

Not to be cited without
permission of the authors¹

DFO Atlantic Fisheries
Research Document 96/88

Ne pas citer sans
autorisation des auteurs¹

MPO Pêches de l'Atlantique
Document de Recherche 96/88

**Status of five enhanced Atlantic salmon (Salmo salar L.) stocks of the
Newfoundland Region in 1995**

by

C. E. Bourgeois, J. P. Davis, J. Murray and V. Mercer
Science Branch
Department of Fisheries and Oceans
P. O. Box 5667
St. John's, Newfoundland A1C 5X1

¹This series documents the scientific basis for the evaluation of fisheries resources in Atlantic Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

Research documents are produced in the official language in which they are provided to the secretariat.

¹La présente série documente les bases scientifiques des évaluations des ressources halieutiques sur la côte atlantique du Canada. Elle traite des problèmes courants selon les échéanciers dictés. Les documents qu'elle contient ne doivent pas être considérés comme des énoncés définitifs sur les sujets traités, mais plutôt comme des rapports d'étape sur les études en cours.

Les Documents de recherche sont publiés dans la langue officielle utilisée dans le manuscrit envoyé au secrétariat.

Abstract

The status of Atlantic salmon in four systems, namely Rocky River, Piper's Hole River, Little River and Flat Bay Brook, presently undergoing salmon enhancement activities are discussed. The systems are located in Salmon Fishing Areas(SFA) 9, 10, 11 and 13 respectively. Egg deposition for each watershed was 33%, 22%,21.7% and 28.8% respectively of the target egg deposition. Of these systems only the Little River would have benefited in 1995 from previous stocking activities. The target egg deposition achieved in 1995 for Piper's Hole River may be an underestimate due to a fence washout. Romaines River in SFA 13 was stocked for the first time in 1995 with 39,577 unfed fry. Total returns for the system are unavailable in 1995.

Résumé

Est examinée la situation du saumon atlantique dans quatre réseaux fluviaux, notamment les rivières Rocky, Piper's Hole et Little, et le ruisseau Flat Bay, actuellement l'objets de projets de mise en valeur des salmonidés. Ces cours d'eau sont situés dans les zones de pêche du saumon (ZPS) 9, 10, 11 et 13, respectivement. La ponte cible dans chacun a été réalisée dans une mesure de 33 %, 22 %, 21,7 % et 28,8 %, respectivement. Seule la rivière Little a bénéficié en 1995 d'activités antérieures d'empoissonnement. Il se peut que la ponte cible réalisée en 1995 dans la rivière Piper's Hole soit une sous-estimation, la barrière de dénombrement ayant été emportée par les eaux. La rivière Romaines de la ZPS 13 a été empoissonnée pour la première fois en 1995 avec 39 577 alevins non alimentés. Des données sur la remonte totale en 1995 ne sont pas disponibles.

Introduction

Rocky River is the largest watershed on the Avalon Peninsula, encompassing a drainage area of 296 km² (Porter et al. 1974) flowing to the sea in salmon Fishing Area (SFA 9) (Fig. 1). A natural falls at the mouth of this river, made this watershed inaccessible to anadromous Atlantic salmon, prior to fishway construction in 1987. The Rocky River requires 3.4 million eggs to meet target egg deposition (Table 1).

The Piper's Hole River flows into the western side of Placentia Bay in SFA 10 (Fig. 1) and requires an egg deposition of 3.159×10^6 eggs (Table 1).

The Little River flows into the Bay d'Espoir in SFA 11 (Fig. 1) approximately 4 km south of the Conne River. The watershed encompasses 183 km² with a complete obstruction at kilometre 4.8 on the main stem of the river which results in anadromous Atlantic salmon having access to less than 30% of the watershed. The Little River requires 313,920 eggs and 976,072 eggs for the accessible and inaccessible portions of the watershed respectively (Table 1).

The Romaines River and Flat Bay Brook are situated in St. Georges Bay in SFA 13. Flat Bay Brook encompasses a watershed area of 635 km². Due to natural obstructions anadromous Atlantic salmon only have access to 89% of the riverine habitat and virtually no standing water habitat (Porter et al., 1974). Porter et al. (1974) record 16,012 (100m²) rearing units accessible to anadromous Atlantic salmon. Romaines River encompasses a watershed area of 98 km² and has 4,572 rearing units of riverine habitat with no standing water accessible to anadromous Atlantic salmon (Table 1).

The intent of this document is to review the status of Atlantic salmon stocks in these watersheds in 1995 and to discuss any possible changes in stock status due to management changes affecting marine exploitation.

Background

For details of the stocking conducted on these watersheds refer to Tables 4, 8 and 10. The Rocky River is the site of an introduction of Atlantic salmon which was conducted from 1984-87, Little River is the site of a ranching project which began in 1989 and Romaines, Flat Bay and Piper's Hole River are the sites of stock augmentation projects which began in 1993 and 1995 respectively.

The Rocky River, since the introduction of anadromous Atlantic salmon, has not been open for a recreational salmon fishery. The Little River watershed has been closed to recreational salmon fishing since 1989. The Flat Bay Brook has been under a special

management regime (quota) since 1986 (Table 10) and was closed to angling in 1995. The Romaines River is an unscheduled watershed.

Management changes implemented in 1992 which were in place through 1995 that impacted marine exploitation of salmon are as follows:

1. Moratorium on commercial salmon fishing along the coast of insular Newfoundland.
2. Moratorium on the cod fishery in areas 2J, 3K and 3L implemented on July 15, 1992. This removed all cod traps from these NAFO areas.
3. Moratorium on the cod fishery in 4R implemented in August of 1993.

Methods

Target egg requirement was calculated based on 240 egg/m² of fluvial habitat and 7 smolts/ha of standing water. Smolt production of 7 smolt/ha was divided by 1.9% to convert this to eggs, (O'Connell et al., 1991).

Spawning escapements were calculated from fishway/fence counts less known removals without inclusion of an estimate for poaching and disease.

The fecundity of Rocky River salmon was estimated based on nineteen fish sacrificed and examined for fecundity in 1994 and an additional 30 fish (5 sacrificed for egg retention) examined in 1995. Fecundity studies were also conducted on Piper's Hole River and Flat Bay Brook and examined 20 and 33 fish on each system respectively in 1995.

The Rocky River egg deposition was calculated based on number of eggs/cm of fish length while all other stocks are based on eggs per kilogram of female weight.

In order to calculate the egg deposition in areas where stocking occurred, an estimate of egg-to-fry survival of 20% (Sturge, 1968) was used to back-calculate the number of fry released to naturally spawned eggs. Sturge (1968), in his work, gave a range of 10-30% for egg-to-fry survival and indicated that a figure of 20% appeared to be a reasonable value. Parr were back calculated to eggs by dividing the number of parr stocked by 0.125 (V. Pepper, pers. comm.) based on parr stocking data obtained from Black Brook. Assumptions are that natural egg to fry survival is 20% and that 40% of the wild fry survive to their first fall. Inherent in this calculation is that 80% of fry placed in grow out cages survive to 90 day fingerlings.

Results and Discussion

The use of fixed parameters, such as 2.4 eggs m² and 7 smolts/ha of standing water, has certain limitations (see O'Connell & Dempson, 1991 for discussion on this topic).

Rocky River

Tables 1-4 detail the accessible rearing area, target egg deposition and biological characteristics for the Rocky River stock.

The results of a two year fecundity study were used in calculating the egg deposition for Rocky River for the first time in 1995 and as such previous egg depositions have been changed to reflect new data. Previously a figure of 2066 eggs/kg. was used however results of a fecundity study indicate that a figure of 1908 eggs/kg. is more accurate for the Rocky River stock. The authors have chosen to utilize a length based relationship to determine egg deposition as fish length records are likely more accurate than fish weight records. The relationship of fish length to total eggs is displayed in Figure 2.

The 1995 escapement of 424 adults to Rocky River was the highest on record and was 174% of the 1987-1991 mean and 150% of the 1992-1994 mean. In 1995 Rocky River would have achieved 40.71 % of it's target egg deposition based on total returns. However, brood removal has lowered this figure to 32.55% which must be considered preliminary until release of fry in the spring of 1996 (Table 4). This increase in escapement may be attributed to three factors; i) the 1994 smolt escapement was the largest on record (Table 5), ii) an increase in smolt to adult survival from 2.4% in 1994 to 3.3 % in 1995 (based on virgin 1SW adults only) but mostly iii) the return of 93 repeat spawners (21% of the returns).

Figure 3 displays smolt to adult survival from 1990-1995 which averaged 2.9% and ranged from 2.3% to 3.5%. For the Rocky River stock in 1995 smolt to adult survival appears to be the major limiting factor in escapement. Table 5 details enumeration of the 1990-1995 smolt escapement. The 1995 adult returns were all resultant from natural spawning. Smolt to adult returns to the river were 2.3%, 2.9%, 3.5%, 2.3% and 3.4% for 1990 to 1994 smolts, respectively. Smolt to adult survival is calculated based on the portion of virgin fish in the escapement. The increase from 1990 and 1991 to 1992 can, in part, be attributed to the moratorium. The decrease in the 1993 smolt survival is most likely due to a decrease in marine survival. The marine survival of the 1994 smolt class approximates the mean of the previous four years.

Table 6 provides insight into the egg/fry-to-smolt survival on the Rocky River. The egg-to-smolt figures compare favourably to other watersheds. At present it appears that

egg-to-smolt survival has declined since 1989. The increase in the 1994 smolt count was due to the high egg deposition in 1990 rather than an increase in egg-to-smolt survival.

Repeat spawners accounted for 14%(59 fish), 9%(20 fish), 17%(48 fish) , 13%(49 fish), 31%(55fish) and 22%(93 fish) of the returns to Rocky River for the years 1990 - 1995 respectively.

The 1996 return to Rocky River is expected to be in the order of 189-323 virgin grilse plus repeat spawners based on the range of smolt to adult survival data collected to date.

Piper's Hole River

The Piper's Hole River has 8,877 units of riverine habitat and 1,184 ha. of lacustrine accessible to anadromous Atlantic salmon and a target egg deposition 2,566,192 eggs. This is a revised target egg deposition for the watershed and it differs from the target presented in O'Connell et. al. (1991).

In 1995 a counting fence operation was conducted on Piper's Hole River for the second time as a fence operation was conducted previously in 1989. The 1995 count was incomplete and could not be reconstructed to estimate the entire run and as such the 1995 count is likely an underestimate. A total of 498 (454 small and 44 large) fish were enumerated through the counting fence. Of these, 50 fish were held for broodstock and 402 were released upstream of the trap. River escapement (fence count plus angling below the fence) is estimated to be 648. Biological characteristic and sex ratio data are not presented as brood were selected by size which biases the data collected.

A total of 176 fish were angled(retained) within the watershed with 85% angled below the fence (pers. Comm. M. Eddy, local fishery officer).

In 1989 a counting fence was operated from June 6- Sept.24 on this river and yielded a partial count of 285 (219 small and 66 large) fish. A total of 112 were angled in 1989 with 90% of the angling occurring below the fence(pers. Comm. Local fishery officer). Spawning is believed to occur below the fence.

Preliminary fecundity figures for Piper's Hole river suggest that the stock produces approximately 1,767 eggs/kg. Additional biological characteristics are those of O'Connell and Dempson (1991). Table 16 details the egg deposition for the watershed for the 1989 and 1995 years.

Little River

Table 1 details the available habitat and target egg deposition for the Little River watershed. The data is presented for the area above and below the obstruction as fish passage is impossible but stocking occurs above the falls. Table 9 details the egg deposition rates for the watershed with a 1995 fence count of 135 adults. The 1995 returns are 167% of the 1987-89 mean escapement, 142% of the 1987-1991 mean escapement and 103% of the 1992-94 mean escapement.

Table 10 details the dates of counting fence operation and the number of smolt and parr enumerated for 1992 - 1993. Of interest is the large number of parr enumerated at the fence each year. The fence site is located approximately 1 km upstream of the river mouth but is under tidal influence. This is suggestive that these parr are smoltifying downstream of the fence site.

Smolt to adult survival figures are not calculated as they are not likely indicative of the entire smolt output prior to 1995.

Romaines River

The Romaines River with 4,572 units of habitat (based on a stream survey conducted in 1993 and 1994) requires an egg deposition of 1,097,280 eggs. A counting fence operation has been conducted on the river from 1993-1995 however no complete counts have been attained. Egg incubation commenced in 1994 and the first fry were stocked in 1995. Table 11 details the information available on egg deposition within the watershed during this time frame. Table 12 details the biological characteristics that are available for this stock.

Flat Bay

The target egg deposition for Flat Bay River is estimated to be 3,842,880 eggs. At present the percentage of the required egg deposition that should come from large salmon cannot be determined due to lack of information on the production potential of the Flat Bay stock. Egg deposition in 1995 was calculated for both large and small salmon and then totalled.

Biological characteristics used in addition to those in Table 14 are as follows; percent female small salmon 72%; percent large salmon female 90% and 1540 eggs/kg. Table 15 details the egg deposition for Flat Bay Brook for the 1994-1995 period.

The counting fence operated from June 22- Sept. 13 with a loss of the count from July 20- July 31. A total of 598 (557 large and 41 large) fish were enumerated with 580 fish enumerated prior to the wash out. Immediately prior to the fence washout the fence

count was low due to low water conditions thus making it difficult to reconstruct the run. Staff on the fence noted the presence of 75 fish immediately below the trap prior to the washout.

River escapement after adjustment is estimated to be 698 adults(650 small and 48 large).

Egg deposition in 1995 accounted for 29% of target compared to 19% in 1994.

References

- O'Connell, M. F., and J. B. Dempson. 1991. Atlantic salmon (*Salmo salar* L.) target spawning requirements for rivers in Notre Dame Bay (SFA 4), St. Mary's Bay (SFA 9), and Placentia Bay (SFA 10), Newfoundland. CAFSAC Res. Doc. 91/18. 14p.
- O'Connell, M. F., J. B. Dempson, and R. J. Gibson. 1991. Atlantic salmon (*Salmo salar* L.) smolt production parameter values for fluvial and lacustrine habitats in insular Newfoundland. CAFSAC Res. Doc. 91/19. 11p.
- Porter, T. R., L. G. Riche, and G. R. Traverse. 1974. Catalogue of rivers in insular Newfoundland. Vol. D. Resource Development Branch, Newfoundland Region. Data Record Series No. NEW/D-74-9: 353p.
- Sturge, C. C. 1968. Production studies of the young stages of Atlantic salmon (*Salmo salar* L.) in an experimental area of Indian River, Notre Dame Bay, Newfoundland. M.Sc. Thesis, Dept. Biology, Memorial University of Newfoundland. 134p.

Table 1: Rearing area and target egg deposition for watersheds examined in present study.

	Riverine habitat (m ²)	Lacustrine habitat (ha)	Target egg deposition
Rocky River	10,823	2,191	3,404,730
Little River	5,221	989	1,253,040
accessible	1,308	0	313,920
inaccessible	3,913	989	939,120
Flat Bay Brook	16,012	0	3,842,880
Romaines River	4,572	0	1,097,280
Piper's Hole River	8,877	1,184	2,566,192

Table2 . Biological characteristics of Rocky River adults.

Year	No. Sampled(aged)	% Female	No. 2 Sea Winter Virgin	Mean Length(cm)	Mean Weight(kg)	% Repeat Spawners	Percentage at various Freshwater Ages				
							2 ⁺	3 ⁺	4 ⁺	5 ⁺	
Rocky River	1990	21	N/A	0	57.1	2.2	14	6	72	16	6
	1991	32	N/A	0	56.9	2.2	9	15	58	27	0
	1992	24	N/A	0	58	2.4	17	18	55	27	0
	1993	32	N/A	0	56.5	2.2	13	3	69	24	3
	1994	68	79	0	56.9	2	31	16	72	12	0
	1995	111	86	1	56	2	22	14	77	9	0
		288	83	1	56.6	2.1	21	13	71	15	1

Table 3 . Biological characteristics of Rocky River smolt.

	Year	No. Sampled	% Female	Mean Length(cm)	Mean Weight(g)	Percent at various freshwater ages				
						2 ⁺	3 ⁺	4 ⁺	5 ⁺	6 ⁺
Rocky River	1988	28	57.1	17.5	54.5	0	64	36	0	0
	1989	28	N/A	14.9	32.4	18	67	11	4	0
	1990	101	84.2	17.3	46.5	1	66	29	4	0
	1991	146	86.3	17.0	43.2	16	70	13	1	0
	1992	71	78.9	17.0	44.5	1	76	21	2	0
	1993	88	71.6	18.9	58.2	13	57	24	6	0
	1994	160	83.8	17.0	45.1	2	66	29	3	0
	1995	124	77.4	17.0	44.8	16	77	7	0	0
		746	80.2	17.2	46.3	8.7	68.3	20.7	2.2	0

Table 4. Details of egg deposition Rocky River 1983-1994.

Year	Fry Stocked	Parr Stocked	Adults Stocked	large	Fishway Count small	total	Broodstock	Total Eggs	% Target Egg
1983	0		0				0	1538875	45
1984	307775		0				0	2172500	64
1985	434500		0				0	970000	28
1986	194000		0				0	1998225	59
1987	399645		140	80	1	81	0	743595	22
1988	0		0	313	6	319	0	1011527	30
1989	0		0	168	9	177	0	561255	17
1990	0		0	401	17	418	0	1359420	40
1991	0		0	211	16	227	0	730874	22
1992	0		0	237	46	283	0	961811	28
1993	0		0	292	72	364	0	1148320	34
1994	0		0	158	19	177	62	857862	25
1995	50,000	31,983	0	385	39	424	76	1106857	33

Note: the 1995 egg deposition is preliminary as 1996 stocking will alter the figure presented.

Table 5. Details of smolt enumeration Rocky River 1990-1995.

Year	Smolt Count	% Smolt-to-Adult Survival
1990	8,287	2.3
1991	7,732	2.9
1992	7,813	3.5
1993	5,115*	2.3
1994	9,781	3.4
1995	7,786	

* Smolt count is an estimate due to fence washout Rocky River 1985 - 1990.

Table 6. Details of egg/fry to smolt survival for Rocky River..

Year	egg to smolt survival (%)	fry to smolt survival (%)	smolt classes
1985		0.08	5*
1986		1.3	4*, 5*
1987		1.6	3*, 4*, 5*
1987	1.00		2*, 3*, 4*, 5*
1988	0.86		2*, 3*, 4*, 5*
1989	1.04		2*, 3*, 4*, 5*
1990	0.56		2*, 3*, 4*
1991	0.0086		2*, 3*
1992	0.0013		2*

Table 7. Biological characteristics Little River adults 1990,1992 - 1995.

Year	Life Stage	Fork Length			Weight			River Age		
		Mean (No.)	S.D.	Range	Mean (No.)	S.D.	Range	Mean (No.)	S.D.	Range
1990	1SW	51.41 (73)	3.79	44.00-62.80	1.34 (73)	.32	.700-2.500	3.02 (62)	.50	2-4
	Repeat	57.40 (4)	1.19	56.20-59.00	1.85 (4)	.15	1.700-2.000	3.00 (4)	.00	3
1992	1SW	51.51 (89)	2.53	46.50-59.00	1.41 (88)	.22	1.100-2.200	3.00 (68)	.42	2-4
	Repeat	63.85 (12)	6.45	53.50-73.00	3.05 (11)	1.20	1.700-5.900	2.80 (10)	.42	2-3
1993	1SW	51.68 (154)	2.81	40.90-59.10	1.48 (154)	.29	1.000-2.700	3.05 (144)	.38	2-4
	Repeat	60.55 (13)	5.62	53.70-72.70	2.29 (12)	.65	1.400-3.800	2.92 (12)	.29	2-3
1994	1SW	51.33 (62)	2.93	41.80-60.20	1.33 (62)	.25	.800-2.200	2.95 (58)	.35	2-4
	Repeat	58.19 (8)	7.42	48.70-71.00	1.97 (8)	.81	1.300-3.600	3.14 (7)	.69	2-4
1995	1SW	51.17 (111)	3.34	44.70-67.60	1.25 (111)	.25	.800-2.900	2.86 (108)	.50	2-4
	2SW	68.00 (1)			3.00 (1)					
	Repeat	61.81 (7)	5.49	55.50-70.80	2.24 (7)	.70	1.500-3.300	3.00 (7)	.58	2-4

Table 8. Biological characteristics of Little River smolt.

Year	No. Sampled	% Female	Mean Length(cm)	Mean Weight(g)	Percent at various freshwater ages		
					2 ⁺	3 ⁺	4 ⁺
1993	43	97.7	17.58	50.73	32.6	58.1	9.3
1995	31	87.1	14.86	28.87	90.3	9.7	0

Note: All smolt samples were collected on a single day each year.

Table 9. Egg deposition rates for Little River 1987-1995.

Year	Fence Count		Spawning escapement	Fry stocked	Fry Stocked	Egg Equiv.		Natural Egg	% Target	Total	% Target	% Target
	large	small		Below Falls	Above Falls	Below Falls	Above Falls	Deposition	Wild	Eggs	Below Falls	Above Falls
1987	64	3	67	0	0	0	0	91,410	29.12%	91,410	29.12%	0.00
1988	65	3	68	0	0	0	0	92,774	29.55%	92,774	29.55%	0.00
1989	102	5	66	0	0	100350	0	90,046	28.68%	190,396	60.65%	0.00
1990	158	15	91	20,070	0	204835	0	124,154	39.55%	328,989	104.80%	0.00
1991	55	6	31	40,967	0	103715	0	42,294	13.47%	146,009	46.51%	0.00
1992	104	21	28	20,743	0	102835	553380	38,201	12.17%	694,416	44.93%	56.69
1993	169	11	80	20,567	110,676	148,090	444,270*	109,146	34.77%	701,506	81.94%	45.52
1994	73	11	88	29,618	88,854	0	0	120,061	38.25%	120,061	38.25%	0.0
1995	118	17	50	0	0	0	0	68,217	21.73%	68,217+	21.73%	0.0

+ data available post fry distribution 1996

Table 10 . Details of smolt and parr enumeration Little River.

Year	Dates of Operation	Number of Smolt	Number of Parr
1992	May 11-July 5	382	1,404
1993	May 11-July 5	324	1,500
1994	May 6- June 13	495	4,018
1995	May 2 - June 22	2,712	1,586

Table 11. Details of egg depositions for Romaines River.

Year	Fence Count	Angling	Total Returns	Brood Removal	Fry Stocked
1993	93	5	117+	0	0
1994	14	2	unknown	12	0
1995	49	0	unknown	37	39,577

+ includes fish observed by fishery officer prior to fence installation

Note: Total returns could not be assessed due to fence washouts in 1993-95.

Table 12. Biological characteristics Romaines River.

Year	Life Stage	Fork Length		Weight	
		Mean	No.	Mean	No.
1994	1 SW	54.1	12	1.63	8

	2 SW	70.2	1	3.30	1
	Repeat	66.1	3	2.55	3
1995	1 SW	50.8	39	1.31	39
	2 SW	73.2	2	4.10	2
	Repeat	73.0	1	3.90	1

Table 13. Angling restrictions Flay Bay Brook 1986-1994.

Year	Quota	Effort	Small Retained	Small Released	Large Released
1986	400	684	174	0	2
1987	300	815	219	0	0
1988	300	871	249	0	5
1989	250	612	130	0	1
1990	250	939	277	0	6
1991	250	977	251	0	2
1992	250	665	223	0	20
1993	250	678	173	0	17
1994	250	615	128	8	32

Table 14 . Biological characteristics Flat Bay Brook stock.

Year	Life Stage	Fork Length		Weight	
		Mean	No.	Mean	No.
1994	1 SW	52.6	39	1.32	39
	2 SW	67.1	3	3.21	3
1995	1 SW	51.7	81	1.30	81
	Repeat	66.0	3	3.07	3
	2 SW	70.6	2	3.0	2
	Repeat	79.8	1	4.90	1

Table 15 . Egg deposition Flat Bay Brook 1994-1995.

Year	Fence Count		Adjusted Count	Angling Retained	River Escapement	Broodstock Removals	Spawning Escapement	% of Target
	Small	Large						
1994	403	67	490	128	554	43	383	19.6
1995	557	41	698	0	698	83	611	28.8+

+ preliminary figure due to egg incubation

Table 16. Egg deposition Piper's Hole River 1989 and 1995.

Year	Fence Count	Angling Retained	River Escapement	Brood stock Removals	Spawning Escapement	% of Target
1989	285	112	386	0	274	24.3
1995	498	176	648	50	399	35.4+

+ preliminary figure due to egg incubation

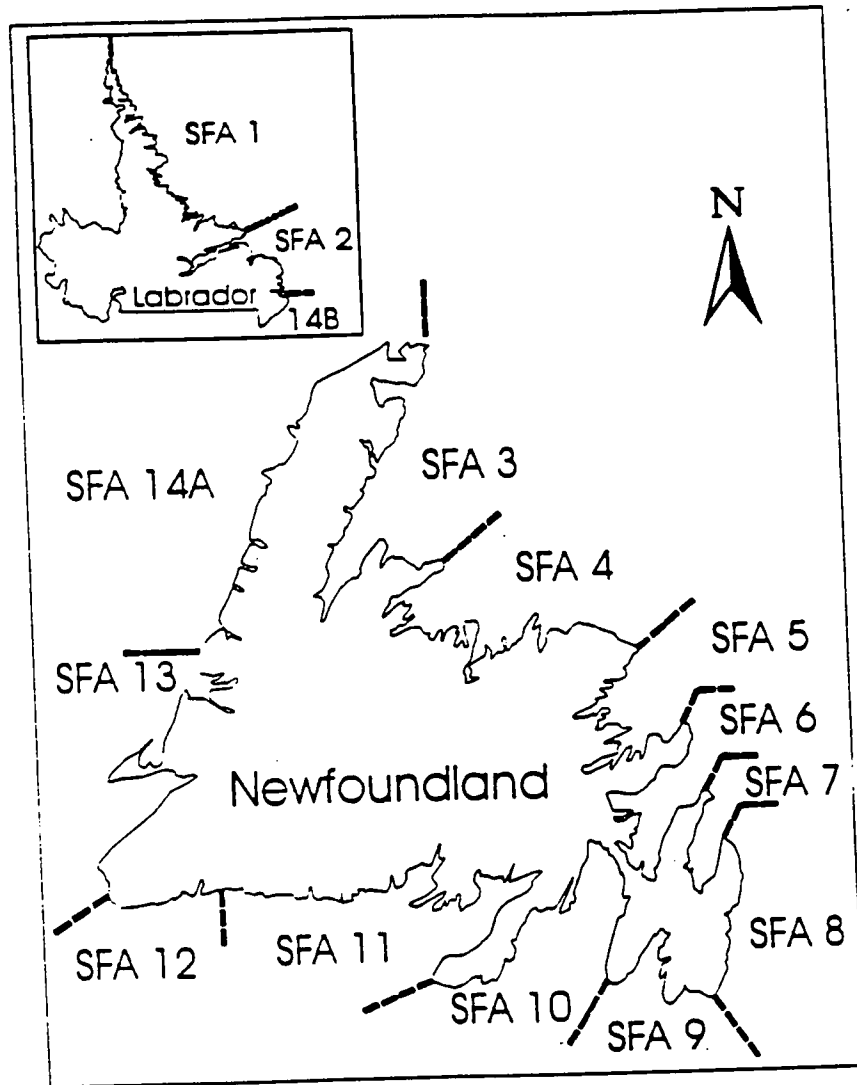


Fig. 1. Map showing the 14 Salmon Fishing Areas of the Newfoundland Region.

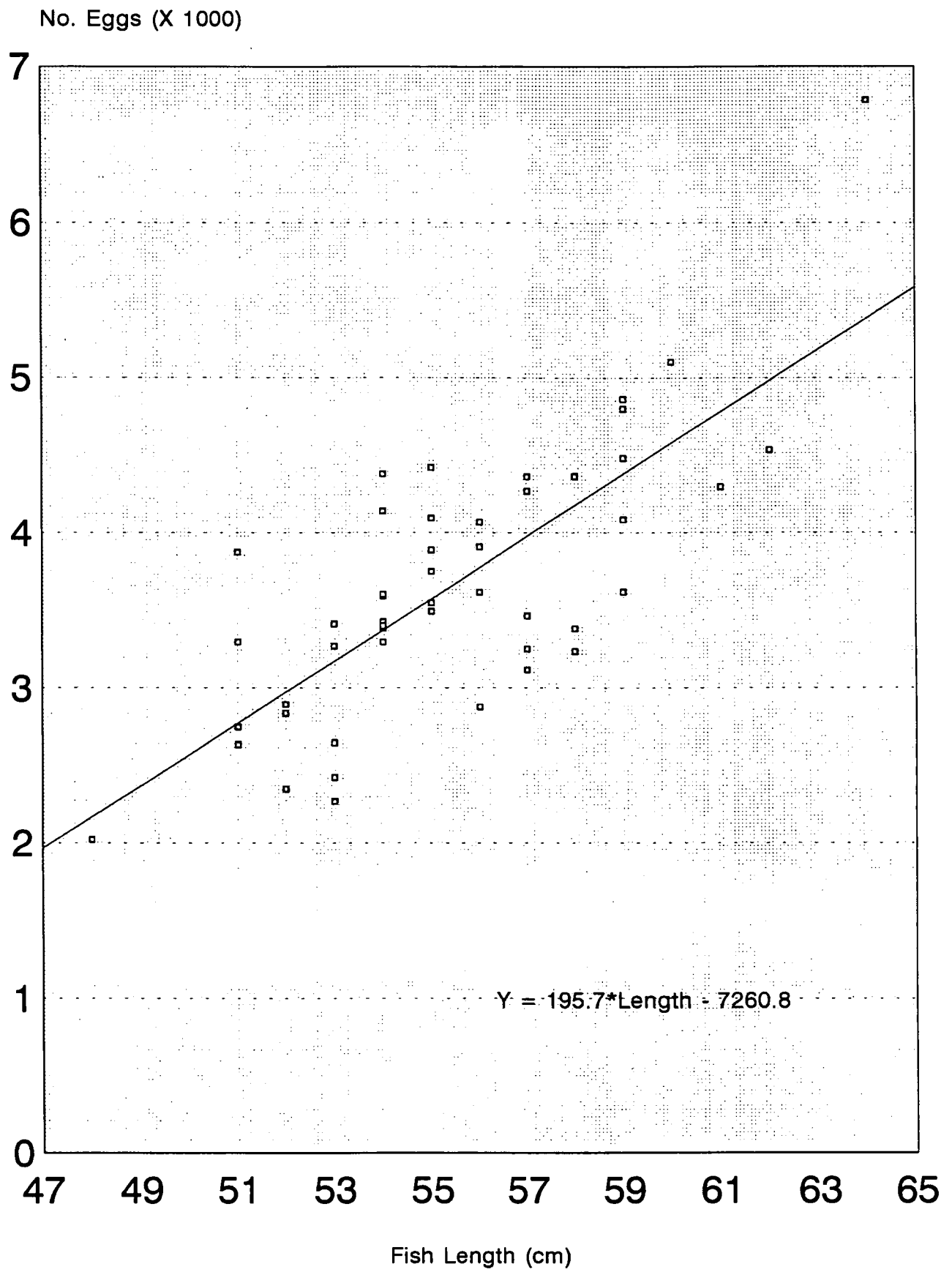


Figure 2. Fecundity relationship Rocky River salmon.

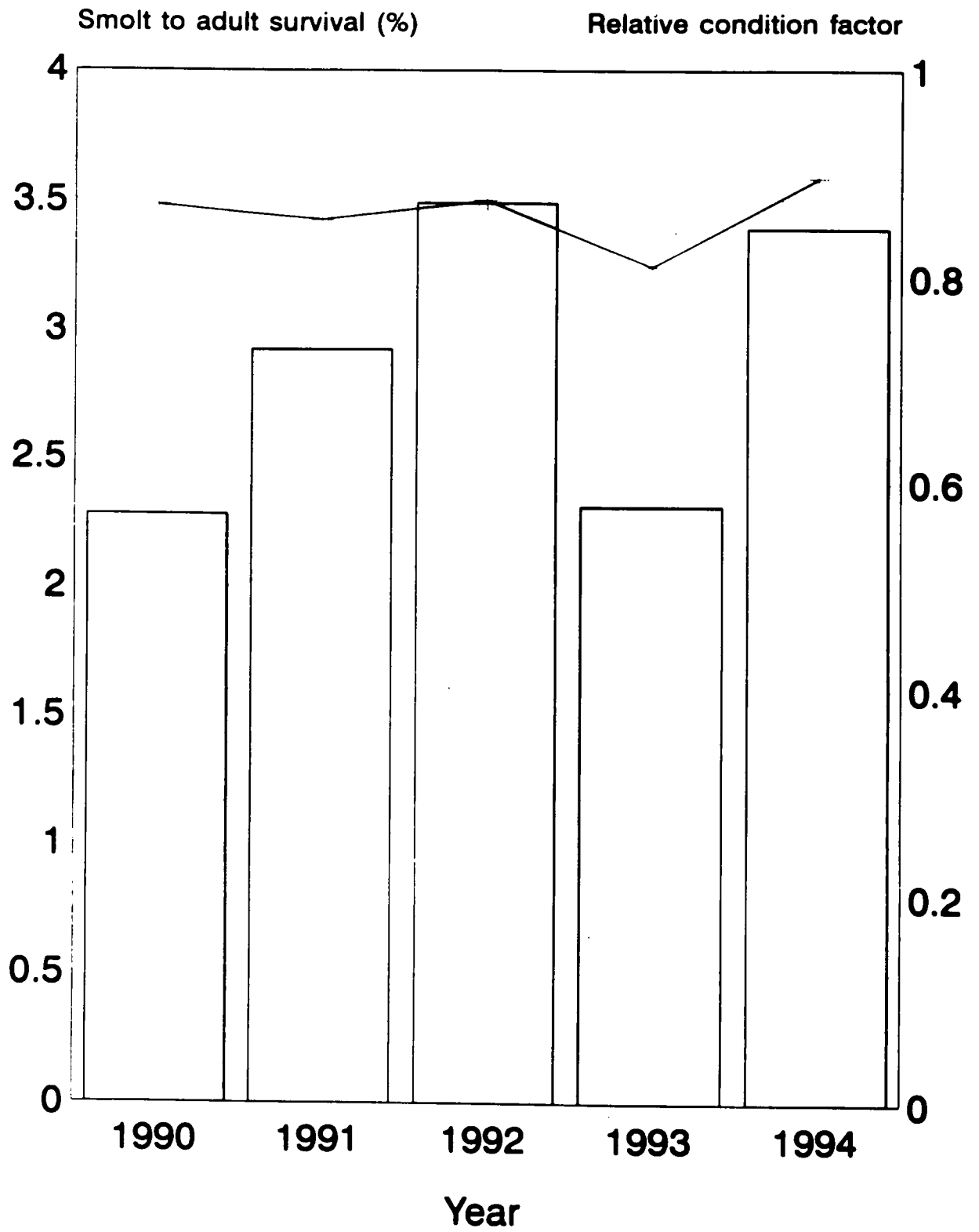


Figure 3. Smolt to adult survival and relative condition factor Rocky River smolts.