fork length, about 12 mm larger than fish caught in the river ($F = 17.7$, $P = 0.0001$), and also weighed 53 grams more (mean = 1389 g) than fish that returned to the river ($F = 2.68$, $P = 0.1030$). The river age distribution of smolts in 1991 was similar to that of 1SW salmon that returned to the river in 1992 ($G^2 = 4.59$, $P = 0.101$), but differed from 1SW salmon caught in the food

fishery trap (G^2 = 11.14, P = 0.004). Of 17 large salmon sampled from the river in 1992, 16 were repeat spawning grilse. Eight of the repeat spawning grilse were consecutive spawners and eight were alternate year spawners.

The condition analysis on small salmon, with year and week factors included in the model, explained 55% of the variaion in weight of the fish (F = 143.78, P = 0.0, N = 1525). Residual diagnostics suggested that the data were approximately normal. Both year and week factors were significant. Salmon returning earlier in the season (weeks 23-27, June 4 - July 8), had higher coefficients than fish returning later in the season (Fig. 3). Year coefficients indicated the lowest condition in 1991 and 1992; two of the years when run timing of retuning adult salmon was late in comparison with other years (Fig. 4).

The condition analysis on salmon smolts, with year and week factors included in the model, explained 95% of the variaion in weight of the fish (F = 2261.75, P = 0.0, N = 1388). Residual diagnostics again suggested that the data were approximately normal. Both year and week factors were significant. Condition of smolts decreased over time from week 18 to 23 (April 30 - May 10) (Fig. 3). Year coefficients indicated the lowest condition in 1990, 1991 and 1992 (Fig. 3). The latter two years were also those in which smolt run timing was also late in comparison with other years (Fig. 4).

Although data are limited (N = 5), Fig. 5 illustrates an association between condition of smolts and small salmon, along with subsequent survival. Higher sea survival of smolts coincides with years when smolts had higher condition coefficients (Fig. 5). A similar pattern has been noted for Northeast Brook, Trepassey (M. O'Connell, personnel communication). To a degree, the higher the sea survival of salmon also coincides when returning salmon were characterized with better condition coefficients. The association between condition of smolt in year i with that of returning adults in year i + 1 is also apparent (Fig. 5). With condition of smolts low again in 1992, these relationships may suggest some adverse impact and corresponding lower than expected returns for 1993.

3. Estimated returns and spawning escapement

There were 1973 salmon < 63 cm and 154 salmon ≥ 63 cm counted at the fish counting fence on Conne River in 1992 (Table 6). This represents a decrease of 5.4% in the number of small salmon but an increase of 77% in the number of large salmon in comparison with 1991. Peak run of salmon was in standard week 27 (July 2-8) with the single largest daily run on July 8 (193 fish; Fig. 6). In past years over 1000 salmon have been counted passing through the fence on some days. Average water temperatures and water levels are summarized in Table 7 for the years 1989-92.

Total returns of adult salmon to Conne River (and estuary) in 1992 are summarized in Tables 8 and 9. The forecast of returns to Conne River in 1992 were expected to be higher than in 1991 (Table 10) based a larger smolt run in 1991. However, concern had been expressed about the possible negative impact of marine environmental conditions on the 1992 returns. Actual returns of small salmon were 4.6% higher than in 1991 but lower than the forecast and indicated that sea survival of smolts decreased to only 3.4% (2.9-4.1%), the lowest recorded to date for Conne River. Sea survival of smolts at Northeast Brook, Trepassey, was also the lowest recorded (2.6%) (M. O'Connell, personnel communication).

Low sea water temperature has been cited as a factor influencing survival of Atlantic salmon. Sigholt and Finstad (1990) found that in cultured Norweigian salmon, low temperature contributed to osmoregulatory failure and poor survival of smolts transfered from freshwater to sea water. Mortality was most pronounced at temperatures below 6° C. Lega et al. (1992) also found that low sea temperature affects water balance in salmon resulting in a decrease in body mositure content and an increase in plasma osmolarity. The most dramatic changes occurred at temperatues below 4° C (Lega et al. 1992). Anomalous environmental conditions, with the worst ice conditions in 30 years and below normal water temperatures, were experienced off the the Newfoundland coast in 1991 (Baird et al 1992; Drinkwater 1992; Narayanan et al. 1992).

In past years (Dempson 1990, 1992) it was observed that in some years there was a differential survival between age 3+ and 4+ smolts with the younger smolts having the higher survival rate. This was not apparent in 1990 adult returns, nor 1992 returns if the age distribution was based on samples collected from the Conne River (Table 12). Sample size, however, was relatively small for 1992 (N = 68) and a different result, consistent with the observed pattern in most other years, occurs if the age distribution is based on samples from the food fishery.

Spawning escapement in 1992 was estimated to be 1783 small salmon and 153 large salmon, the lowest value recorded for small salmon (Tables 8). Mean length of female small salmon in 1992 was 50.3 cm, which results in a mean number of eggs per female of 2357. With 82% of the run made up of female salmon, the number of eggs per fish is 1933. Estimated total number of eggs deposited was:

small salmon = 3.446 million eggs

large salmon = 0.523 million eggs

for a total egg deposition of 3.969 million, 51% of the current target egg requirement and similar to that in 1991.

With Conne River typically being an early run stock, minimal benefit was expected as a result of the commercial fishery moratorium. Results in 1992 provide additional support that commercial exploitation on the Conne River stock was not high.

Size of fish returning to the river was consistent with past years. The increase in numbers of large salmon returns in 1992 relative to small salmon returns, may, however, be indicative of some positive benefit.

5. Forecast of 1993 returns

The estimated number of smolts in 1992 was 68208 (95% confidence limit = 61334-75052) (Table 13); about 9% lower than the previous year. The percentage of smolts at each river age and the estimated number of smolts in each age group are summarized in Tables 13 and 14, respectively.

The distribution of expected adult returns is illustrated in Figure 7. The median estimate of the number of 1SW salmon expected to return to Conne River in 1993 is 4469, with the 5th and 95th percentiles of 4044 and 4901, respectively. The lower forecast reflects the influence of decreased smolt to adult survival in recent years. As indicated in Figure 7, there is a high probability that 1993 returns should exceed those of 1991 and 1992. Again, it is stressed that sea survival cannot be predicted and that should adverse environmental conditions prevail and affect survival of the 1992 smolt class, (again it is noted above that condition of smolts in 1992 was also low) then as occurred in 1991 and 1992, returns in 1993 could be lower than expected. On the other hand, should marine survival increase beyond that observed in recent years, say to at least 8%, then returns should exceed 5000 fish. The need to carry out in-season evaluations cannot be emphasized enough in order to ensure conservation targets are achieved.

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Table 1. Opening and closing dates for 1992 Atlantic salmon recreational and native food fisheries potentially harvesting salmon of Conne River origin.

Fishery	Season
Recreational[1]	June 20 - September 7
Native Food[3]	June 1 - July 31

[1]River closed as of July 5.
[2]Food fishery closed on July 10, 1992.

Table 2. Summary of dates of operation for downstream smolt mark-recapture studies, and upstream adult fence counts at Conne River, Newfoundland.

Year	Smolt mark-recapture studies		Adult counting fence	
	Start	Finish	Start	Finish
1986			May 12	Sept 10
1987	April 26	June 16	May 18	Sept 8
1988	May 9	June 14	May 21	Aug 29
1989	May 9	June 15	May 20	Aug 28
1990	May 3	June 20	May 23	Aug 6
1991	May 3	June 16	May 26	Aug 18
1992	May 10	June 15	May 26	Aug 10

Table 3. Commercial landings (t) of Atlantic salmon in Statistical Section 36, SFA 11, 1974-91.

Year	Small	Large	Total	Proportion small
1974	14.2	37.5	51.7	0.28
1975	22.5	24.3	46.8	0.48
1976	20.1	51.8	71.9	0.28
1977	3.3	13.0	16.3	0.20
1978	1.3	3.9	5.2	0.25
1979	3.6	8.7	12.4	0.29
1980	13.2	8.0	21.3	0.62
1981	2.9	8.7	11.7	0.25
1982	9.1	12.4	21.5	0.42
1983	5.5	7.2	12.7	0.43
1984	4.8	6.7	11.5	0.42
1985	14.8	23.9	38.7	0.38
1986	17.6	11.4	29.0	0.61
1987	7.7	8.5	16.3	0.47
1988	1.7	2.5	4.2	0.40
1989	5.5	6.1	11.7	0.47
1990	3.3	5.8	9.1	0.36
1991	2.0	8.8	10.8	0.19
Mean				
1982-91	7.2	9.3	16.6	0.42
1987-90	4.0	6.3	10.4	0.38

Table 4. Atlantic salmon landings (in numbers of fish) in the sport fishery 1953-92, and in the native food fishery, 1986-92, for the Conne River.

	Sport fishery				Native food fishery			
	Effort	Salmon				Salmon		
Year	rod days	<63 cm	>63 cm	Total	Quota	<63 cm	>63 cm	Total
1953	445	138	26	164				
1954	134	120	23	143				
1955	99	303	37	340				
1956	308	476	36	512				
1957	413	369	23	392				
1958	610	480	55	535				
1959	555	393	18	411				
1960	89	387	0	387				
1961	644	491	0	491				
1962	769	873	11	884				
1963	855	1007	10	1017				
1964	1073	1296	25	1321				
1965	1242	983	39	1022				
1966	1436	879	43	922				
1967	1629	570	3	573				
1968	2379	1724	49	1773				
1969	2909	1751	38	1789				
1970	2909	1673	66	1739				
1971	3483	1707	33	1740				
1972	3194	2509	42	2551				
1973	3427	2139	10	2149				
1974	4033	1988	17	2005				
1975	3800	1903	17	1920				
1976	3894	1931	27	1958				
1977	3375	1665	5	1670				
1978	3122	1735	7	1742				
1979	2147	1010	0	1010				
1980	3512	2238	14	2252				
1981	5029	2691	2	2693				
1982	5268	3302	24	3326				
1983	6972	2192	21	2213				
1984	6709	2343	0	2343				
1985	5202	2729	0	2729				
1986	6038	2060	0	2060	1200	519	3[a]	522
1987	4979	1598	0	1598	1200	18	0	18
1988	5504	1544	0	1544	1200	607	2	609
1989	4414	1036	0	1036	1200	381	1	382
1990	2740	767	0	767	1200	959[1]	11	970
1991	679	108	0	108	1200	281	3	284
1992	1499	329	0	329	1200	484	5	489
Mean								
1987-91	3663	1011						
1982-91	4851	1768						

[a]Dead in trap.

[1]Total for 1990 does not include approximately 50 fish found dead and partially destroyed in traps.

Table 5. Summary of biological characteristic information for Atlantic salmon samples from Conne River, Newfoundland, 1986-92.

			Length (mm)			Weight (g)			River Age (y)			Sex ratio	
Class	Year	N	Mean	SD	Min-max	Mean	SD	Min-max	Mean	SD	Min-max	N	% female
smolt	1986	145	153	12.0	125-210				3.25	0.48	2-5		
	1987	271	144	16.5	106-198	29.1	9.8	11.5-73.8	3.32	0.54	2-5	270	77
	1988	328	147	15.7	102-201	32.2	10.4	12.4-78.8	3.38	0.51	3-5	327	73
	1989	288	152	21.3	98-265	35.0	14.0	9.8-123.2	3.24	0.53	2-5	288	79
	1990	271	148	21.2	100-253	30.5	13.1	10.3-122.8	3.29	0.47	2-5	271	74
	1991	246	153	19.9	104-244	33.5	13.6	12.6-112.5	3.19	0.44	2-5	245	66
	1992	169	149	15.6	116-189	30.1	8.9	14.9-59.2	3.28	0.51	2-5	169	71
1 SW	1986	357	506	23.0	440-570	1451	220.4	900-2900	3.38	0.57	2-5	356	76
	1987	372	509	23.4	430-580	1493	245.9	600-2600	3.19	0.46	2-5	326	78
	1988	267	506	26.1	440-600	1352	226.5	1000-2200	3.14	0.42	2-4	261	80
	1989	140	512	23.3	460-580	1411	201.7	1000-2000	3.18	0.50	2-5	135	79
	1990	174	508	23.4	449-575	1454	184.4	1100-2000	3.27	0.52	2-5	141	81
	1991	39	514	22.8	455-552	1364	174.7	1000-1700	3.18	0.39	3-4	33	70
	1992	68	503	21.0	453-552	1336	261.0	900-1900	3.15	0.53	2-5	34	82
2 SW	1986	1	630			2600			3.00			1	100
	1989	2	665	21.2	650-680	2700			3.50	0.71	3-4	1	100
	1992	1	650			2700			3.00				
PS	1986	2	580	28.2	560-600	2100	424.3	1800-2400	3.00			2	100
	1987	5	536	23.2	520-576	1680	277.5	1400-2100	3.00	0.71	2-4	4	100
	1988	5	556	24.1	530-590	1640	260.8	1500-2100	2.80	0.84	2-4	5	40
	1989	19	649	55.4	550-710	2163	763.3	1500-3500	3.05	0.23	2-4	8	63
	1990	3	564	51.4	505-601	-	-	-	3.33	0.58	3-4	-	-
	1991	6	624	71.4	548-720				3.50	0.55	3-4	1	100
	1992	16	631	67.1	530-770				3.19	0.54	2-4	1	100

Table 6. Weekly summary of numbers of Atlantic salmon enumerated at the counting fence on Conne River, Newfoundland, 1986-1992.

		Number of Fish													
		Small							Large						
Date	Week	1986	1987	1988	1989	1990	1991	1992	1986	1987	1988	1989	1990	1991	1992
May 14-20	20	0	0	0	0				2	0	0	0			
May 21-27	21	0	0	0	0	0			4	0	0	0	0		
May 28-Jun 3	22	6	2	0	3	0			14	0	0	10	0		1
Jun 4-10	23	108	17	11	38	1		5	42	15	7	2	0	2	3
Jun 11-17	24	870	1905	652	946	82	44	67	87	294	123	85	37	9	8
Jun 18-24	25	2690	3713	1939	2119	569	137	513	160	116	119	154	110	16	53
Jun 25-Jul 1	26	1899	1514	2256	856	1706	234	408	67	38	114	31	127	16	42
Jul 2-8	27	612	515	730	216	115	739	547	7	7	16	3	44	18	17
Jul 9-15	28	848	1374	769	248	588	584	259	13	17	5	9	21	7	20
Jul 16-22	29	263	32	344	3	172	178	66	4	0	17	0	20	9	5
Jul 23-29	30	114	126	91	15	88	83	37	0	4	3	0	2	5	1
Jul 30-Aug 5	31	54	3	268	4	0	14	67	2	0	11	0	0	1	4
Aug 6-12	32	7	25	1	21	0	65[2]	14	0	1	2	0	0	4	
Aug 13-19	33	2	0	0	0	-	27		0	0	0	0	-		
Aug 20-26	34	11	6	57	0	-			0	0	1	0	-		
Aug 27-Sep 2	35	31	38[1]	0	0	-			1	0	0	0	-		
Sep 3-9	36	0	417	-	-	-			0	0	-	-	-		
Total		7515	9687	7118	4469	4321	2105	1983	397	498	418	319	361	87	154

[1] Includes estimate of 400 fish in lower part of the river at the time the counting fence was removed in 1987.
[2] Includes estimate of 19 fish in lower part of the river at the time the counting fence was removed in 1991.
[3] Includes estimate of 10 fish in lower part of the river at the time the counting fence was removed in 1992.

Table 7. Summary of mean weekly water temperatures (°C) and water levels (cm) at the counting fence on Conne River, Newfoundland, 1989-92.

		Mean water temperature				Mean water level			
Date	Week	1989	1990	1991	1992	1989	1990	1991	1992
May 7-13	19	12.9	6.6	8.4	5.5	-	65.3		
May 14-20	20	11.0	9.6	7.1	8.5	27.5	47.5		
May 21-27	21	14.5	7.5	8.2	11.3	22.0	41.8	49.8	38.5
May 28-Jun 3	22	14.6	12.5	9.4	13.1	46.8	26.2	40.8	53.6
Jun 4-10	23	16.4	13.6	10.8	12.6	34.4	21.9	22.3	67.5
Jun 11-17	24	14.3	16.4	12.8	14.0	16.7	11.9	21.8	75.4
Jun 18-24	25	17.9	13.8	14.9	16.6	14.0	59.9	16.2	57.1
Jun 25-Jul 1	26	19.0	17.6	17.5	15.8	12.9	42.1	8.6	35.2
Jul 2-8	27	17.2	17.5	15.1	12.5	5.6	19.1	6.9	38.0
Jul 9-15	28	18.4	16.9	16.9	15.8	15.8	12.3	6.1	48.7
Jul 16-22	29	18.5	18.8	19.6	17.4	34.1	9.1	4.9	35.4
Jul 23-29	30	18.9	20.5	19.5	18.5	20.7	23.6	9.4	27.3
Jul 30-Aug 5	31	19.6	19.0	18.3	17.1	20.1	14.1	2.1	52.4
Aug 6-12	32	20.4	21.4	15.3	18.6	31.6	10.0	21.4	45.4
Aug 13-19	33	20.3		19.4			13.6		
Aug 20-26	34	18.3							
Aug 27-Sep 2	35	14.0							
Sep 3-9	36								
Average		17.0	14.7	14.2	12.7	22.7	27.8	15.2	48.8

Table 8. Total estimated returns of small salmon to Conne River, Newfoundland, with a summary of mortalities and removals, and estimated spawning escapement, 1986-92.

	Year						
	1986	1987	1988	1989	1990	1991	1992
Returns to Conne R.							
Food Fishery (estuary)*	766	451	506	317	840	234	403
Angling below fence				180	213	70	137
Mortalities below fence	21	17	3	2	3	2	0
Fence count	7515	9287	7118	4469	4321	2086	1973
Estimated count		400				19	10
Total	8302	10155	7627	4968	5377	2411	2523
1) Released at Fence	7515	9687	7118	4469	4321	2105	1983
Removals and mortalities							
Mortalities above fence	27	21	7	4	2	5	8
Angling above fence	2060	1598	1544	856	554	38	192
Brood stock removal		245					
2) Total	2087	1864	1551	860	556	43	200
Spawning escapement							
(1) - (2)	5428	7823	5567	3609	3765	2062	1783
Egg deposition							
x 10^6	9.86	14.66	10.65	6.95	7.50	3.68	3.45
% of target met	126	188	137	89	96	47	44

* Food fishery includes fish caught in the estuary for tagging studies in 1986 and 1987. Proportions of Conne River origin fish in 1986 and 1987 were 0.792 (N=967) and 0.914 (N=493) respectively. For remaining years, the weighted mean (0.833) was used.

Table 9. Total estimated returns of large salmon to Conne River, Newfoundland, with a summary of mortalities and removals, and estimated spawning escapement, 1986-92.

	Year						
	1986	1987	1988	1989	1990	1991	1992
Returns to Conne R.							
Food Fishery (estuary)*	14	18	2	1	11	2	4
Angling below fence							
Mortalities below fence	1	0	0	0	0	0	1
Fence count	397	498	418	319	361	87	154
Estimated count							
Total	412	516	420	320	372	89	159
1) Released at Fence	397	498	418	319	361	87	154
Removals and mortalities							
Mortalities above fence	1	0	0	0	0	0	1
Angling above fence	0	0	0	0	0	0	0
Brood stock removal		10					
2) Total	1	10	0	0	0	0	1
Spawning escapement							
(1) - (2)	396	488	418	319	361	87	153
Egg deposition							
x 10^6	1.48	2.07	1.77	1.09	1.23	0.30	0.52
% of target met	19	27	23	14	16	4	7

* Food fishery includes fish caught in the estuary for tagging studies in 1986 and 1987. Proportions of Conne River origin fish in 1986 and 1987 were 0.792 (N=967) and 0.914 (N=493) respectively. For remaining years, the weighted mean (0.833) was used.

Table 10. Comparison of 1SW salmon forecasts in year i-1 with actual returns in year i for Conne River, Newfoundland.

	Return year				
	1988	1989	1990	1991	1992
Forecast	7900-8800	6180-6798	6824-7896	4539-5324	3500-7244
Actual return	7627	4968	5377	2411	2523
Return/forecast	86.7-96.5	73.1-80.4	68.2-78.9	45.3-53.1	34.8-72.1

Table 11. Smolt to adult survival for Conne River Atlantic salmon.

	Number of smolts year i	Number of grilse year i-1	% survival	Confidence limit
1987	74585	7627	10.2	9.3-11.3
1988	65692	4968	7.6	6.9-8.1
1989	73724	5383	7.3	6.4-8.1
1990	56943	2410	4.2	3.9-4.6
1991	74645	2523	3.4	2.9-4.1

Table 12. Estimates of smolt to adult survival by age class for Conne River and Northeast Brook, Trepassey, Newfoundland. Values in brackets refer to percent survival if age distribution of grilse was based on sample from the native food fishery.

		Conne River			Northeast Brook		
Smolt class	Age class	Smolt year i	Grilse year i + 1	% survival	Smolt year i	Grilse Year i + 1	% survival
1987	3	49226	6113	12.4	368	45	12.2
1987	4	22375	1285	5.7	713	44	6.2
1988	3	41386	3691	8.9	547	33	6.0
1988	4	23649	1029	4.4	927	29	3.1
1989	3	52344	3651	7.0	376	22	5.9
1989	4	17694	1547	8.7	1158	42	3.6
1990	3	39861	1977	5.0			
1990	4	15944	433	2.7			
1991	3	59716	1892	3.2 (3.5)			
1992	4	13436	445	3.3 (2.0)			

Table 13. Estimated size of the Conne River, Newfoundland, Atlantic salmon smolt population, 1987-92, as determined from mark-recapture studies. Mean river age, percentage of smolts at each river age and sample size are also presented.

Year	N tagged	Population estimate	95% confidence interval	Coefficient of variation	Mean river age (y)	Percent in each age group				N
						2	3	4	5	
1987	4975	74585	67597-81573	5.1	3.3	2	66	30	2	271
1988	3235	65692	59862-71522	4.8	3.4	0	63	36	1	328
1989	2699	73724	66598-80850	5.1	3.1	3	71	24	2	288
1990	3719	56943	52315-61571	4.4	3.3	1	70	28	1	271
1991	2753	74645	62033-87527	9.0	3.2	1	80	18	1	246
1992	3758	68208	61334-75052	5.4	3.3	1	73	24	2	169

Table 14. Estimated total number of smolts in each age group, for Conne River, Newfoundland, 1987-92.

Year	River age (y)				Total
	2	3	4	5	
1987	1492	49226	22375	1492	74585
1988	0	41386	23649	657	65692
1989	2212	52344	17694	1474	73724
1990	569	39861	15944	569	56943
1991	747	59716	13436	746	74645
1992	682	49792	16370	1364	68208

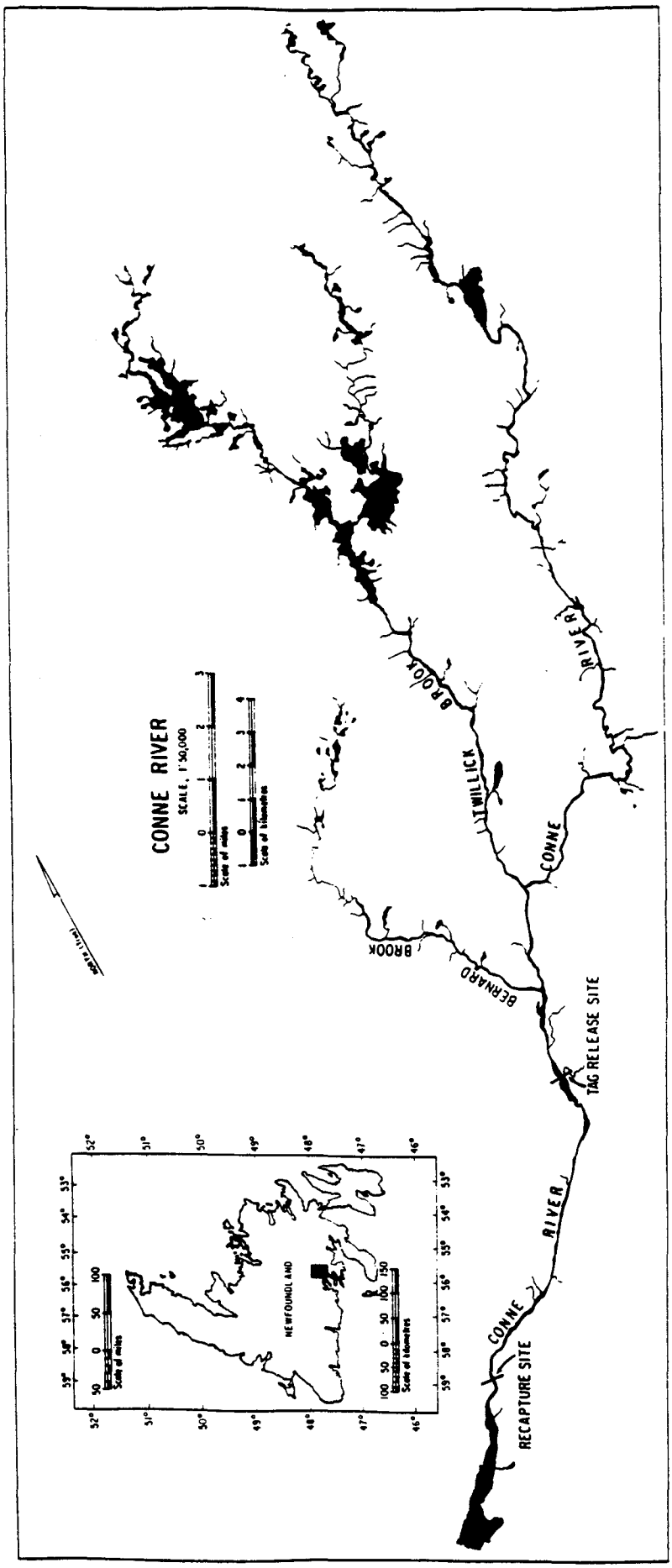
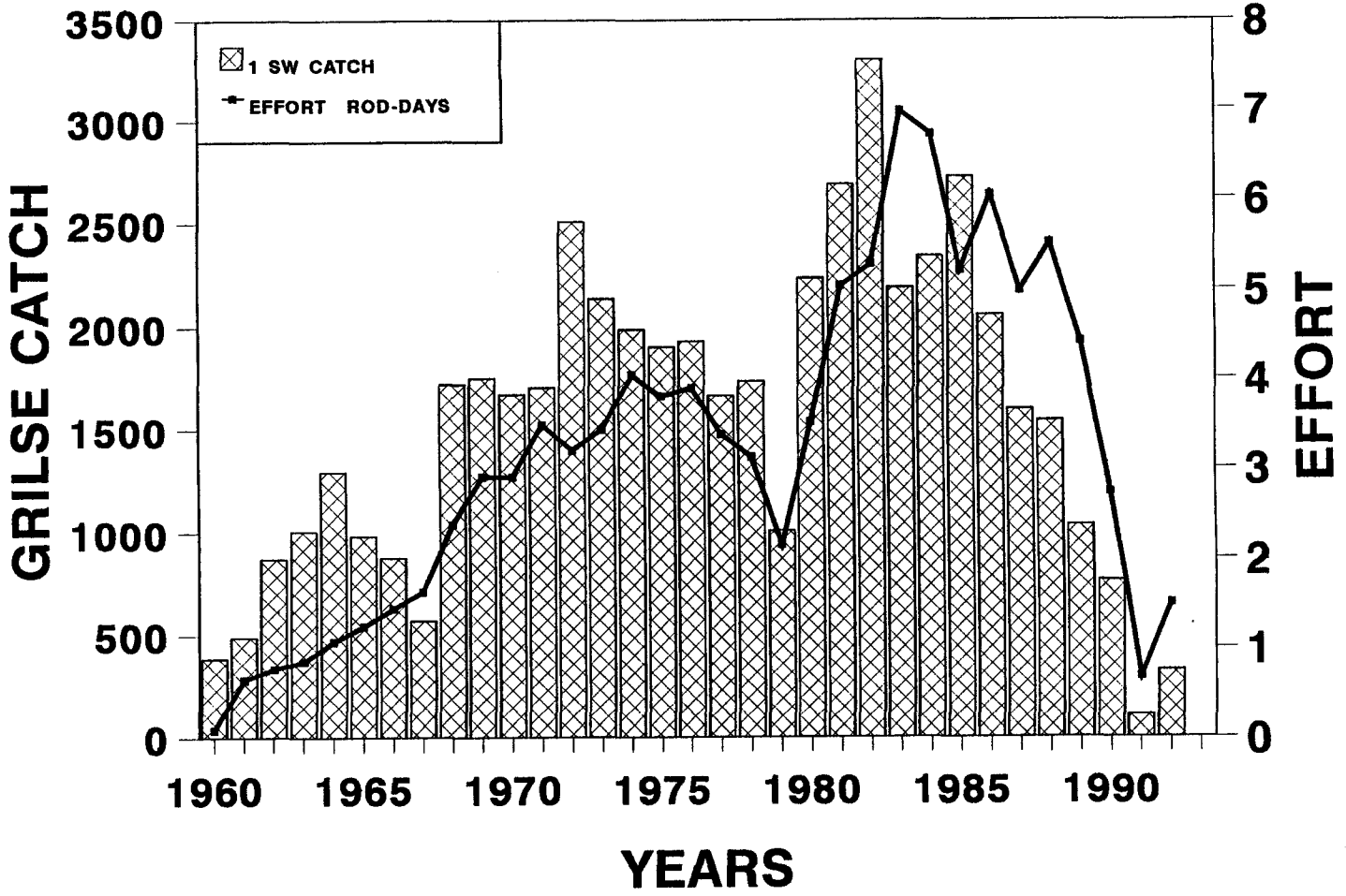


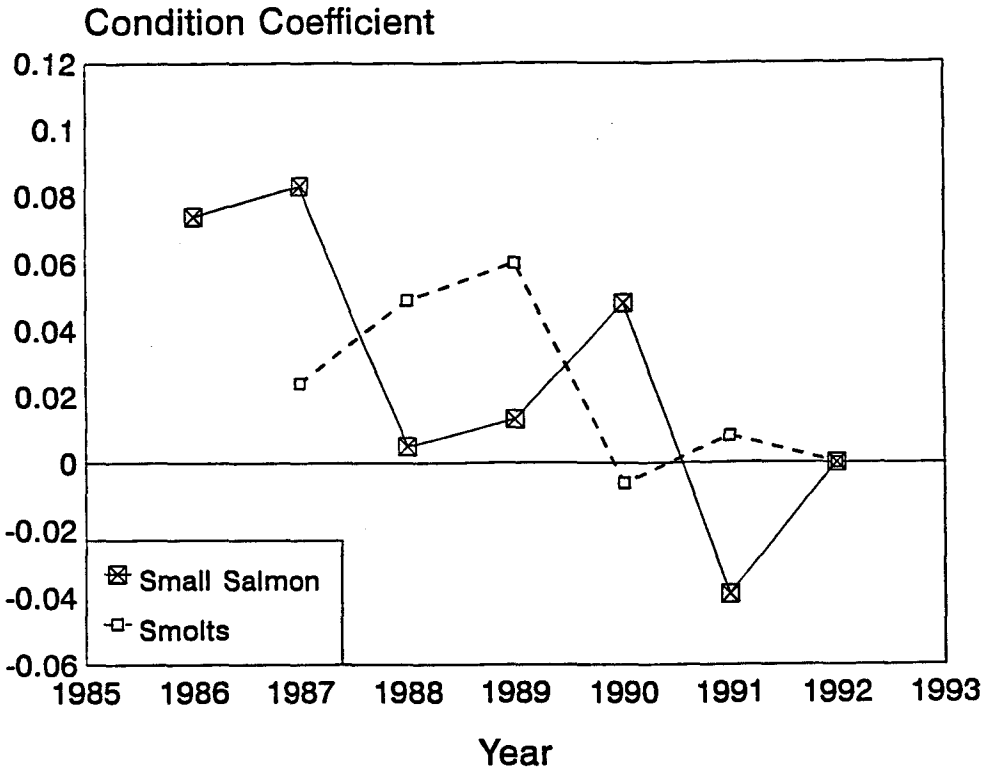
Fig. 1. Conne River, Newfoundland, SFA 11, illustrating the location of fish counting fences used for the mark-recapture survey. Recapture site is also the location of the upstream adult counting fence.

Recreational Catch - Conne River



Fishery closed for 1 month in 1990
Quota of 100 fish in 1991
Quota of 330 fish in 1992

Fig. 2. Summary of the small salmon recreational catch (bars) and effort (rod-days in thousands, line) for Conne River, Newfoundland, SFA 11, 1960-92.



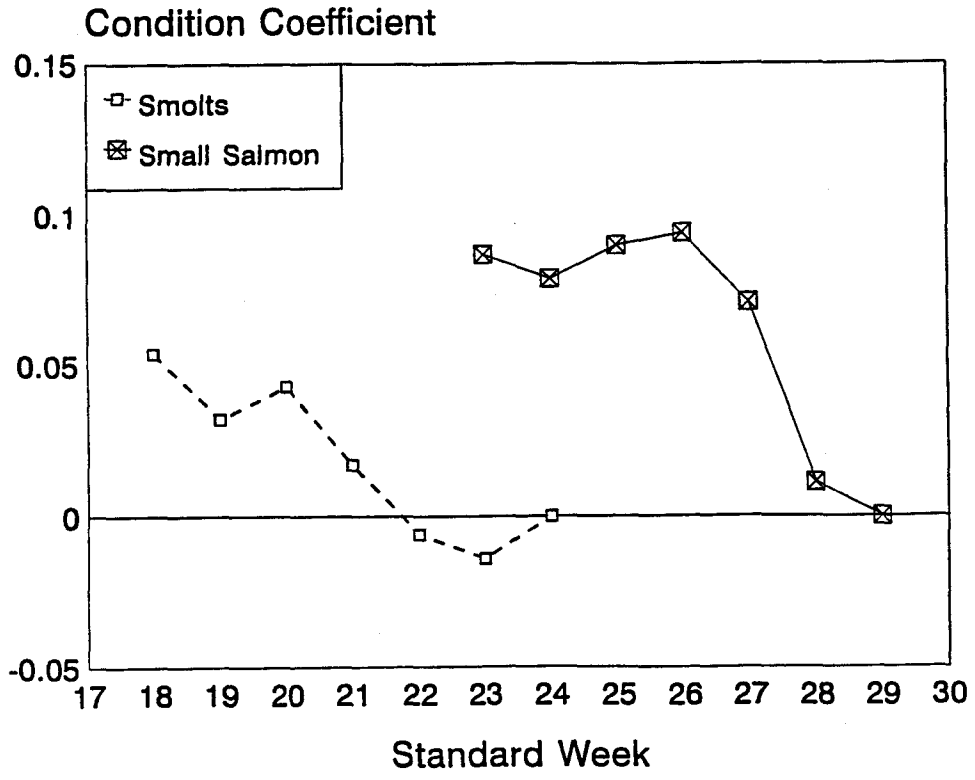
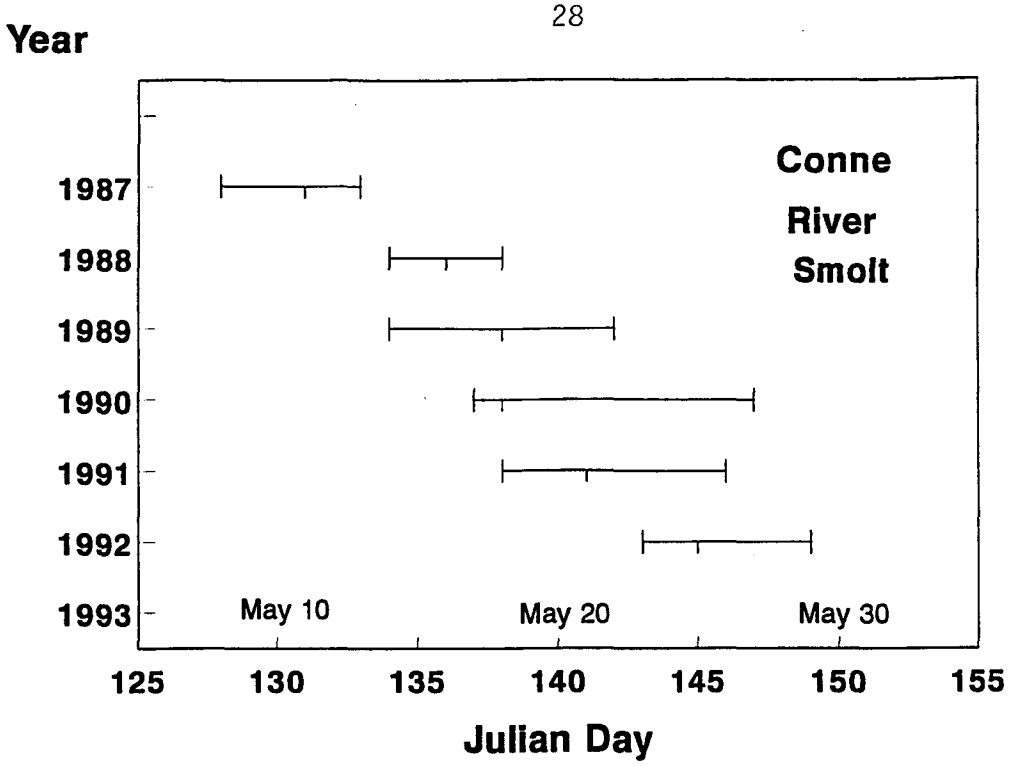


Fig. 3. Index of change in condition over years and weeks for Atlantic salmon smolts and small salmon from Conne River.



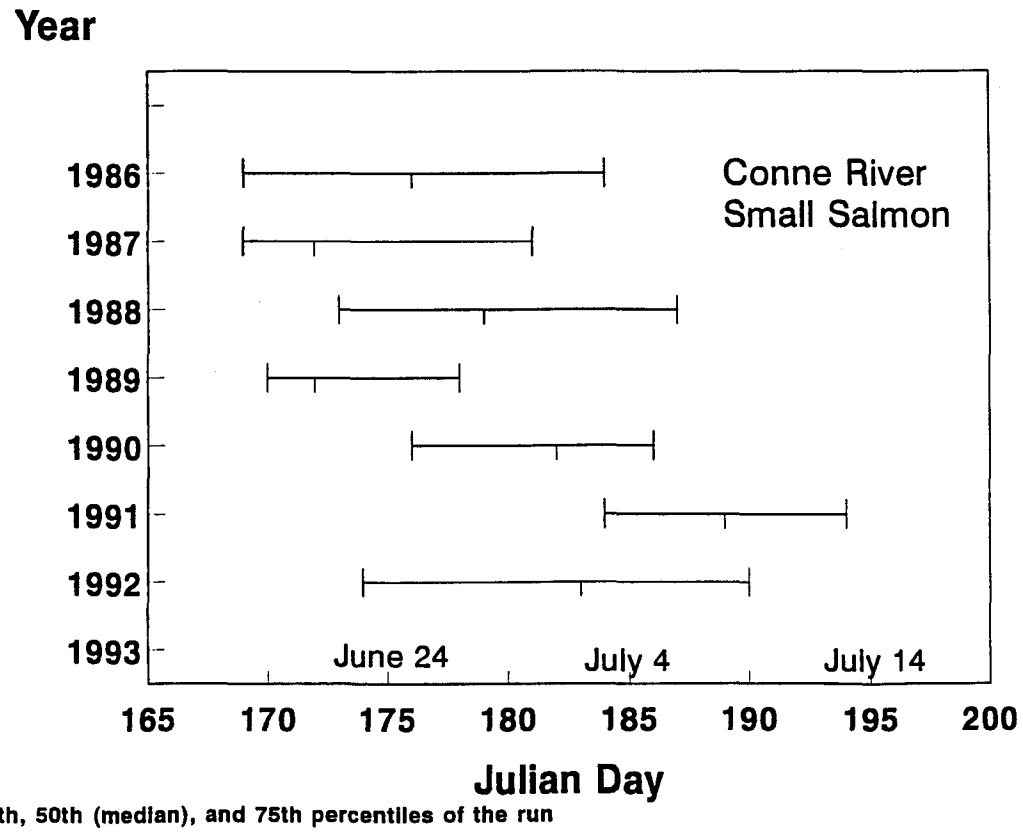
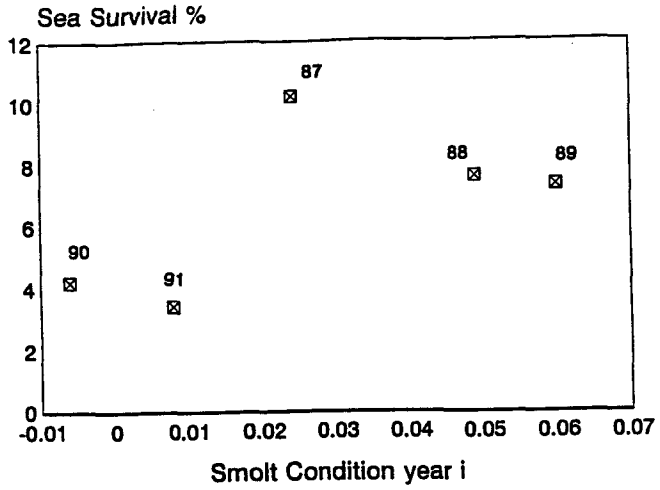
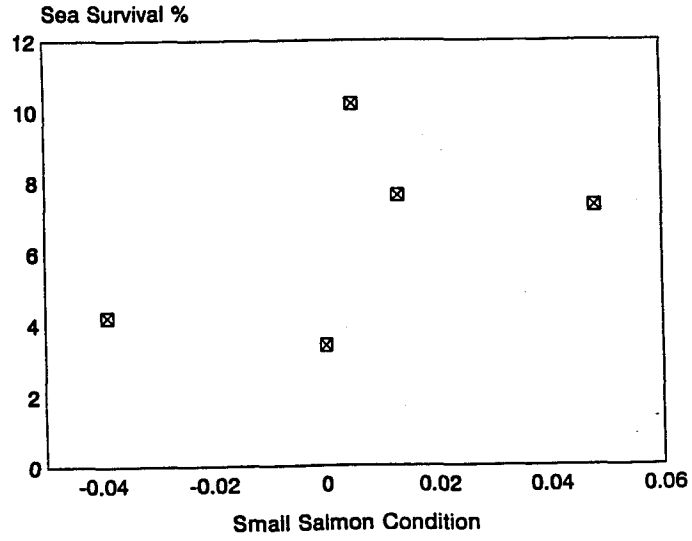
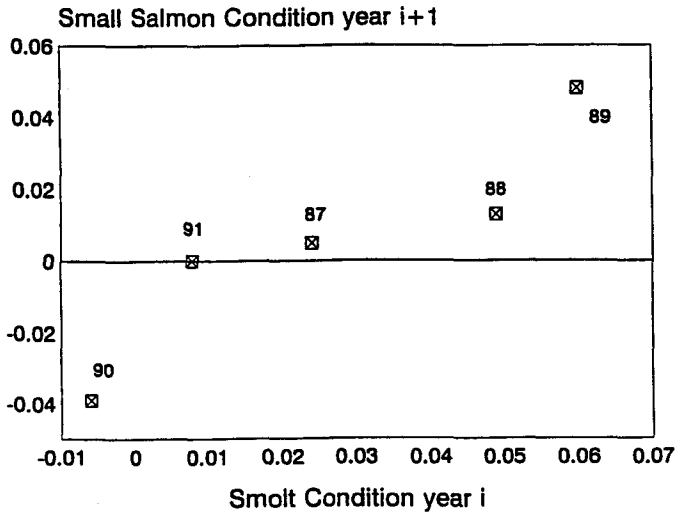


Fig. 4. Run timing of smolt and adult salmon in Conne River. The median point, along with the 25th and 75th percentiles are illustrated.



Year is year of smolt migration
Survival is survival to 1SW salmon





Year is year of smolt migration

Fig. 5. Association between sea survival and smolt and adult salmon condition, and condition of smolts in year i with small salmon condition in year i+1, for Conne River.

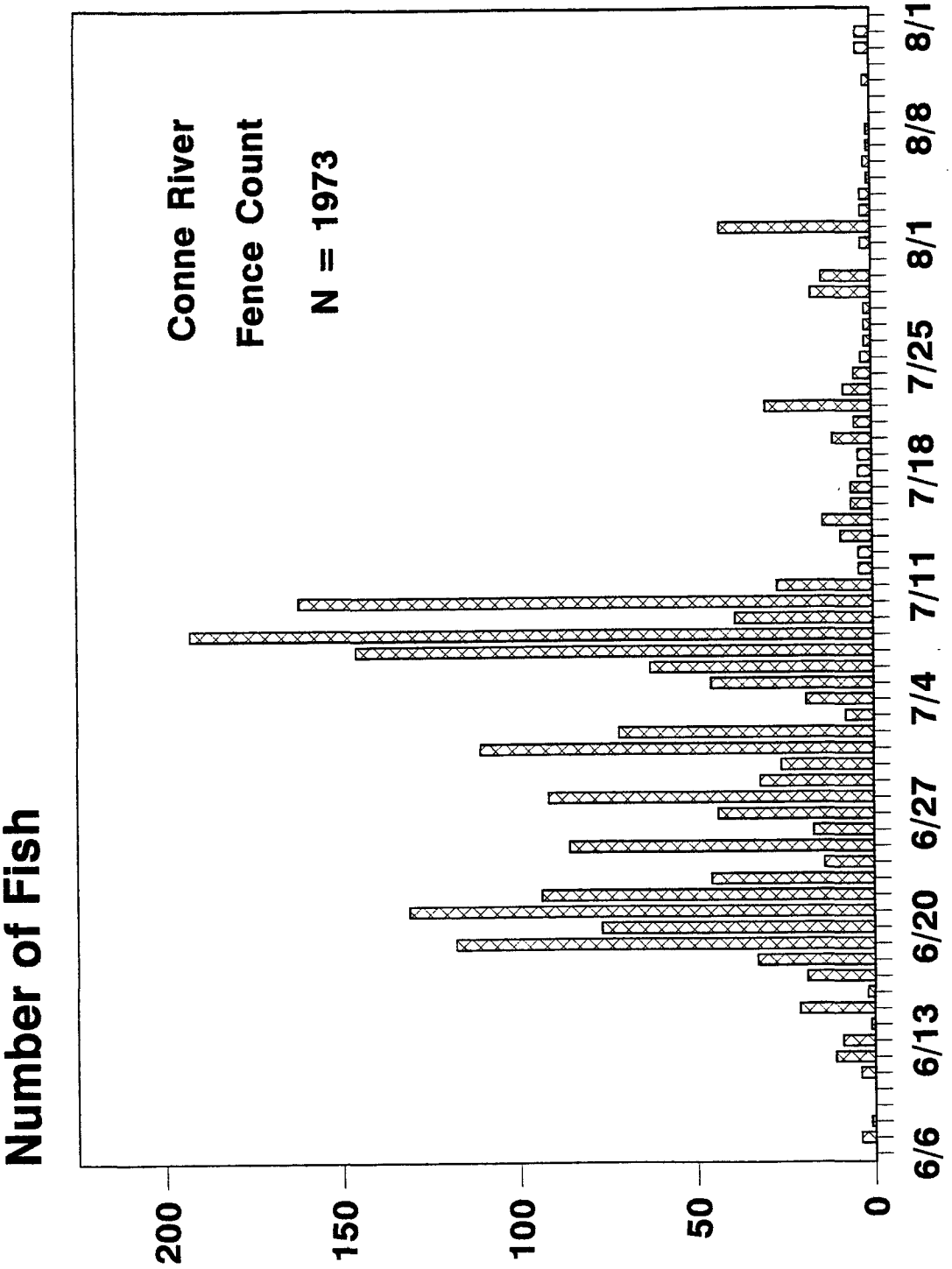
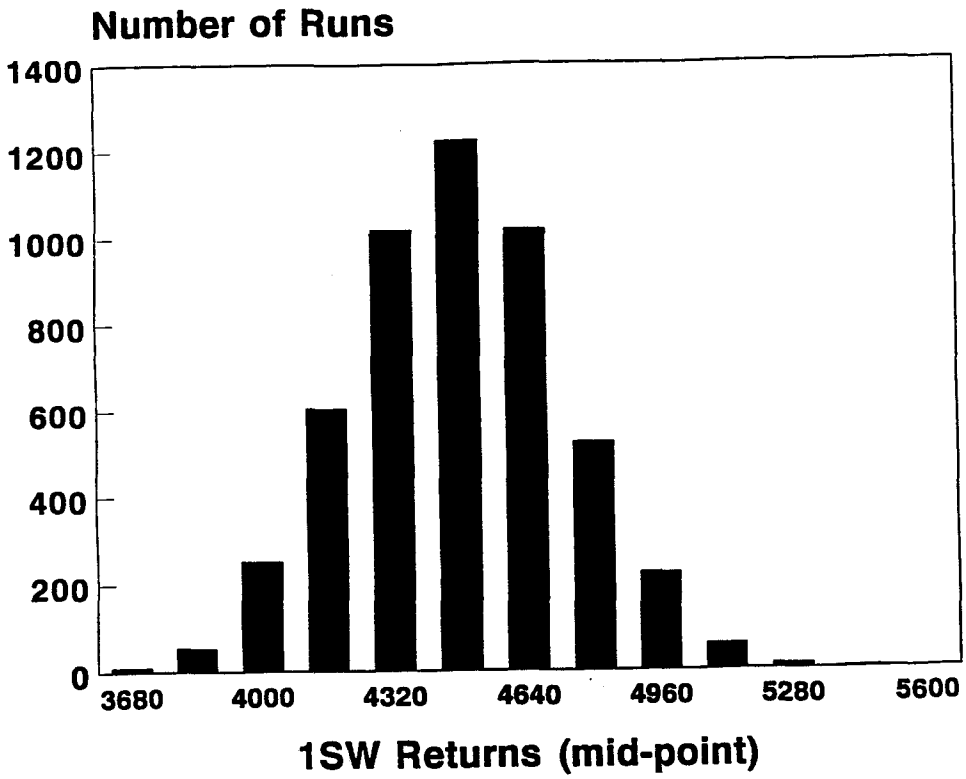


Fig. 6. Daily counts of small salmon returns to the fish counting fence on Conne River, 1992.



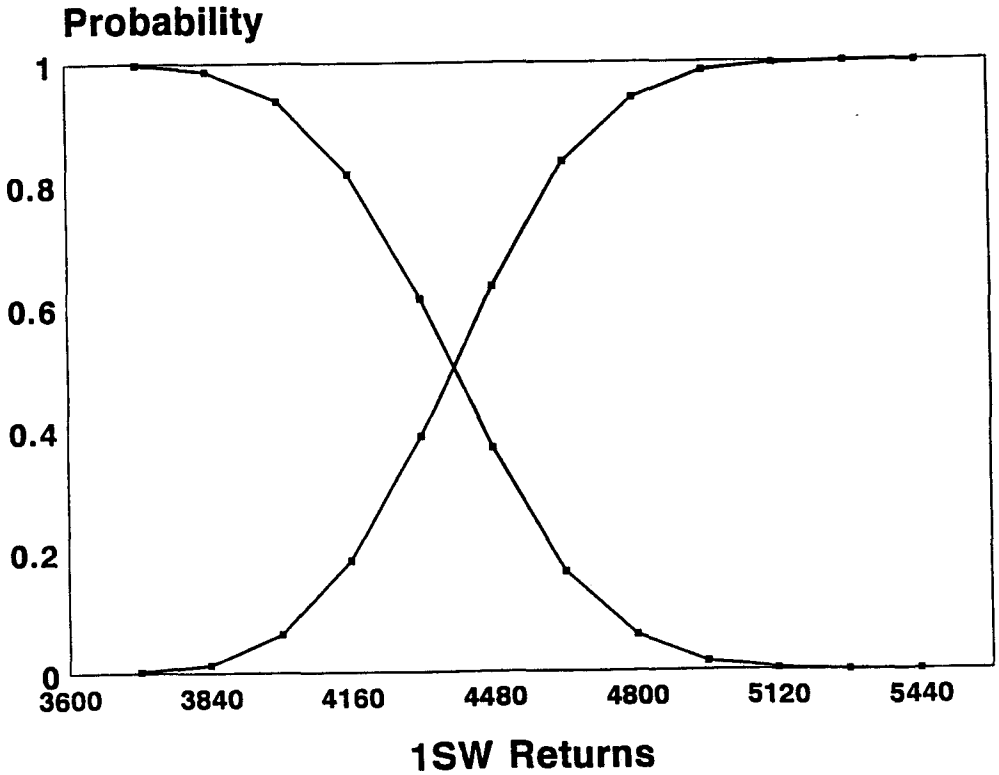


Fig. 7. Frequency distribution of estimated 1SW salmon returns to Conne River, 1993 (upper). Lower figure illustrates the cummulative probability and 1-cummulative probability of 1SW returns to Conne River.