

**Status of Rocky and Little rivers Atlantic salmon (*Salmo salar* L. ) stocks of  
the Newfoundland 1997**

by

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<sup>1</sup> La présente série documente les bases scientifiques des évaluations des ressources halieutiques 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.

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### Abstract

The status of Atlantic salmon in two systems, namely Rocky River and Little River are assessed. Egg deposition for each watershed was 56%, and 202% respectively of the required conservation egg deposition. Flat Bay Brook, Romaines River and Piper's Hole River are updated in terms of stocking activities. The 1997 Rocky River smolt count of 16,900 is the highest on record.

### Résumé

La situation du saumon de l'Atlantique de deux bassins versants, ceux des rivières Rocky et Little, a fait l'objet d'une évaluation. La ponte dans ces bassins correspondait respectivement à 56 % et 202 % des besoins de conservation. Une mise à jour des activités d'ensemencement est faite pour le ruisseau Flat Bay et les rivières Romaines et Piper's Hole. Le dénombrement de saumoneaux de la rivière Rocky, de 16 900 poissons en 1997, est le plus élevé jamais enregistré.

## Introduction

The watersheds discussed in this paper have all undergone enhancement/fry stocking activities.

Rocky River is the site of a colonization project where a run of Atlantic salmon was established. Little River is the site of a ranching project. Romaines River, Flat Bay Brook and Piper's Hole River are the sites of stock augmentation projects.

The intent of this document is to review the status of Atlantic salmon stocks in the Rocky River and Little River watersheds in 1997 and to update enhancement stocking activities in 1997 that affect the 1996 egg depositions in Piper's Hole River, Romaines River and Flat Bay Brook.

## Methods

### Biological Characteristics

Biological characteristics used in this document are those determined for individual stocks (see Tables 2,3,7, and 10).

### Habitat Determinations

Rocky River the largest watershed on the Avalon Peninsula, encompasses a drainage area of 296 km<sup>2</sup> (Porter et al. 1974) flowing to the sea in Salmon Fishing Area 9 (SFA 9) (Fig. 1). Prior to fishway construction in 1987 a natural falls at the mouth of this river, made this watershed inaccessible to anadromous Atlantic salmon. Rocky River requires 3.4 million eggs to meet the required conservation egg deposition (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 km<sup>2</sup> (Porter et al. 1974) with a complete obstruction at kilometer 4.8 on the main stem of the river which results in anadromous Atlantic salmon having access to less than 30% of the watershed. Little River requires 313,920 and 976,072 eggs for the accessible and inaccessible portions of the watershed respectively for conservation (Table 1).

Romaines River and Flat Bay Brook are situated in St. George's Bay in SFA 13. Flat Bay Brook encompasses a watershed area of 635 km<sup>2</sup>. Due to natural obstructions anadromous Atlantic salmon have access to 89% of the riverine habitat on Flat Bay Brook and very little standing water habitat (Porter et. al., 1974). Porter et. al. (1974) record 16,012 (100m<sup>2</sup>) rearing units accessible to anadromous Atlantic salmon. Romaines River encompasses a watershed area of 98 km<sup>2</sup> and has 4,572 rearing units of riverine habitat with no standing water accessible to anadromous Atlantic salmon (Table 1) (Bourgeois et. al. 1996).

The Piper's Hole River flows into the western side of Placentia Bay in SFA 10 (Fig. 1) and requires an egg deposition of  $3.159 \times 10^6$  eggs for conservation (Bourgeois et. al. 1996) for the accessible portion of the watershed (Table 1).

### Enhancement/Stocking Activities

The Rocky River was stocked with unfed fry from a controlled flow spawning channel from 1984 to 1987; unfed fry from 1995 to 1996 from a recirculation incubator; 90 day fingerlings from the latter source in 1995 and adult salmon in 1987. For the stockings from 1984 to 1987 the brood source was Little Salmonier River. For additional detail on stocking activities refer to Table 4.

Little River was stocked with unfed fry from 1989 to 1996 with the exception of 1994. Eggs from Little River were incubated in deep substrate incubation boxes and in recent years in fiberglass troughs. For additional detail on stocking activities refer to Table 8.

Romaines River (brood source) was stocked from 1995 to 1997 with unfed fry produced in a portable recirculation incubator utilizing fiberglass troughs.

Flat Bay Brook (brood source) was stocked from 1995 to 1997 with unfed fry produced in a portable recirculation incubator utilizing fiberglass troughs.

Piper's Hole River (brood source) was stocked from 1996 to 1997 with unfed fry produced in a portable recirculation incubator utilizing fiberglass troughs.

### Recreational Fishery

Rocky River, since the introduction of anadromous Atlantic salmon, has not been open for a recreational salmon fishery.

Little River downstream of the obstruction has been closed to angling since 1989.

Flat Bay Brook has been under a special management regime (quota) since 1986 and was closed to angling in 1995 and 1996 with catch and release recreational fishery in 1997.

The Romaines River is an unscheduled watershed.

### Management Measures

Management restrictions implemented in 1992 which were in place through 1997 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 reduced the by-catch of Atlantic salmon.
3. Moratorium on the cod fishery in 4R implemented in August of 1993 further reduced the by-catch of Atlantic salmon.

### Fecundity

Numbers of female fish examined in fecundity studies conducted on Rocky River, Flat Bay Brook and Piper's Hole River are detailed in the following table:

River	Number of females examined (No. of females sacrificed for egg retention)		
	1994	1995	1996
Rocky River	19(19)	30(5)	N/A
Flat Bay Brook	N/A	33(7)	26(8)
Piper's Hole River	N/A	21(5)	28(9)

Female salmon examined for fecundity were sampled for fork length, whole weight and scale sampled. Fish were manually stripped of their eggs, fertilized and then counted directly. Fish examined for egg retention were sacrificed and any remaining eggs removed, kept separate, fertilized and then counted directly. Percentage of eggs retained were used to adjust the egg counts of fish that were released alive.

The Rocky River and Flat Bay Brook egg depositions were calculated based on average number of eggs/cm of fish (female) fork length while egg depositions for other stocks are based on average number of eggs per kilogram of female weight for the respective years. Percentage females in the population was calculated using the sex ratio of broodstock for the particular year and mean weight of females collected from broodstock. Rocky River egg deposition in 1997 was based on the combined fecundity data for 1994 and 1995. Flat Bay Brook and Piper's Hole River egg depositions for 1995 and 1996 utilized fecundity data from the respective year(s).

### Egg Depositions

The conservation egg requirement was calculated based on 2.40 egg/m<sup>2</sup> of fluvial habitat and 368 eggs/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).

Egg depositions were calculated as follows;

- 1) For length based relationships the appropriate regression equation was solved using mean length of females for large and small separately then multiplied by the respective number of females and the two totals summed.
- 2) For weight based the mean weight of females for large and small was multiplied by the number of eggs per kg. and then multiplied by the respective number of females and the two totals summed.

In order to determine the egg deposition in areas where fry stocking occurred, an estimate of egg-to-fry survival of 20% (Sturge, 1968) was used to back-calculate the number of fry released to equivalent 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.

Spawning escapements were calculated from fishway/fence counts less known removals with a 10% mortality rate applied to hook-and-released salmon (since 1993).

#### Smolt Operations

In 1997 a smolt fence was operated on the Rocky River for the eighth year: dates of operation and dates of first and last smolt listed below.

Year	Dates of Operation	Date of First Smolt	Date of Last Smolt
1990	Apr. 26 - June 8	Apr. 27	June 8
1991	Apr. 23 - June 19	May 1	June 19
1992	Apr. 27 - June 16	Apr. 29	June 15
1993	Apr. 28 - June 14	May 4	June 11
1994	Apr. 29 - June 16	May 1	June 16
1995	May 2 - June 14	May 2	June 14
1996	Apr. 25 - May 22	Apr. 26	May 22
1997	May. 6 - June 23	May 6	June 23

The Rocky River smolt fence operated from May 6 to June 23 in 1997 with the exception of two short periods when rods were removed due to high water and associated debris. Rods were removed on May 11 and 27 for 26 and 13 hours respectively. The adjustment for May 11 was based on the average of the 3 pre and post daily counts. The adjustment for the May 27 count was complicated as the count likely peaked during this high water incident. The rods were removed at 0200 hours and reinstalled at 1600 hours. From 0000 hours to 0200 hours a total of 600 smolt were enumerated

For the May 11 and May 12 removal the mean of the 3 day pre and post counts was utilized.

For the May 27 removal the ratio of fish from 1600hrs. to 2400 hrs to the daily total for the day before and the day after was applied to the 1600 -2400 count on the day of the washout.

A smolt fence has operated on the Little River since 1992 and from May 14 - July 8 in 1997.

Smolt that were sampled had the following data collected; fork length, whole weight, scale sample and sex.

Smolt condition was calculated as  $\text{weight}/\text{length}^3$ .

### Adult Counts

In 1997, as in past years, a trap was installed in the upper most pool of the Rocky River fishway which, was operated from July 3 to Sept. 26.

An adult counting fence operated on Little River from July 3 to Sept. 26 in 1997.

### Smolt to adult survival

Smolt to adult survival was calculated based on the portion of virgin 1 SW fish in the escapement. This was determined by removing the repeat spawners from the fish enumerated.

### Fin-clipped smolt

As part of the 1995 enhancement activities on Rocky River, 50,000 fry were raised for 90 days in semi-natural conditions resulting in the release of 31,983 parr that were adipose fin-clipped. Evaluation of the 2<sup>+</sup> component of this stocking was undertaken in 1997 in part through the examination of 30% of the run for the presence of adipose fin-clips.

## **Results and Discussion**

The use of fixed parameters, such as 2.4 eggs m<sup>2</sup> and 7 smolts/ha of standing water, has certain limitations (see O'Connell & Dempson, 1995 for discussion on this topic).

### Rocky River

The 1997 freshwater escapement (total returns) of 524 (435 small and 89 large) adults to Rocky River was the highest on record and was 215% of the 1987-1991 mean and 174% of the 1992-1996 mean. In 1997 Rocky River achieved 56 % of it's conservation egg deposition (Table 4).

Reconstruction of the 1997 smolt run was complicated by low water conditions throughout the run and loss of the count on high water which was the peak day of the run. Adjustments for May 11 and 12 were 33 smolt per day with the adjustment for May 27 being a daily total of 2,064 smolt. Total smolt count in 1997 was 16,900 smolt which is the highest on record. This count (see Table 5) is 195% of the 1990 - 1996 mean count. The 1997 smolt run was comprised of 11.1% age 2<sup>+</sup>, 75% age 3<sup>+</sup> and 13.9% age 4<sup>+</sup> smolt from the 1993 - 1995 egg depositions (Table 4).

Figure 3 displays smolt to adult survival from 1990-1996 which averaged 3.07% and ranged from 2.3% to 4.15%. In 1997 smolt-to-adult survival decreased to 2.78% and was the third lowest value for the seven years where data were available. Table 5 details enumeration of the 1990 - 1997 smolt output. The 1997 adult returns were all resultant from natural spawning. The increase in sea survival from 1990 and 1991 to 1992 can, in part, be attributed to the closure of the commercial fishery. The decrease in the 1993 and 1996 smolt survival is most likely due to a decrease in natural marine survival.

Figure 3 also displays the relative condition factor of the outmigrating smolt which was the highest in 1996 but yielded one of the lowest smolt-to-adult survival rates observed to date.

Table 6 provides insight into the egg/fry-to-smolt survival on the Rocky River. At present it appears that egg-to-smolt survival has been improving since 1990 with the 1992 and 1993 egg depositions yielding the highest egg-to-smolt survival figures recorded to date.

In 1997, river age 2<sup>+</sup> smolts from the 1995 stocking of 31,983 reared parr were first observed. These smolt had an average mean length and weight of 17.5 cm and 49.1 g respectively and were larger than the average of the 1997 smolt (see Table 3).

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. An analysis of covariance revealed a significant relationship between the length of female fish and number of eggs ( $p < 0.05$ ) however no significant relationship was found with year. As a result of this analysis of covariance, fecundity data from the two years were combined. Regression analysis of raw, and log transformed data revealed significant relationships for both and provided  $R^2$  values of .57 and .56 respectively. Figure 2 displays the regression line and equation for the linear regression of total number of eggs on fish length.

#### Predicted adult returns

Forecasts in terms of virgin grilse returns in year  $X + 1$  have been made since 1994 for Rocky River and are listed in the text table below. Forecasts were made based on the range of smolt-to-adult survivals observed to date.

Year	Prediction	Observed
1997	300-496 virgin grilse	353 virgin grilse
1996	189-323 virgin grilse	314 virgin grilse
1995	234-318 virgin grilse	324 virgin grilse

Based on the range of smolt-to-adult survivals observed the forecast for 1998 returns is 410-740 virgin grilse (mean value 547) plus repeat spawners.

#### Little River

Table 1 details the available habitat and the required egg deposition for the Little River watershed. The data is presented for the area above and below the obstruction since fry stocking occurs above the falls. In 1997 a fence count of 478 (399 small & 79 large) adults was recorded. The 1997 returns are 590% of the 1987-89 mean, 503% of the 1987-1991 mean and 100% of the 1992-1996 mean.

In 1997 Little River achieved 202% of it's required conservation egg deposition (see Table 8).

Table 9 details the dates of counting fence operation and the number of smolt and parr enumerated for 1992 - 1997. Table 10 details the biological characteristics of smolt sampled in Little River. 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 were not calculated as they would not likely be indicative of the entire smolt output.

There were 145,921 fry were stocked above the falls in Little River in 1997.



Flat Bay

In 1997 there were 149,555 fry stocked into this system which changed the 1996 egg deposition to 85% of conservation requirement.

Romaines River

In 1997 50,138 fry were stocked into this system in 1997.

Piper's Hole River

There were a total of 86,903 fry distributed to Piper's Hole River in 1997.

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Table 1. Rearing area and conservation egg deposition for watersheds referenced in present study.

	Riverine habitat (m <sup>2</sup> )	Lacustrine habitat (ha)	Conservation 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

Table 2. Biological characteristics of Rocky River adults.

Year	No. Sampled	% Female	No. 2 Sea Winter Virgin	Mean Length(cm)	Mean Weight(kg)	% Repeat Spawners	Freshwater Age			
							2 <sup>+</sup>	3 <sup>+</sup>	4 <sup>+</sup>	5 <sup>+</sup>
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	2.0	31	16	72	12	0
1995	111	86	1	56	2.0	22	14	77	9	0
1996	18	N/A	0	54.9	2.0	17	6	61	33	0
1997	41	N/A	1	59.6	2.5	34	13	85	2	0

Table 3. Biological characteristics of Rocky River smolt.

Year	No. Sampled	% Female	Mean Length(cm)	Mean Weight(g)	Percentage at various Freshwater Ages				
					2 <sup>+</sup>	3 <sup>+</sup>	4 <sup>+</sup>	5 <sup>+</sup>	6 <sup>+</sup>
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
1996	203	83.4	16.6	44.1	6	82	10	0	1
1997	110	75.5	17.2	46.3	11	76	13	0	0
Finclip	116	56.3(16)	17.5	49.1	100	0	0	0	0

Table 4. Details of egg deposition Rocky River 1983-97.

Year	Fry Stocked	Parr Stocked	Adults Stocked	Total	Adult Count Small	Large	Broodstock	Total Eggs	% Conservation Egg
1983	0		0				0	1,538,875	45
1984	307775		0				0	2,172,500	64
1985	434500		0				0	970,000	28
1986	194000		0				0	1,998,225	59
1987	399645		140	81	80	1	0	743,595	22
1988	0		0	319	313	6	0	1,011,527	30
1989	0		0	177	168	9	0	561,255	17
1990	0		0	418	401	17	0	1,359,420	40
1991	0		0	227	211	16	0	730,874	22
1992	0		0	283	237	46	0	961,811	28
1993	0		0	364	292	72	0	1,148,320	34
1994	0		0	177	158	19	62	857,862	25
1995	50,000	31,983	0	424	385	39	76	1,918,012	56
1996	162,231	0	0	401	356	45	0	1,163,295	34
1997	0	0	0	524	435	89	0	1,917,225	56

- The 1997 biocharacteristics for Rocky River egg deposition are the same as those used for 1996.

Table 5. Details of smolt enumeration Rocky River 1990-95.

Year	Smolt Count	% Smolt-to-Adult Survival
1990	8287	2.47
1991	7732	2.93
1992	7813	3.49
1993	5115*	2.30
1994	9781	3.39
1995	7577	4.15
1996	14,261* +	2.8
1997	16,900*	

\* Smolt count is an estimate due to fence washout  
+ No. Of smolt released is 13,057

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 <sup>+</sup>
1986		1.3	4 <sup>+</sup> , 5 <sup>+</sup>
1987		1.6	3 <sup>+</sup> , 4 <sup>+</sup> , 5 <sup>+</sup>
1987	1.00		2 <sup>+</sup> , 3 <sup>+</sup> , 4 <sup>+</sup> , 5 <sup>+</sup>
1988	0.86		2 <sup>+</sup> , 3 <sup>+</sup> , 4 <sup>+</sup> , 5 <sup>+</sup>
1989	1.04		2 <sup>+</sup> , 3 <sup>+</sup> , 4 <sup>+</sup> , 5 <sup>+</sup>
1990	0.56		2 <sup>+</sup> , 3 <sup>+</sup> , 4 <sup>+</sup> , 5 <sup>+</sup>
1991	1.02		2 <sup>+</sup> , 3 <sup>+</sup> , 4 <sup>+</sup> , 5 <sup>+</sup>
1992	1.61		2 <sup>+</sup> , 3 <sup>+</sup> , 4 <sup>+</sup>
1993	1.25		2 <sup>+</sup> , 3 <sup>+</sup>
1994	0.23		2 <sup>+</sup>

Table 7. Biological characteristics Little River adults 1990, 1992 - 1996.

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)	-	-	-	-	-
1996	Repeat	61.81 (7)	5.49	55.50-70.80	2.24 (7)	.70	1.500-3.300	3.00 (7)	.58	2-4
	1SW	53.12 (113)	2.23	46.00-58.70	1.41 (131)	.21	.960-2.120	2.60 (110)	.58	2-4
	Repeat	66.50 (1)	-	-	1.58 (1)	-	-	-	-	-

Table 8. Egg deposition rates for Little River 1987-97.

Year	Fence Count		Spawning Escapement	Fry Stocked		Natural Egg Deposition	% Conservation Wild Below Falls	Total Eggs	% Conservation Total
	Small	Large		Below Falls	Above Falls				
1987	64	3	67	0	0	91,410	29%	91,410	7%
1988	65	3	68	0	0	92,774	29%	92,774	7%
1989	102	5	66	100350	0	90,046	29%	190,396	15%
1990	158	15	91	204835	0	124,154	40%	328,989	26%
1991	55	6	31	103715	0	42,294	14%	146,009	12%
1992	104	21	26	102835	553380	35,473	11%	691,688	55%
1993	169	11	75	148,090	444,270*	102,325	33%	694,685	55%
1994	73	11	84	0	0	114,604	37%	114,604	9%
1995	118	17	45	115,660	346,980	61,395	20%	524,035	42%
1996	674	127	663	0	729,605	904,551	288%	1,634,156	130%
1997	399	79	464	0	0	633,049	202%	633,049	51%

Table 9. Details of smolt and parr enumeration Little River.

Year	Dates of Operation	No. Smolt	No. 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
1996	May 2 - June 5	4,449	585
1997	May 14 - July 8	2,521	336

Table 10. Biological characteristics of Little River smolt.

Year	No. Sampled	% Female	Mean Length(cm)	Mean Weight(g)	% at Age		
					2 <sup>+</sup>	3 <sup>+</sup>	4 <sup>+</sup>
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
1996	51	94.1	16.16	39.40	5.9	90.2	3.9
1997	79	85.7	15.69	41.62	23.1	71.8	5.1

Note: 1993 & 1995 smolt samples were collected on a single day.

1996 samples collected over 5 days.

1997 samples collected May 22 - June 11

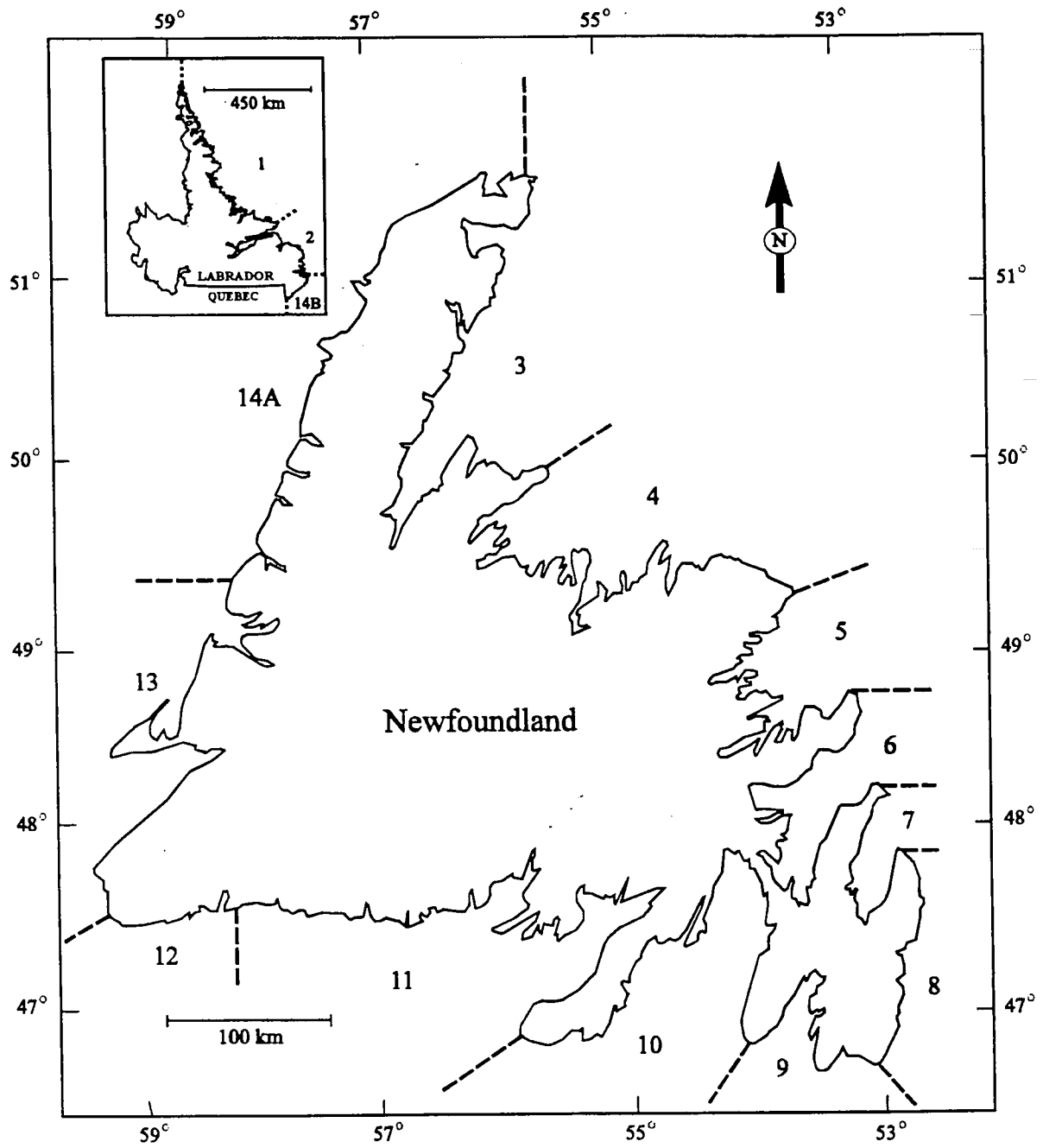


Fig. 1. Map showing the 14 Salmon Fishing Areas of the Newfoundland Region.



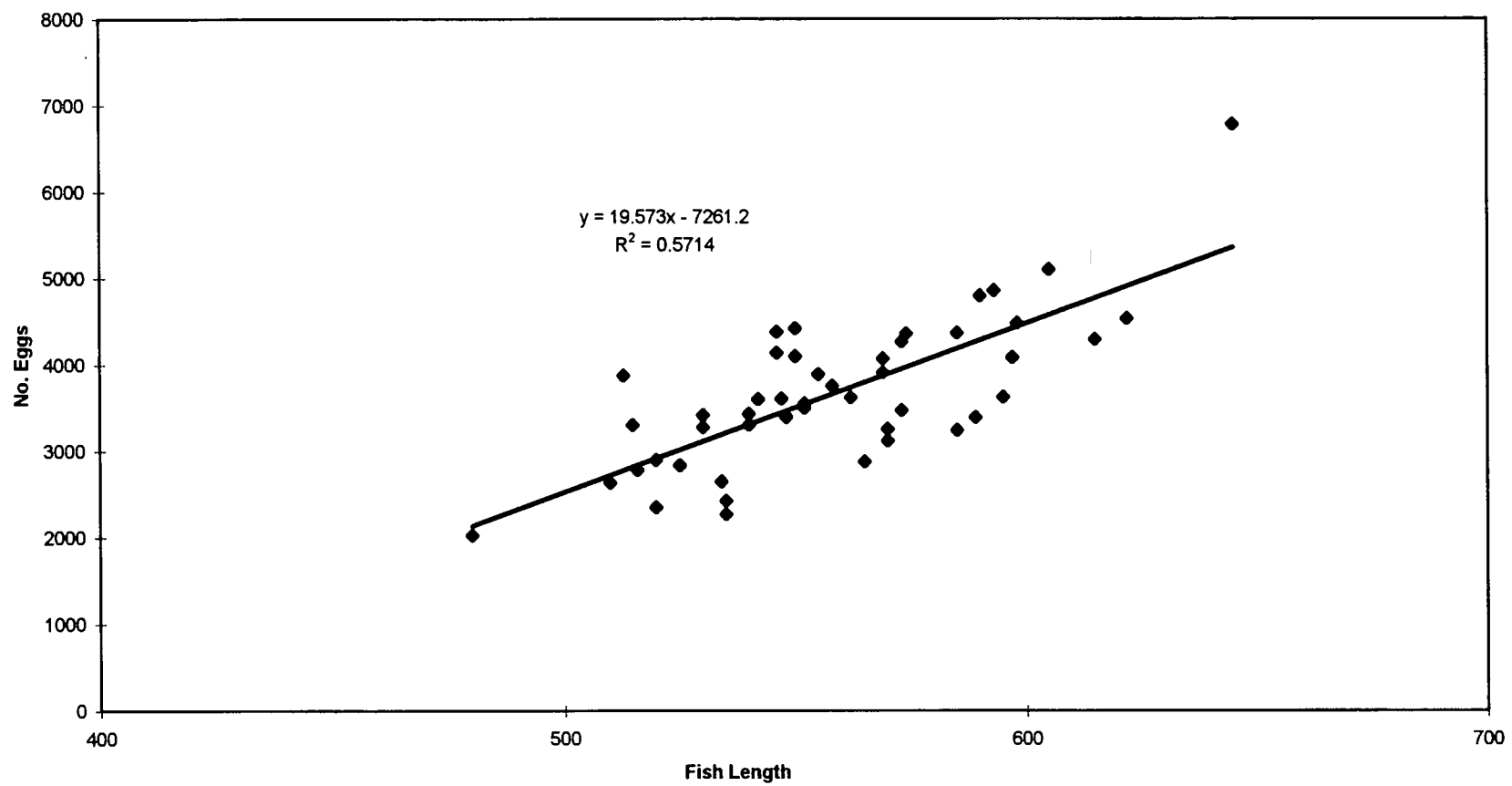


Figure 2. Fecundity relationship for Rocky River salmon.

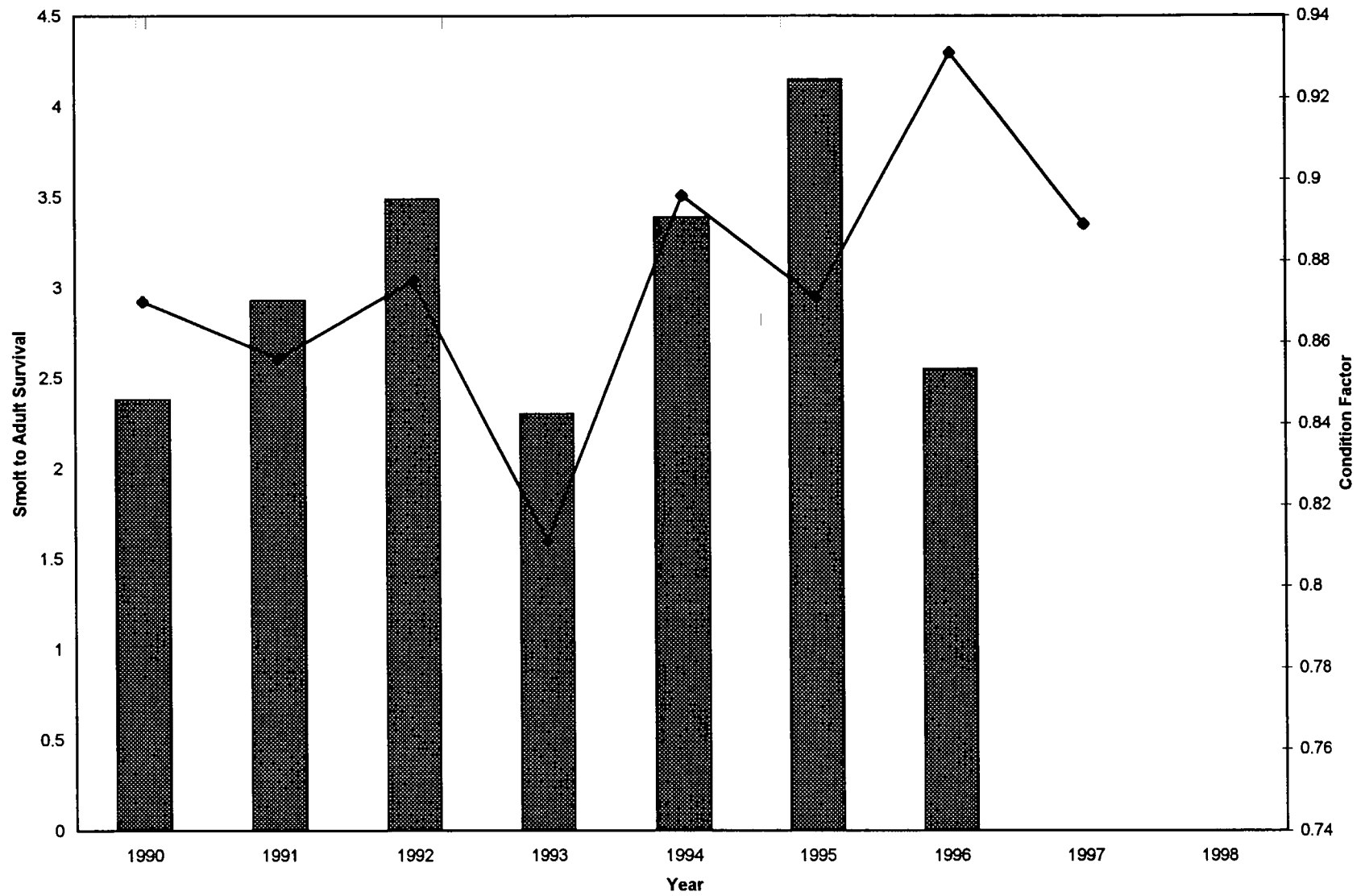


Figure 3. Smolt-to-adult (1SW) survival and relative condition factor of Rocky River smolt.