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Assessment of the Atlantic Salmon Population
of Conne River, Newfoundland, 1987

by

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Abstract

Results obtained from a fish counting fence provided the basis for the assessment of the Atlantic salmon population in Conne River, Newfoundland, in 1987. Total adult production was estimated to be 14,000-21,000 salmon, an increase of 22% over the prediction for 1987. Total returns to the river were 9704 salmon < 63 cm and 498 salmon > 63 cm. Egg deposition in 1987 was estimated to be 15.72×10^6 eggs which is 69% higher than the revised target egg deposition of 9.32×10^6 eggs. This is equivalent to a surplus of approximately 3400 salmon < 63 cm. A low recreational catch of 1598 salmon (37% below the previous five-year average catch of 2525 fish), and a food fishery harvest of only 18 salmon contributed to the surplus number of fish in the Conne River in 1987. A mark-recapture experiment indicated an output of 70,000-78,000 smolt in 1987. With sea survival estimated at 0.18, the predicted population size in 1988 is 12,600-14,040. Assuming a commercial exploitation of 0.375, then 7900-8800 salmon are expected back to the river with an available harvest of 3900-4800 salmon in 1988.

Résumé

Les résultats recueillis à une barrière de dénombrement du poisson ont servi de base à l'évaluation de la population de saumon de l'Atlantique de la rivière Conne (Terre-Neuve) en 1987. On a ainsi déterminé que la production totale d'adultes allait de 14 000 à 21 000 saumons, soit une augmentation de 22 % par rapport aux prévisions pour 1987. Les remontes totalisaient 9 704 saumons de 63 cm ou moins et 498 saumons de plus de 63 cm de longueur. La ponte estimative en 1987 a été fixée à $15,72 \times 10^6$ oeufs, soit une augmentation de 69 % par rapport au niveau cible révisé de $9,32 \times 10^6$ oeufs. Ceci équivaut à une production excédentaire d'environ 3 400 saumons de moins de 63 cm de longueur. De faibles prises sportives de 1 598 saumons (37 % de moins que les prises quinquennales moyennes précédentes de 2 525 poissons) et la capture de seulement 18 saumons par les autochtones ont contribué aux effectifs supplémentaires présents dans la rivière Conne en 1987. Les résultats d'une étude de marquage et de recapture ont révélé une production de saumoneaux allant de 70 000 à 78 000 individus en 1987. Si l'on fixe le taux de survie en mer à 0,18, les prévisions des effectifs en 1988 varieront de 12 600 à 14 040 poissons. Si le taux d'exploitation commerciale s'élève à 0,375, on peut s'attendre à ce que 7 900 à 8 800 saumons reviendront à la rivière Conne, dont 3 900 à 4 800 pourront être capturés en 1988.

Introduction

The Conne River, located in the Bay d'Espoir area, Management Zone 11 (Fig. 1), is one of the largest producers of Atlantic salmon in insular Newfoundland. A fish counting fence operated on the Conne River in 1986 and recorded an escapement, before removals by the recreational fishery, of 7536 salmon < 63 cm and 398 salmon > 63 cm. This counting fence was again operated in 1987. Similar to the situation in 1986, there were three authorized user groups prosecuting fisheries on the Conne River salmon population: commercial, recreational, and native food fisheries. The opening and closing dates for these fisheries, and amendments to these dates, are summarized in Table 1. The restrictions for the food fishery were the same as in 1986 with a quota of 1200 salmon < 63 cm in length with a maximum allowable retention of 200 fish per week. Retention of salmon > 63 cm was prohibited in the recreational fishery.

Prior to the opening of the native food fishery, a fire destroyed the gear which was to have been used. Consequently, a request was submitted to the Department of Fisheries and Oceans for permission to use commercial salmon gill nets. This request was granted with the following provisions: the date of the fishery was changed to June 12-July 5; the Band Council was allowed to fish no more than two berths at any one time with a maximum of 50 fathoms of gear per berth; and the minimum mesh size permitted was 114 mm.

The objective of this assessment was to summarize results of the various fisheries in 1987, evaluate the status of the Conne River salmon population, and provide a prognosis for 1988.

Methods

Landings

Data on landings in the recreational fisheries were collected by Department of Fisheries and Oceans (DFO) Fisheries Officers. Landings in the native food fisheries were obtained from the Conne River Native Band Council. Landings from the commercial fisheries in Statistical Section 36 (Fig. 1) were unavailable at the present time.

Population Size - 1987

Upstream Atlantic salmon migrants were enumerated at a fish counting fence, located about 1 km upstream from the mouth of Conne River, which operated from May 18 to September 8, 1987.

Population sizes of salmon < 63 cm and salmon > 63 cm were calculated separately, then summed.

Two estimates of the size of the Conne River anadromous salmon population were obtained using two levels of exploitation in the commercial fisheries:

$$P = [C + a (f_f + t_n)] / 1 - m$$

where P = population size
 C = number of untagged salmon enumerated in the Conne River
 a = estimated proportion of salmon caught in food fishery and research gill nets which were of Conne River origin = 0.914 (Reddin and Short, pers. comm.)
 f_f = number of salmon caught in food fishery
 t_n = number of salmon caught in research nets
 m = assumed commercial exploitation rate. An upper limit of 0.5 and a lower limit of 0.25 were used, similar to the assessment in 1986 (Porter et al. 1986).

Egg Deposition - 1987

Biological characteristics (fork length, whole weight, sex and age) of upstream migrating salmon were obtained from sampling salmon caught in the sport fishery. Counts of eggs were obtained from ripe salmon < 63 cm held at the Bay D'Espoir Salmon Hatchery and sampled from October 20 to 23, 1987 (N = 30). Fecundity was determined from the relationship presented in Figure 2 and substituting the mean length of female salmon sampled in the sport catch. The number of spawners was calculated as follows:

Spawners = salmon released at the fence - unrecorded mortalities - angling catch - removal for brood stock.

Unrecorded mortalities, which include natural mortality in the river prior to spawning and illegal removals, was assumed to be the same proportion as last year at 5% of the upstream run.

Egg deposition by salmon < 63 cm and salmon $\geq$ 63 cm was calculated separately and then summed.

Egg deposition = spawners x % female x fecundity at mean length.

Target Spawning Requirements

Similar to last year (Porter et al. 1986), a ratio of eggs per recruit was developed for the fluvial habitat of Conne River. This ratio was then applied to the population size estimated for 1987 to obtain the total number of eggs required to seed Conne River. This technique assumes similar survival rates from egg to recruits for stream and lacustrine production. In addition, the estimated population size in 1987, which is larger than in 1986, is considered the optimum production for Conne River.

The target number of spawners required to seed Conne River was calculated by attributing all egg deposition to salmon < 63 cm. The numbers of salmon > 63 cm entering the river in 1987 was again about 5% of the total upstream run. Any spawning occurring from these fish would provide a buffer to spawning requirements.

$$\text{Target number of spawners} = \frac{\text{target egg deposition}}{\text{mean fecundity} \times \% \text{ female}}$$

Results

Landings

The landings in the sport fishery and Native food fishery are summarized in Table 2. The recreational catch was 1598, a reduction of 22% from 1986 and 37% below the previous five-year average catch of 2525 fish. The number of rod-days decreased by 18% over the previous year. Both catch and catch per unit effort were below previous five- and ten-year means.

Owing to delays in obtaining gill nets, the food fishery did not begin until June 22. In total, only 18 fish were landed.

At the present time information was not available on the commercial landings in Statistical Section 36. During the past five years, 1982-86, there was an average of 10.4 t of small salmon and 12.3 t of large salmon caught in the commercial fishery in Statistical Section 36.

Population Size

There were 9304 salmon < 63 cm and 498 salmon > 63 cm counted at the fish counting fence on Conne River. Mortalities found in the river downstream from the fence are included in the total (7 untagged fish and 10 tagged fish). An additional 400 salmon < 63 cm were estimated to be in the lower part of the river at the time the counting fence was removed on September 8. It is believed that the low water experienced during 1987 delayed the normal passage of these fish. There was no significant difference, however, in the timing of the run of salmon into Conne River between 1986 and 1987. There were 493 salmon < 63 cm (including 1 fish of unknown size but assumed to be < 63 cm) and 20 salmon > 63 cm caught in the estuary either in the food fishery or research nets (D. Reddin, pers. comm.). Out of this total, 399 salmon were tagged and released in the estuary. Of these tagged fish, 219 salmon < 63 cm and 4 salmon > 63 cm were subsequently recorded entering the Conne River. The number of untagged salmon < 63 cm in the river was 9485 (9304 + 400 - 219). Population size based on a commercial fisheries exploitation of 0.5 would be as follows:

$$\text{salmon} < 63 \text{ cm} = [9485 + 0.914(493)] / 1 - 0.5 = 19,871$$

$$\text{salmon} \geq 63 \text{ cm} = [494 + 0.914(20)] / 1 - 0.5 = 1,025.$$

Total population size = 20,896. This estimate is 22% greater than last year.

Population size based on a commercial exploitation rate of 0.25 results in an estimate of 13,247 salmon < 63 cm and 683 salmon $\geq$ 63 cm for a total of 13,930.

Egg Deposition

Table 3 summarizes removals or mortalities of salmon in the Conne River in 1987. Total spawning escapement was estimated to be 7344 salmon < 63 cm and 463 salmon $\geq$ 63 cm.

The mean fork length of female salmon < 63 cm obtained from sampling the recreational catch was 50.7 cm, which gives a mean fecundity of 2402 eggs per female. The percentage of females was 78% (N=384, females=300). No fecundity-length data were available for salmon > 63 cm, but the mean length of salmon obtained from tagging mortalities was 69.5 cm. Similar to last year, an estimate of the fecundity of these fish was obtained using the fecundity-length relationship for salmon < 63 cm in size and was 5111 eggs per fish. The percentage of salmon $\geq$ 63 cm which were female was 83%, the same value used in 1986.

Estimated spawning escapements of large and small salmon are summarized in Table 3. The estimated number of eggs deposited are as follows:

$$\begin{aligned}\text{salmon} < 63 \text{ cm} &= 7344 \times 2402 \times 0.78 = 13.76 \times 10^6 \text{ eggs} \\ \text{salmon} \geq 63 \text{ cm} &= 463 \times 5111 \times 0.83 = 1.96 \times 10^6 \text{ eggs}\end{aligned}$$

Total egg deposition = 15.72×10^6 eggs.

Target Spawning Requirements

Estimated parr rearing habitat in the fluvial portion of Conne River is 13,180 units. Egg deposition requirements for the fluvial habitat at 240 eggs per unit is 3.2×10^6 eggs. The number of recruits to the fisheries which can be attributed to production in fluvial habitat and assuming a production of three smolt per unit (O'Connell 1986) and a survival of 0.18 (Reddin 1981) is:

$$13,180 \times 3 \times 0.18 = 7,117 \text{ fish}$$

The number of eggs per recruit, therefore, is 444 eggs. The target egg deposition for a production of 21,000 salmon would be:

$$21,000 \times 444 = 9.32 \times 10^6 \text{ eggs,}$$

and the target number of spawners would be:

$$9.32 \times 10^6 / 2402 \times 0.78 = 4977 \text{ salmon} < 63 \text{ cm.}$$

This represents an increase in the target number of spawners of 66% over the previous year. This can be largely attributed to a decrease in the fecundity of the salmon, and an increase in the total estimated population size. Alternatively, for a population size of 14,000 salmon (0.25 commercial exploitation), required egg deposition would be 6.22×10^6 eggs or 3318 spawners. For this assessment, the target number of spawners was taken as a rounded average of the above values, or approximately 4000 salmon < 63 cm.

Forecast

A mark-recapture experiment was carried out to estimate the number of smolts leaving the Conne River in 1987. Two partial counting fences, located about 11 km apart, were used to catch migrating smolts. A total of 4975 smolts was tagged and released using numbered Floy streamer tags. Mean length of smolts was 153 mm (115-220 mm, SD=16.9 mm, N=230). A total of 14,373 smolts was caught in the downstream trap, of which 993 were tagged. A maximum-likelihood estimate derived by Darroch (1961) for a two-sample stratified population was applied to estimate the smolt run. The estimated number of smolts was 67,889 (63,601-72,177). This may be an underestimate of the total smolt population as substantial numbers of parr have been caught in the estuary from late April to October and 2367 parr were counted going through the downstream partial counting fence in the spring. The timing of the parr run was also significantly later than the smolt run ($P < 0.01$). If it can be assumed that the ratio of smolts counted at the fence to total estimated population of smolts (14,373/67,889) is the same for parr counted at the fence, then the total run of parr would be in the order of at least 11,200 fish. Excluding any parr residing in the estuary for more than one year, and applying a survival of 0.54 (Chadwick 1982) adds an additional 6050 smolts to the estimate, giving a total estimate of about 70,000-78,000 smolts. At the present time there is no estimate of smolt-to-adult survival for the Conne River system.

Porter et al. (1986) forecasted the population size in 1987 to be 11,400-17,100 salmon. The population estimated for 1987 was about 22% higher at 14,000-21,000 salmon. Using an estimate of 70,000-78,000 smolt and applying a sea survival of 0.18, 1969-71 average for Sand Hill River (Reddin 1981), predicts a population size in 1988 of 12,600-14,040 salmon. This value is somewhat less than the population size estimated in 1987. With an average commercial exploitation of 0.37 (midpoint of 0.25 and 0.5), then 7900-8800 salmon are expected to return to the Conne River in 1988. Available harvest in Conne River would be approximately 3900-4800 salmon.

Discussion

Landings in the recreational fishery dropped by 22% in 1987. Part of the decrease can be attributed to a reduction in the number of rod-days by 18% and also may be due to the influence of low water levels on catchability of the fish. The recreational catch in 1987 was 37% lower than the average catch for the previous five years (1982-86 mean = 2525 salmon < 63 cm). In the absence of the fish counting fence, a completely different interpretation may have been applied to the status of the Conne River salmon stock in 1987. Angling exploitation rate in 1986, as derived from the recreational catch divided by the number of salmon < 63 cm released upstream, was 0.275 (2060/7488). In 1987, angling exploitation was only 0.165 (1598/9666), if data for the entire year are considered. Using information up to the approximate end of the recreational fishery (July 13), then angling exploitation was 0.181 (1598/8853), a decrease of 34% from the previous year.

The addition of a second adult trap and a better overall fence design resulted in a more continuous passage of fish through the counting fence in 1987. It did not appear that the counting fence delayed upstream migration, except perhaps for the few hundred salmon which entered the river in late summer when water levels were excessively low.

The estimate of the required number of spawners is substantially higher than the value calculated last season. The current method of determining this value, using an estimate of the population size and number of eggs per recruit rather than determining it solely on the basis of habitat, is subject to annual variation. It does have the advantage of adjusting the target number of spawners on the basis of observed production potential of the number of adults returning to the system. There is clearly a need, however, for an updated estimate of marine survival and commercial exploitation rates. Until a thorough analysis of the production capacity of the standing water habitat can be determined for this system, estimating target spawners on the basis of habitat is not feasible. Given the large amount of standing water habitat on the Conne River system, the revised target number of spawners appears more realistic than the previous value.

The estimate of fecundity for 1987 based on ripe salmon < 63 cm was approximately 30% less than the earlier value based on green egg counts from fish sampled in the recreational fishery. The current value is now more in line with fecundity estimates for other salmon populations in Atlantic Canada (Randall 1985). The difference from last year could be due to annual variation in fecundity, or more likely, due to atresia. Prouzet et al. (1984) reported atresia up to 30% is possible in Atlantic salmon and found total and relative fecundity remained relatively stable between years while differences in sex ratios may occur. It is possible that atresia was higher in 1987 because of the severe environmental conditions (extremely low water levels and high river water temperatures) experienced by these fish. It is clear that additional studies on the annual variation in fecundity of ripe fish and an evaluation of atresia is important to the assessment of this and other salmon populations.

The estimated egg deposition in 1987 of 15.72×10^6 eggs is 69% higher than the revised target egg deposition requirements of 9.32×10^6 (with commercial exploitation assumed at 0.50). This is equivalent to about 3400 salmon < 63 cm surplus to that required for spawning in 1987. In the event that the recreational catch attained average levels in 1987 and the food fishery had been successful in obtaining the quota of 1200 salmon, then this surplus would have been about 1400 salmon < 63 cm.

Forecasts for 1988 have been made on the basis of one year of data on a mark-recapture estimate of the outgoing smolt population. While the confidence limits around the estimate are small, and the method appears promising to evaluate the smolt run in subsequent years, there is still no relationship for smolt-to-adult returns for this system. This aspect should be repeated for a number of years in addition to investigating the seasonal utilization of the estuary in order to determine the contribution of smolts from this habitat to the total for the system.

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

Fishery	Season	Amended season
Recreational	June 13 - September 7	June 13 - July 14 ^a
Commercial	June 5 - July 10	-
Native food	June 5 - July 31	June 12 - July 5 ^b

^aRiver closed to angling July 15 due to low water levels.

^bGear used in food fishery amended from a modified cod trap to commercial salmon gill nets.

Table 2. Atlantic salmon landings (in numbers of fish) in the sport fishery 1955-87, and in the native food fishery, 1986-87, for the Conne River.

Year	Sport fishery				Native food fishery			
	Effort rod days	Salmon			Quota	Salmon		
		< 63 cm	≥ 63 cm	Total		< 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
Mean								
1982-86	6038	2525	-	-				
1977-86	4737	2194	-	-				

NOTE: Conne River Micmac Indian Band Council reports taking 2,000-3,000 salmon for food each year prior to 1986.

^aDead in trap.

Table 3. Summary of mortalities and removals, and estimated spawning escapement of Atlantic salmon in Conne River, Newfoundland, 1987. Bracketed figures represent 1986 values.

	<u>Salmon < 63 cm</u>	<u>Salmon ≥ 63 cm</u>
<u>Upstream migrants</u>		
Fence count	9287 (7515)	498 (397)
Estimated count	<u>400</u>	<u>0</u>
(1) Total migrants	9687	498
<u>Removals and mortalities</u>		
Known mortalities above counting fence	21	0
Unrecorded mortalities - 5% of (1)	484	25
Angling harvest	1598	0
*Brood stock	<u>240</u>	<u>10</u>
(2) Total removals	2343	35
Spawning escapement - (1) - (2)	7344 (5054)	463 (376)
Egg deposition	13.76 x 10 ⁶	1.96 x 10 ⁶

*Brood stock: 167 female salmon < 63 cm
8 female salmon ≥ 63 cm

78 male salmon < 63 cm
2 male salmon ≥ 63 cm

**ZONES DE GESTION POUR
TERRE-NEUVE ET LE LABRADOR**
**MANAGEMENT ZONES FOR
NEWFOUNDLAND AND LABRADOR**

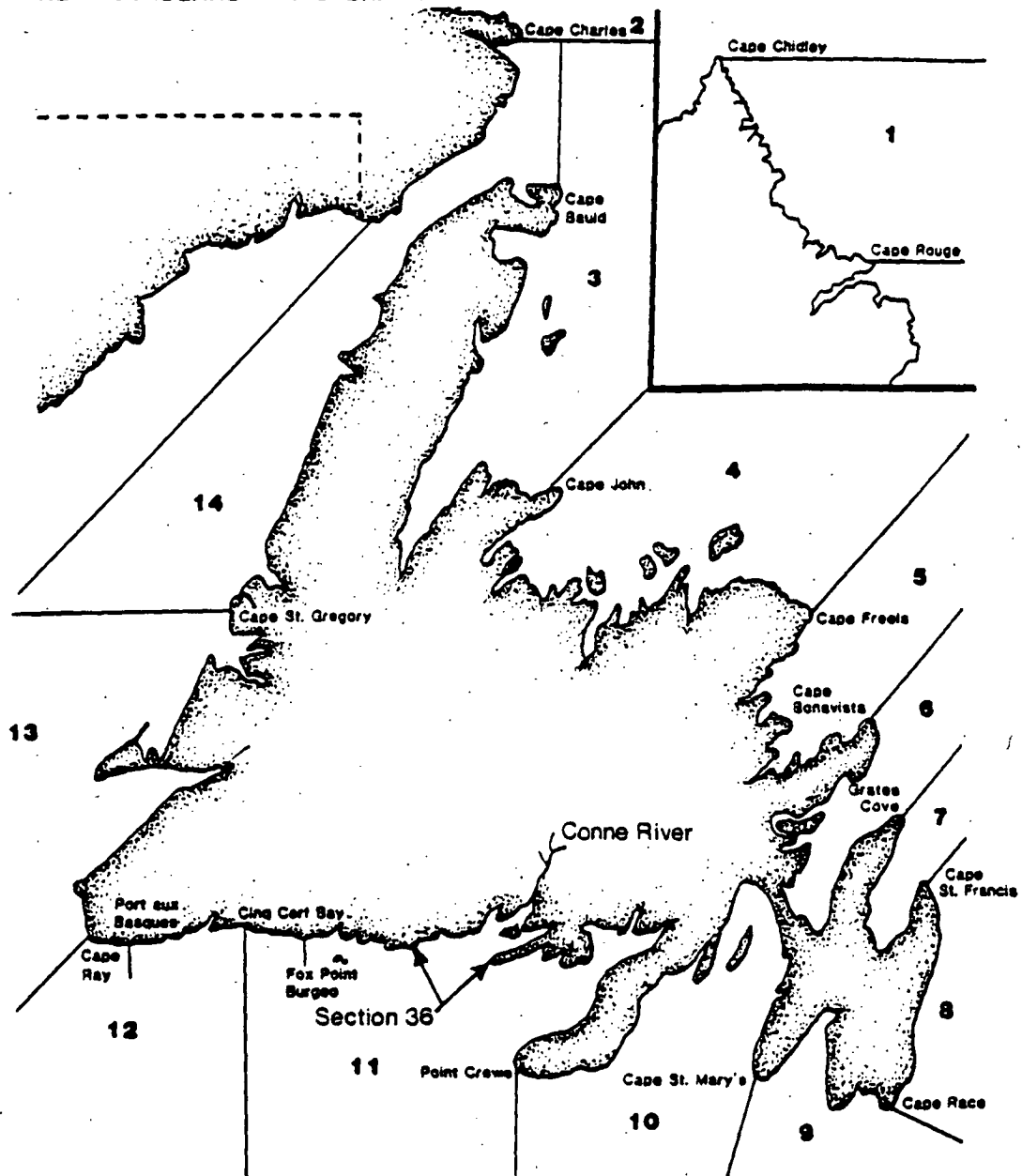


Fig. 1. Map of Salmon Management Zones and Statistical Section 36. Location of Conne River is also shown.

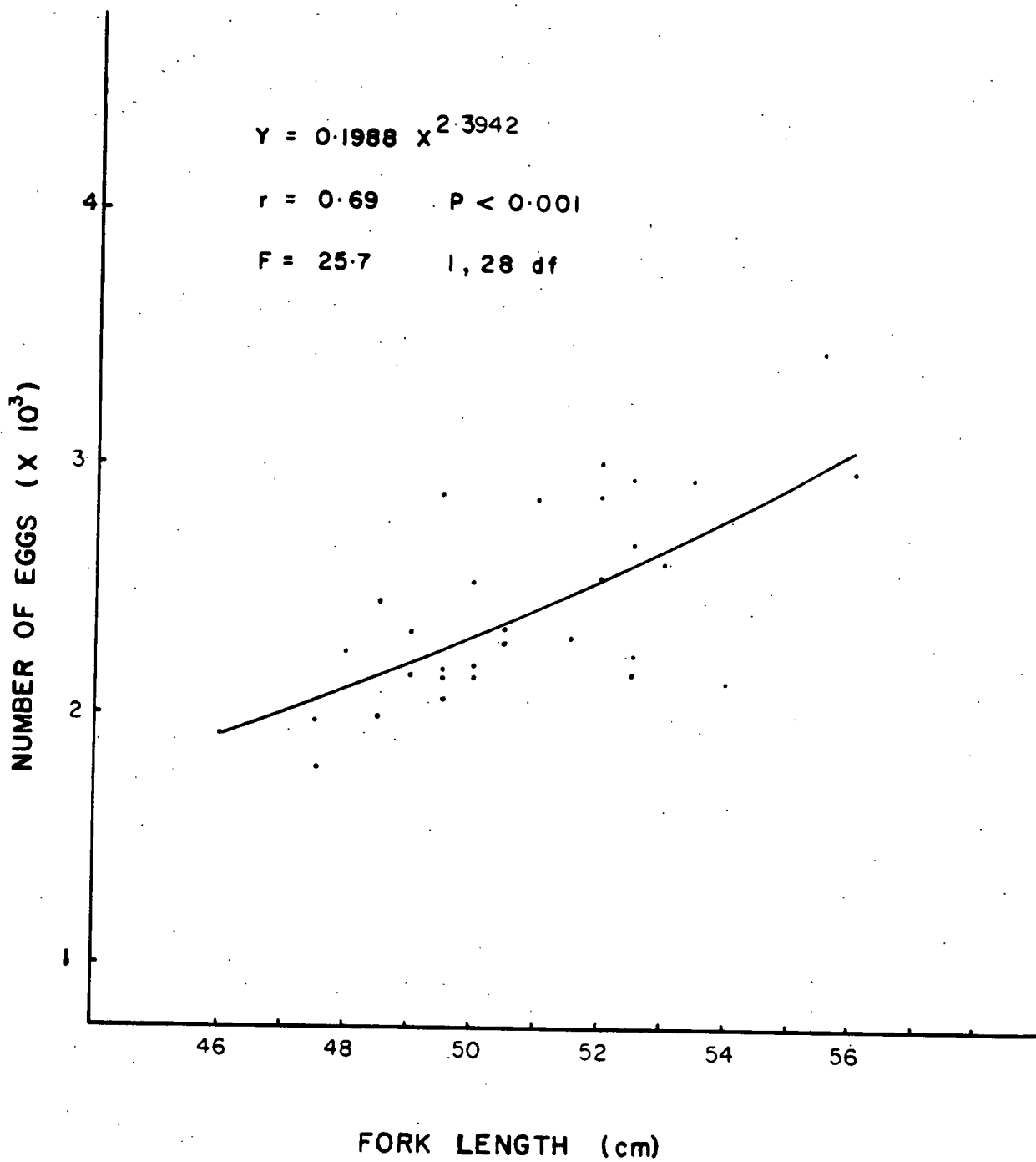


Fig. 2. Fecundity-length relationship for salmon < 63 cm for Conne River, 1987.