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Estimated Spawning Requirements and Indices of Stock Status of Atlantic Salmon in the St. Mary's River, Nova Scotia

by

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Abstract

The St. Mary's River is the largest producer of sport-caught Atlantic salmon in eastern Nova Scotia. Evidence that a small, high-profile 3SW virgin component of the stock has diminished relative to the 1SW component has contributed to increased protection for MSW salmon and a need to determine target spawning escapements and stock status.

An estimated stream production area of $3.1 \times 10^6 m^2$ and target egg deposition of 2.4 eggs/m^2 combined with the 1972-84 1SW, 2SW and 3SW age and sex compositions suggested that target spawning escapement should consist of 2,436 1SW and small repeat-spawning salmon, 437 small MSW and 281 large MSW salmon.

Available data do not permit a statistically valid assessment of the stock status in 1985. However, a significant correlation between sport catches and resultant age 0+ parr densities on the West River, St. Mary's, suggested that 1SW salmon alone likely contributed 50% of the required egg deposition on that river. It was inferred from the catch and release of 807 MSW salmon that the escapement of MSW fish likely contributed to the balance of requirements.

Résumé

Dans l'est de la Nouvelle-Ecosse, c'est dans la rivière St. Mary's que les pêcheurs sportifs capturent le plus grand nombre de saumons atlantiques. Des indications selon lesquelles une composante petite mais très visible de saumons vierges 3HM avait diminué par rapport à la composante de saumon 1HM, ont amené un renforcement de la protection assurée aux saumons PHM et ont fait ressortir la nécessité de déterminer l'état du stock et d'établir un niveau-cible en ce qui a trait aux échappements pour la reproduction.

La superficie estimée de la zone productrice en eau courante ($3,1 \times 10^6$ m^2), l'objectif de ponte (2,4 oeufs/m^2) et la composition en fonction de l'âge et du sexe des populations de saumons 1HM, 2HM et 3HM pour 1972-1984, indiquent que l'objectif du frai devrait comprendre 2 436 saumons 1HM et petits saumons ayant frayé au moins une fois, 437 petits saumons PHM et 281 grands saumons PHM.

Les données actuelles ne permettent pas de faire une évaluation statistiquement valable de l'état du stock en 1985. Une corrélation significative entre les prises provenant de la pêche sportive et les densités subséquentes de tacons d'âge 0+ sur la rivière West, St. Mary's, indiquent que le saumon 1HM à vraisemblablement fourni à lui seul 50 % de la ponte requise dans cette rivière. On a déduit à partir de la capture et de la libération de 807 saumons PHM que l'échappement des poissons PHM à vraisemblablement fourni le reste.

Introduction

The St. Mary's River sustains the largest recreational fishery for Atlantic salmon on the eastern shore of Nova Scotia. This document presents both physical and biological data to; a) estimate a target egg deposition and spawning requirement and b) suggest recent status of the stocks. Data are insufficient to estimate specific numbers of salmon spawning in 1985 or forecast to return in 1986.

Background

The St. Mary's River (Fig. 1) drains a mostly forested area of 1,355 km^2 in portions of Guysborough, Antigonish, Pictou and Halifax counties, N.S. The river consists of two main branches - the East River St. Mary's which is 27 km in length and has two large lakes in its main stream and the West River St. Mary's which is 56 km in length and is without mainstream lakes. The two branches join to form the St. Mary's River at Melrose and descend 19 km to head-of-tide at Sherbrooke.

pH values $\geq$ 5.4 in April 1982 (McPhail pers. comm.) suggest that the East River is not immediately threatened by acidification. The larger West River has tributaries with fishery-threatening pH values of 5.1-5.4. Sites on Indian Man and South Lake brooks provided pH readings in the range 4.7-5.0 which induce some fish mortality.

With an average annual sport catch of 795 salmon, 1970-1983, the St. Mary's River has provided more than four times the yield of its nearest rival on the eastern shore (Salmon Fishing Area 20; Table 1). Perhaps the highest appeal for recreational fishermen is the 3SW virgin component of the stock purportedly unique to the East River, St. Mary's.

While sport and commercial statistics go back over 50 and 30 years, respectively, biological data and juvenile indices of abundance are generally limited to short time series collected by several investigators (ref. Acknowledgements) during the last 15 years. Both the public and fisheries managers have been concerned about the diminishing number of MSW fish relative to 1SW fish in the recreational harvest. Management plans have restricted open seasons and fishing areas (Table 2) in an effort to increase the spawning escapment of the valuable 3SW component.

Methods

Salmon Landings

Exploitation of the St. Mary's salmon resource occurs in homewater commercial and recreational fisheries and, presumably, distant commercial fisheries. Commercial catches in salmon and non-salmon gear, 1949-1984, for Fishery Statistical District (FSD) 17 (Fig. 1; salmon landings in FSDs 16 and 18 are insignificant) and angling catches since 1930 are shown in Table 3. Landings of

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three commercial fishermen within the estuary of the St. Mary's River, 1979-1984, were extracted from logbooks, adjusted to a June 1 - July 31 season and examined as a possible index of spawning escapement.

The contribution to salmon landings of releases of hatchery fry (age-0+ fish) in the 1950's (e.g., 0.46×10^6 fish of Miramichi origin in 1954) and early 1960's is unknown but suspected to be minimal. Plantings of tagged fish, 1972-1974 (Gray and Cameron 1980) and 1982 to the present (Semple pers. comm.), have contributed only one known fish (1SW) to local landings.

Biological Characteristics

Biological data from salmon of the St. Mary's River were recorded by various investigators who sampled adult fish from the sport fishery, estuarial berths of the commercial fishery or various broodstock collections.

Length-weight A length-weight relationship was established for 401 male and female fish collected in 1969-70 and 1972-74 and is of the form:

$$Wt = 0.00000247FL^{3.3424} \quad (r^2=0.92;\ \text{Fig. 2a})$$

Fecundity A length-fecundity relationship was estimated from 25 individual and five different lots of age-graded broodstock removed to, and spawned at, fish culture stations in 1972, 1983, 1984 and 1985. For each of the five lots, regression analysis was weighted by the number of fish comprising mean length and egg count data. Egg numbers were determined by the displacement method. The equation is of the form:

$$Fec=340.832e^{0.0389FL} \quad (r2=0.93;\ n=53;\ \text{Fig. 2b}).$$

Sex Ratios Estimates of sex ratios were derived from a composite of 383 fish examined and aged in the sport fishery, 1972-74, 1979-81 and 1983-84 (Table 4). Seventy-eight percent of the sample was $\overline{<}$ 63 cm fork length (incl. a few repeat spawners) and of a male:female ratio of 1.0:1.1 (52% F). The remaining 86 MSW fish provided a ratio of 1.0M:1.7F (63% F). Within the MSW component, repeat spawning and virgin 2SW and 3SW fish were 59, 87 and 57% female, respectively (n=17, 53 and 16). Repeat spawning and 3SW-virgin or large salmon combined were 73% female.

Sea-age Proportions The sea-age composition of St. Mary's River salmon was determined from the same data base used to derive sex ratios (Table 4). One sea-winter fish (incl. a few small repeat spawners) averaged 78% of the sample. MSW fish were divided into small and large fish constituting 14 and 9% of the aged sample. Despite the general contention that the virgin 3SW fish originate specifically from the East River, St. Mary's, the recreational data were considered inadequate to estimate separately the sea-age ratios of salmon originating from each of the East, West and main rivers, St. Mary's.

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Steam Production Area

Estimates of spawning/rearing substrate are dependent on spot measurements of widths from a ground survey by MacEachern (1954) and stream length measurements from NTS maps, scale 1:50,000. The estimated production area excluding lakes is:

	Area(m^2)	% of total
West River	1,868,400	61
East River	704,800	23
Main River	505,300	16
Total	3,078,500	100

Egg Deposition/Spawning Requirements

Requirements for egg deposition were assumed to be 2.4 eggs/m^2 for the 3,078,500m^2 of production area. The number of 1SW, 2SW (small salmon) and 3SW + repeat spawners (large salmon) required for the total river was calculated by the method of Cutting and Gray (MS 1984) as:

$$\frac{\text{egg requirements}}{\text{eggs/fish}} \times \text{proportion of each sea-age (size-group) in the population.}$$

Eggs/fish is the sum of the products of the mean fecundity, proportion that size group was of the population and percentage females in each size group. A mean fecundity for grilse (incl. a few repeat spawners) was calculated by solving the length-fecundity equation for a length of 57 cm. This length was calculated by solving the mean weight for grilse (1.8 kg) in the sport catch, 1970-83, in the length-weight relationship. Fecundities for the small and large MSW fish were calculated by using respective mean lengths of 74 cm and 85 cm derived from 283 fish sampled in broodstock collections, the sport fishery and commercial fishery.

Juvenile Densities

Electrofishing has been conducted in various years since 1969 at a number of sites on both the East and West rivers (Gray et al. 1978; Cameron and Gray 1979; Ingram pers. comm.). Removal data for sites with some continuity over the years were reanalyzed to provide maximum likelihood estimates of age-0+ and age-1+ parr (Tables 5 and 6). Age-2+ parr comprised less than 3% and 6% of the total age 1 and older parr densities on the East and West rivers, respectively, and are excluded from this document. Significant ($p \lesssim 0.05$) correlations between densities in neighbouring sites over time permitted the estimation of some missing values and the calculation of annual mean densities for each river using a larger number of continuously "sampled" sites. Densities theoretically descriptive of the combined East and West rivers were calculated by weighting individual means by their respective production areas (East=0.27; West=0.73).

Spawning Escapement

Indices of spawning escapement were sought by examining correlation coefficients between sport fishery statistics, local and FSD 17 commercial statistics and juvenile densities on both the East and West rivers (Table 7). Multiple regressions were run to determine if river discharge in July and August explained additional variation between sport catch and both juvenile densities and commercial landings.

Forecasting Adult Recruitment

Indices of adult recruitment were also sought among the variables listed in Table 7. Correlations between 1SW and 2SW sport data were also "enhanced" by removing 5% of grilse (assumed to be small repeat spawners) from landings each year and by splitting 2SW fish (4.4 kg average) from older (6.9 kg average) large salmon. Correlation coefficients between sport and commercial statistics of FSD 17 and sport and commercial statistics of other FSDs of the Atlantic coast background to Amiro et al. (MS 1985) were also reviewed.

Results

Egg requirements

Egg requirements for the entire St. Mary's River were calculated as:

$$2.4 \text{ eggs m}^{-2} \times 3{,}078{,}500 \text{ m}^2 = 7{,}388{,}400 \text{ eggs}$$

Spawning Requirements

The egg deposition of an average fish was calculated as follows:

Size/age class	Eggs/ female	x	Prop. F	x	Prop. of run	=	Eggs
57 cm; 1SW/small repeats	3,130		0.52		0.78		1,270 (.54)
74 cm; small MSW	6,060		0.57		0.14		484 (.20)
85 cm; large MSW	9,300		0.73		0.09		611 (.26)
Total							2,365 (1.00)

The total number of fish required was derived as:

$$7{,}388{,}400/2{,}365 = 3{,}124$$

Size/age class requirements are:

1SW/small repeats	3,124 x 0.78 =	2,436
small MSW	3,124 x 0.14 =	437
large MSW	3,124 x 0.09 =	281

Spawning Escapements

No significant correlations were found between sport and commercial statistics (Table 8). Significant correlations are, however, shown for the numbers of both grilse (column 6) and total salmon (column 7) in the sport fishery and age-0+ parr in the West River in the following year (r=0.73; 0.70; $p_{0.05}$=0.71). MSW fish by themselves in the sport fishery (col. 5) were not correlated with West River juvenile densities (r=0.13; $p_{0.05}$=0.71) to the same extent as were MSW fish in FSD 17 commercial fisheries (column 1) (r=0.68; $p_{0.05}$=0.71) and sport plus commercial fisheries (col. 2 and 7) (r=0.78; $p_{0.05}$=0.71).

Available information does not permit the estimation of the number of fish escaping to spawn in the entire St. Mary's River, 1985. This is because sport landings and juvenile densities on the East River and combined East and West rivers (possible index of escapement) are not correlated (Table 8).

Inferences about the relative level of spawning escapement in the West River, 1985, may be inferred from a Conservation and Protection Branch (C&P) estimate of the retention of 1SW fish (0.66 of the value estimated from angler licence stub returns, 1984), a significant relationship between C&P estimates of 1SW fish retained (column 6) and the index of age-0+ parr (fry) abundance in the West River in the following year and the assumption that approximately 29 age-0+ parr/100 m^2 represents a "normal" abundance (Elson 1967) resultant of a target egg deposition of 2.4 eggs/m^2. Thus, available data suggest that substitution of a C&P harvest value of 779 1SW fish (0.66x1,180) in the equation age-0+ parr=3.09+.01 Catch (r=0.73) forecasts an index density of 10.8 age-0+ parr/100m^2 in the West River, 1986. This value may be construed to be 37% (10.8/29) of a normal abundance and perhaps resultant of a spawning escapement of only 37% of the target.

Similar inferences cannot be made about the level of escapement to the East River, St. Mary's. However, release by the sport fishery of an estimated 807 MSW fish and the absence of a commercial fishery suggest an index of age-0+ parr abundance in 1986 should at least equal the 7-year mean value of 29/100 m^2 for years when there were both sport and commercial removals. Such a value implies that the target escapement had been met in 1985.

Forecasts

Regression of the limited age-0+ and age-1+ parr data on 1SW and MSW recruits to the sport fishery two to four years later (assumes 100% of juveniles smoltify at age 2) provided the following correlation coefficients:

X	Y	r	df	P=0.05	Significance
East R. age 0+	1SW sport	0.56	2	0.95	N
	MSW sport	0.41	2	0.95	N
East R. age 1+	1SW sport	0.05	3	0.88	N
	MSW sport	0.81	2	0.95	N
West R. age 0+	1SW sport	0.02	3	0.88	N
	MSW sport	0.96	2	0.95	Y
West R. age 1+	1SW sport	0.05	4	0.81	N
	MSW sport	0.04	3	0.88	N

The utility of a single relationship based on four pairs of data is marginal but could be construed to suggest that an age-0+ parr density of 9.8/ 100 m^2 in 1981 could contribute to 231 MSW fish in the 1986 sport fishery (second highest since 1970 with commercial fishery operating). One sea-winter recruits to the sport fishery from estimated egg equivalents of 1SW and 1SW + MSW fish harvested in the sport fishery four or five years previous provided no leads.

A correlation coefficient for the regression of 2SW sport, 1971 to 1984, on 1SW sport, 1970-83 exclusive of 1974-75 and 1975-76 which were believed to have been impacted by low river discharges and a closure of the sport fishery, was significant ($r=0.73$; $p=0.01$). The significance and utility of same was lost however when 1969-70 C&P data and 1984-85 license stub data were included.

No correlations, particularly those of MSW fish in the sport or commercial fisheries FSD 17 on 1SW fish in other fisheries (sport in particular) were indicative of other regionally useful predictors.

Discussion

The absence of a significant correlation between juvenile densities of the East and West rivers, the apparent higher production level of the East River (average of 3 times the age-0+ parr and 2 times the age-1+ parr) and the correlation between age-0+ parr and age-1+ parr on the East River only suggest that the usual variables indicative of stock strength are not all encompassing on the St. Mary's. This is perhaps because of differential selection by fisheries (in part imposed by regulation), non-random distribution of spawners between the East and West rivers, establishment of electrofishing sites which are not representative of juvenile-producing habitat or shortness of the time series.

Concerns about the selection of a target egg requirement for the West River of 2.4 eggs/m^2 are raised by the apparent stability of low age-1+ parr densities (2.8/100m^2; range of 2.2 to 5.9) resulting from highly variable age-0+ densities and the suspected limitations of occasionally low pH values.

Presently no model will predict 1SW and MSW returns to the St. Mary's River. Deductively, however, a high 1SW return to the sport fishery in 1985 suggests relatively high returns of 2SW fish in 1986.

Returns in 1986 will be augmented by 1SW fish resultant of a release of 22,100 smolts in 1985. Of 2- and 3SW parentage and 1- and 2-year smolt age, it is premature to forecast the proportion which will return as grilse in 1986.

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TABLE 1. Average recreational landings of 1SW and MSW salmon, 1SW:MSW ratios and acidity profiles for rivers of eastern shore Nova Scotia averaging ≥ 20 recreational fish/season, 1970-1983.

Rank	River	14-year mean no. of fish 1SW	MSW	Ratio 1SW: MSW	pH[a]
1	St. Mary's	670	125	5.4:1	4.7 - >5.4[b]
2	Moser's	169	11	15.4:1	4.7 - >5.4
3	West River, S.H.	142	7	20.3:1	< 4.7 - 5.0
4	Ecum Secum	89	4	22.3:1	- - - - - -
5	Musquodoboit	35	43	0.8:1	> 5.4
6	Salmon, Pt. Dufferin	70	3	23.3:1	4.7 - 5.0
7	Salmon, Guysborough	49	23	2.1:1	>5.4
8	Liscomb	59	5	11.8:1	< 4.7 - 5.0
9	Ship Harbour	40	9	4.4:1	5.1 - 5.4
10	Kirby	35	1	35:1	- - - - - -
11	Gaspereau Br.	28	1	28:1	- - - - - -
12	Tangier	25	2	12.5:1	<4.7 - 5.0
13	New Harbour	17	10	1.7:1	4.7 - 5.4
14	Country Harbour	14	11	1.3:1	> 5.4
15	Isaac's Harbour	17	4	4.3:1	4.7 - 5.0

[a] inference of pH values: <4.7, no natural reproduction; 4.7 - 5.0, some mortalities likely; 5.1 - 5.4 fisheries threatened; > 5.4 no immediate acidification threat.

[b] East, West and Main rivers >5.4; most tributaries of West River, 5.1-5.4; Archibald, Indian Man and South L. brooks, 4.7-5.0, in April.

TABLE 2. Open fishing seasons for recreational fishermen of the St. Mary's River and commercial salmon fishermen of FSD 17, 1970-85.

Year	Location	Dates of open season: Regular	Exceptions
a) Recreational			
1970-74	St. Mary's	May 1 - Sep 19	
1975	St. Mary's	May 1 - Sep 19	Portions: May 1-Jul 17 (low HOH)
1976	" "	" "	East R. below Aspen; May 1-Jun 14
1977	" "	" "	East R. below Aspen; May 1-31
1978	" "	" "	" " " " ; May 1-31
			East and West rivers; May 1-Aug 11
1979	" "	" "	East R. below Aspen; May 1-31
1980	" "	" "	" " " " ; May 1-28
			Remainder; May 1-Aug 29
1981	" "	May 15 - Aug 15	East River, May 15-Jun 20
1982	Main r.	May 22 - Aug 15	
	East R.	May 22 - 31	
	West R.	Jun 1 - Jul 31	
1983	Main r.	May 18 - Aug 15	
	East R.	May 18 - Jun 4	
	East R.	Jul 1 - 31 (grilse only)	
	West R.	Jun 1 - Jul 31	
1984	Main r.	May 18 - Aug 15 (grilse only)[a]	
	East R.	May 18 - Jul 31 " "	
	West R.	Jun 1 - Jul 31 " "	
1985	Main r.	May 18 - Aug 29 " "	
	East R.	May 18 - Aug 14 " "	
	West R.	Jun 1 - Aug 14 " "	
b) Commercial			
1970 - 80	FSD 17	Apr 15 - Aug 15	
1981 - 83	" "	Jun 1 - Jul 31	
1984	" "	Jun 18 - Jul 6	
1985	" "	None	

[a] Not an enforceable regulation for most of the 1984 season.

TABLE 3. Recreational and commercial catch data for St. Mary's River and FSD 17, respectively, 1930-1985 (core sources: Redbooks[a]; Allen and Lindsey, 1967)

Year	Recreational Numbers Grilse	Recreational Numbers Salmon	Recreational Numbers Total	Recreational Weight (kg)	Commercial Numbers	Commercial Weight(kg)
1930 - 39			$\bar{x}$=312 s=244.7			
1940			617			
41			301			
42			208			
43			1,005			
44			651			
45			806			
46			207			
47			237			
48			1,063			
49			336			8,029
1950			264			5,534
51			1,070	3,894		2,948
52			831	3,524		4,853
53			1,164	4,950		5,352
54			415	2,181		3,039
55			253	1,211		1,588
56			488	1,446		998
57			144	525		3,357
58			735	2,795		1,860
59			550	2,290		2,158
1960			278	1,036		2,010
61			451	1,842		5,199
62			869	2,860		4,204
63			480	2,023		3,790
64			994	3,052		2,025
65	352	130	482	1,534		2,412
66	271	102	373	1,058		---
67	204	95	299	947		2,859
68	240	162	402	1,326		1,010
69	499	160	659	1,785		800
1970	454	213	667	1,900	98	432
71	269	73	342	832	180	687
72	470	105	575	1,372	358	1,498
73	505	146	651	1,618	265	1,169
74	1,314	164	1,478	3,221	200	836
75	180	55	235	538	479	2,014
76	1,050	97	1,147	2,573	440	2,025
77	458	120	578	1,167	427	1,707
78	151	97	248	758	404	1,940
79	1,152	66	1,218	1,900	191	828
1980	1,492	152	1,644	2,721	649	2,550
81	858	272	1,130	2,635	399	1,608
82	566	61	627	1,086	405	1,380
83	456	117	573	1,163	285	1,120
84	461(903)[b]	61(228)[b]	522	1,022	209	817
85	--(1,180)[bc]	--(807)[bc]	--	--	--	--

[a] Atlantic Salmon Sport Catch Statistics (C&P) and Atlantic Salmon Commercial Catch Statistics, Maritime Provinces, annual series beginning 1970 and 1967, respectively. Published by DFO and its precursors.
[b] license stubs incl. releases
[c] preliminary

TABLE 4. Composite sex ratios for 383 aged and measured Atlantic salmon harvested in the recreational fishery, St. Mary's River, 1972-74, 1979-81, and 1983-84.

	Small(≤ 63 cm)				Large (>63 cm)					
	1SW		Repeat spawner		2SW		3SW		Repeat spawner	
Year	M	F	M	F	M	F	M	F	M	F
1972	9	4	2	1						
1973	5	12			2	3				
1974	21	33			9	10	1	6	2	
1979	13	9	1			3		1	1	4
1980	9	8				1		1		
1981	38	39			1	5	1	6	2	3
1983	8	4		3	5				1	2
1984	36	40	1	1	6	8			1	1
Totals	139	149	4	5	23	30	2	14	7	10
Ratios (M:F)	(0.48:0.52)				(0.43:0.57)		(0.13:0.87)		(0.41:0.59)	
Mean ratio	(0.48:0.52)				(0.37:0.63)					

TABLE 5. Site and mean densities (maximum likelihood estimates) per 100 m^2 of age-0+ juvenile Atlantic salmon in the St. Mary's River, 1975-1985.

Site	1975	1976	1978	1979	1980	1981	1982	1983	1984	1985
East River										
McKeen Bk. #2	---	13.6		23.7	---			24.7	11.7	---
East R. #3	11.3	42.7		21.4	28.6			16.0	13.8	20.8
East R. #4	52.3	60.6			29.1			---	19.7	---
Black Bk. #7	56.4	5.9		64.6	19.3			9.6	13.7	14.6
East R. #9	18.2	4.7			12.3			---	0.4	---
Moose R. #12	28.5	0.3		58.2	118.2			0.5	15.5	11.1
Garden R. #19	---	16.4		64.4	33.9			48.0	15.0	---
$Mean_3$(SD)	32.1(22.8)	16.3(23.0)		48.1(23.3)	55.4(54.6)			8.7(7.8)	14.3(1.0)	15.5(4.9)
$Mean_n$(SD)	33.3(20.2)	20.6(22.5)		46.5(22.0)	40.2(39.0)			19.8(18.1)	12.8(6.0)	20.8[a]
West River										
West R. #21			4.1	12.3	18.0	20.6	9.3	13.4	7.8	13.2[a]
West R. #24			1.7	3.2	1.9	18.0	3.0	11.4	5.1	7.5[a]
West R. #25			4.0	5.0	7.9	14.9	9.3	6.4	3.9	6.4
West R. 26			0.6	0.2	5.9	9.9	2.2	2.2[a]	0.1[a]	2.2[a]
South Bk. #27			4.6	37.6	7.4	33.0	14.0	12.4	13.2	41.9
Nelson R. #30			3.6	8.1	24.2	49.0	21.6	15.2	10.4	7.0
West R. #34			1.9	2.6	7.8	10.8	4.4	4.8	2.3[a]	4.2[a]
West R #35			6.6	13.7	2.7	30.9	14.3	12.7	5.8	9.1
$Mean_4$(SD)			4.7(1.3)	16.1(14.8)	10.6(9.4)	32.0(14.0)	14.8(5.1)	11.7(3.8)	8.3(4.2)	16.1(17.2)
$Mean_8$(SD)			3.4(1.9)	10.3(12.0)	9.5(7.7)	23.4(13.4)	9.8(6.7)	9.8(4.7)	6.1(4.3)	11.4(12.7)
East and West (wt'd)				20.1	17.8			12.5	7.9	13.9

[a] Estimated from significant ($p \lesssim 0.05$) regressions of densities at that site(s) on densities in a neighbouring site(s).

TABLE 6. Site and mean densities (maximum likelihood estimates) per 100 m^2 of age-1+ juvenile Atlantic salmon in the St. Mary's River, 1975-1985.

Site	1975	1976	1978	1979	1980	1981	1982	1983	1984	1985
East River										
McKeen Bk. #2		0.2		0.7				10.9	1.8	
East R. #3	0.0	0.0		2.0	1.5			1.0	0.8	2.9
East R. #4	1.7	5.0		2.3[a]	4.3			2.1[a]	0.9	2.1[a]
Black Bk. #7	4.0	11.6		5.1	9.2			4.8	2.0	4.8
East R. #9	8.0	1.8			3.0				1.7	
Moose R. #12	11.8	9.8		3.7	26.5			11.8	2.1	4.8
Garden R. #19	10.6[a]	7.8		5.5	26.6			11.4	5.5	4.3[a]
Mean$_3$(SD)	5.3(6.0)	7.1(6.2)		3.6(1.6)	12.4(12.8)			5.9(5.5)	1.6(0.7)	4.2(1.1)
Mean$_5$(SD)	5.6(5.3)	6.8(4.5)		3.7(1.6)	13.6(12.1)			6.2(5.1)	2.3(1.9)	3.8(1.2)
West River										
West R. #21			1.3	1.2	2.8	3.2	3.2	0.6	0.9	1.7[a]
West R. #24			3.9	2.4	1.8	2.9	1.2	1.6	3.4	2.5[a]
West R. #25			4.5	1.6	2.6	6.4	3.2	3.7	2.0	2.8
West R. 26			4.8	1.5	2.5	5.4	2.1	3.3[a]	1.8[a]	2.5[a]
South Bk. #27			13.8	2.3	3.5	5.9	6.3	2.3	4.3	11.8
Nelson R. #30			2.3	2.9	2.8	11.9	6.5	3.2	1.2	4.0
West R. #34			2.8	4.4	4.7	4.0	5.5	3.3	4.1[a]	4.1[a]
West R #35			2.7	1.8	3.4	7.6	2.6	0.9	0.3	2.2
Mean$_4$(SD)			5.8(5.4)	2.2(0.6)	3.1(0.4)	8.0(2.7)	4.6(2.0)	2.5(1.2)	2.0(1.7)	5.2(4.5)
Mean$_8$(SD)			4.5(3.9)	2.3(1.0)	3.0(0.9)	5.9(2.9)	3.8(2.0)	2.4(1.2)	2.2(1.5)	4.0(3.3)
East and West (wt'd)				2.7	5.9			3.4	2.2	4.0

[a] Estimated from significant ($p \leq 0.05$) regressions of densities at that site on densities in a neighbouring site.

TABLE 7. Sport, commercial, juvenile and discharge data used in search of indicies of escapement and recruitment for the St. Mary's River, 1970-85.

Year i	Commercial harvest FSD[17] MSW()[a]	Commercial harvest FSD[17] Total	Commercial harvest Local[b] MSW()[a]	Commercial harvest Local[b] Total	Sport harvest[c] MSW	Sport harvest[c] 1SW	Sport harvest[c] Total	Sport harvest[c] Eggs(10^6)	Sport + Comm.	Jul-Aug Dischg.	Juvenile densities (no./100m²) East R. Age0+ i+1	Juvenile densities East R. Age0+ i+1	Juvenile densities East R. Age1+ i+2	Juvenile densities West R. Age0+ i+1	Juvenile densities West R. Age1+ i+2	Juvenile densities East & West (wt'd) Age0+ i+1	Juvenile densities East & West (wt'd) Age1+ i+2
Column	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(2+7)	(9)	(10)	(11)[e]	(12)[f]	(13)[g]	(14)[g]	(15)	(16)
1970	87(16)	93			213	454	667	1.7	760	90.6							
1971	134	178			73	269	342	0.7	520	119.2							
1972	322	350			105	470	575	1.2	925	46.6							
1973	252(3)	264			146	505	651	1.4	915	59.3			5.6				
1974	178(3)	200			164	1,314	1,478	2.8	1,678	25.2	32.1	33.3	6.8				
1975	416(27)	440			55	180	235	0.5	675	1.9	16.3	20.6					
1976	433	477			97	1,050	1,147	2.2	1,624	10.3					4.5		
1977	348	428			120	458	578	1.1	1,006	59.2			3.7	3.4	2.3		2.7
1978	404(32)	405			97	151	248	0.7	653	10.1	48.1	46.5	13.6	10.3	3.0	20.1	5.9
1979	180	190	79(7)	87	66	1,152	1,218	1.8	1,408	61.3	55.4	40.2		9.5	5.9	17.8	
1980	559(16)	650	190(6)	133	152	1,492	1,644	2.6	2,264	16.0				23.4	3.8		
1981	322(20)	398	101(8)	115	272	858	1,130	2.5	1,528	35.2			6.2	9.8	2.4		3.4
1982	211(24)	403	75(14)	86	61	566	627	1.0	1,030	31.1	8.7	19.8	2.3	9.8	2.2	12.5	2.2
1983	259(6)	311	71(3)	86	117	456	573	1.1	884	92.0	14.3	12.8	3.8	6.1	4.0	7.9	4.0
1984	218(2)	330(515)[j]	192(3)	124	61(228)[k]	461(698)[k]	522(926)[k]	0.9(1.9)	852(1,441)	24.4	15.5	20.8		11.4		13.9	
1985	0	0	0	0	0(807)	—(1,180)	—(1,987)[n]	--	—	—							

[a] estimate of 3SW and older fish ($\overline{>}$ 6.9 kg)
[b] log books from 3 inside berths adjusted to Jun 1-Jul 31 season
[c] C&P estimates
[d] 3 sites
[e] n sites
[f] 5 sites
[g] 8 sites
[h] 3-week season
[j] catch in salmon gear adjusted to Jun 1-Jul 31 and is comprised of 104 1SW and 411 MSW fish; by catch unadjusted
[k] licence stubs; retained
[m] licence stubs; released
[n] preliminary

TABLE 8. Summary of regression analyses in search of indices of stock strength of Atlantic salmon, St. Mary's River, N.S.

	Commercial harvest				Sport harvest[c]						Juvenile densities (no./100m^2)						
	FSD17		Local[b]						Sport +	Jul-Aug	East R.			West R.		East & West (wt'd)	
	MSW()[a]	Total	MSW()[a]	Total	MSW	1SW	Total	Eggs(10^6)	Comm.	Dischg.	Age0+ i+1		Age1+ i+2	Age0+ i+1	Age1+ i+2	Age0+ i+1	Age1+ i+2
Columns	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(2+7)	(9)	(10)	(11)[e]	(12)[f]	(13)[g]	(14)[g]	(15)	(16)
1			0.97		0.03						0.01			0.68	0.11	0.28	
2							0.26				0.55	0.29	0.00	0.68	0.37		
3					0.51						0.20	0.20		0.74	0.03		
4							0.44				0.22	0.14	0.95	0.75	0.21		
5											0.17	0.14	0.07	0.13	0.38		
6													0.24	0.73	0.53		
7											0.22		0.21	0.70	0.46		0.52
8											0.35	0.05	0.06	0.58	0.29		
2+7											0.06	0.03	0.22	0.78	0.32	0.03	0.54
9																	
10													0.98				
11													0.93				
12																	
13															0.20		

[a] estimate of 3SW and older fish ($\gtrsim$ 6.9 kg)
[b] log books from 3 inside berths adjusted to Jun 1-Jul 31 season
[c] C&P estimates
[d] 3 sites
[e] n sites
[f] 5 sites
[g] 8 sites

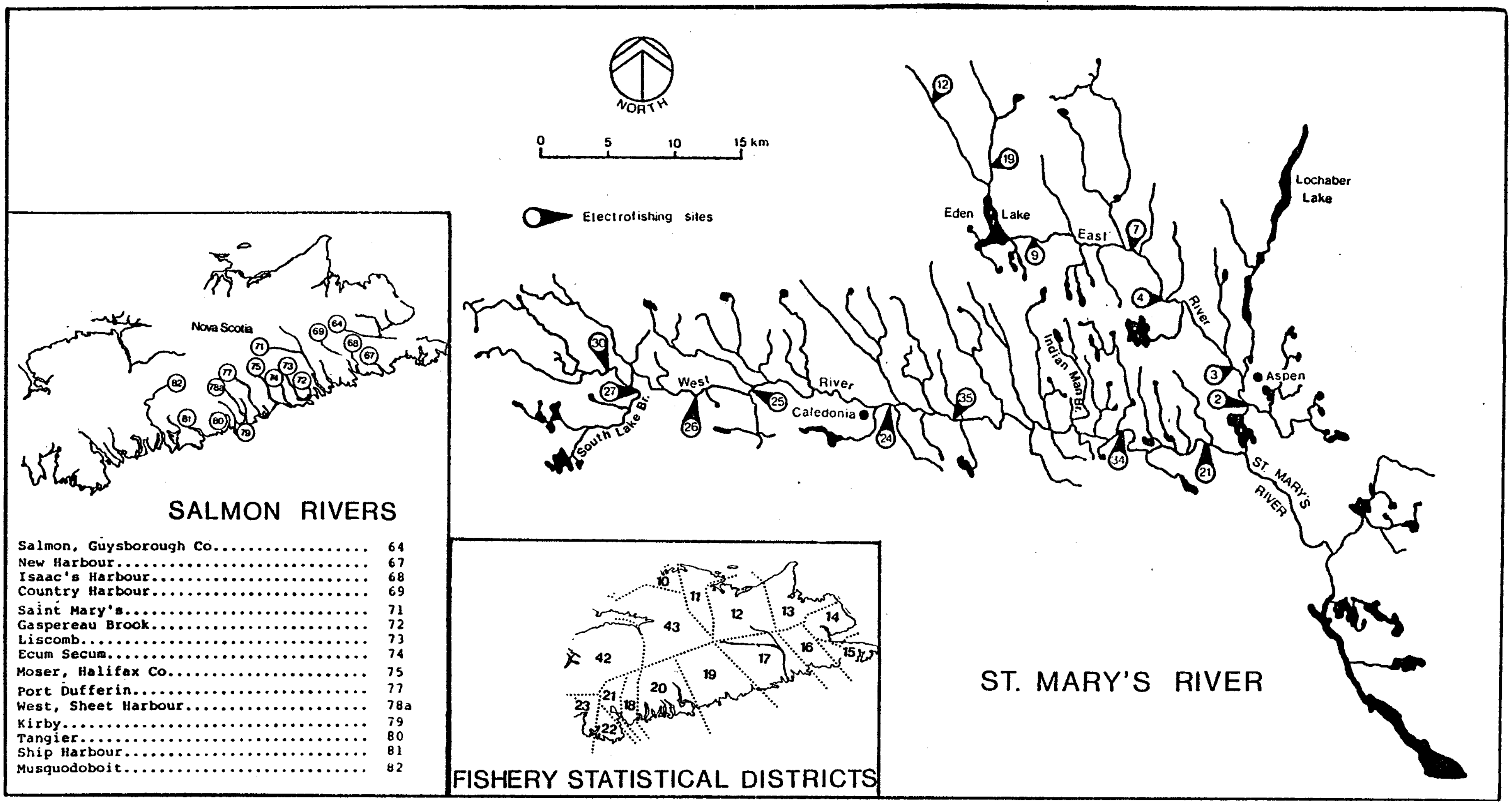

FIG. 1. The St. Mary's River, its tributaries and electrofishing sites and (insets) the location of rivers averaging ≥ 20 salmon per season, 1970-83, and Fishery Statistical Districts (FSDs) of the eastern shore, Nova Scotia.

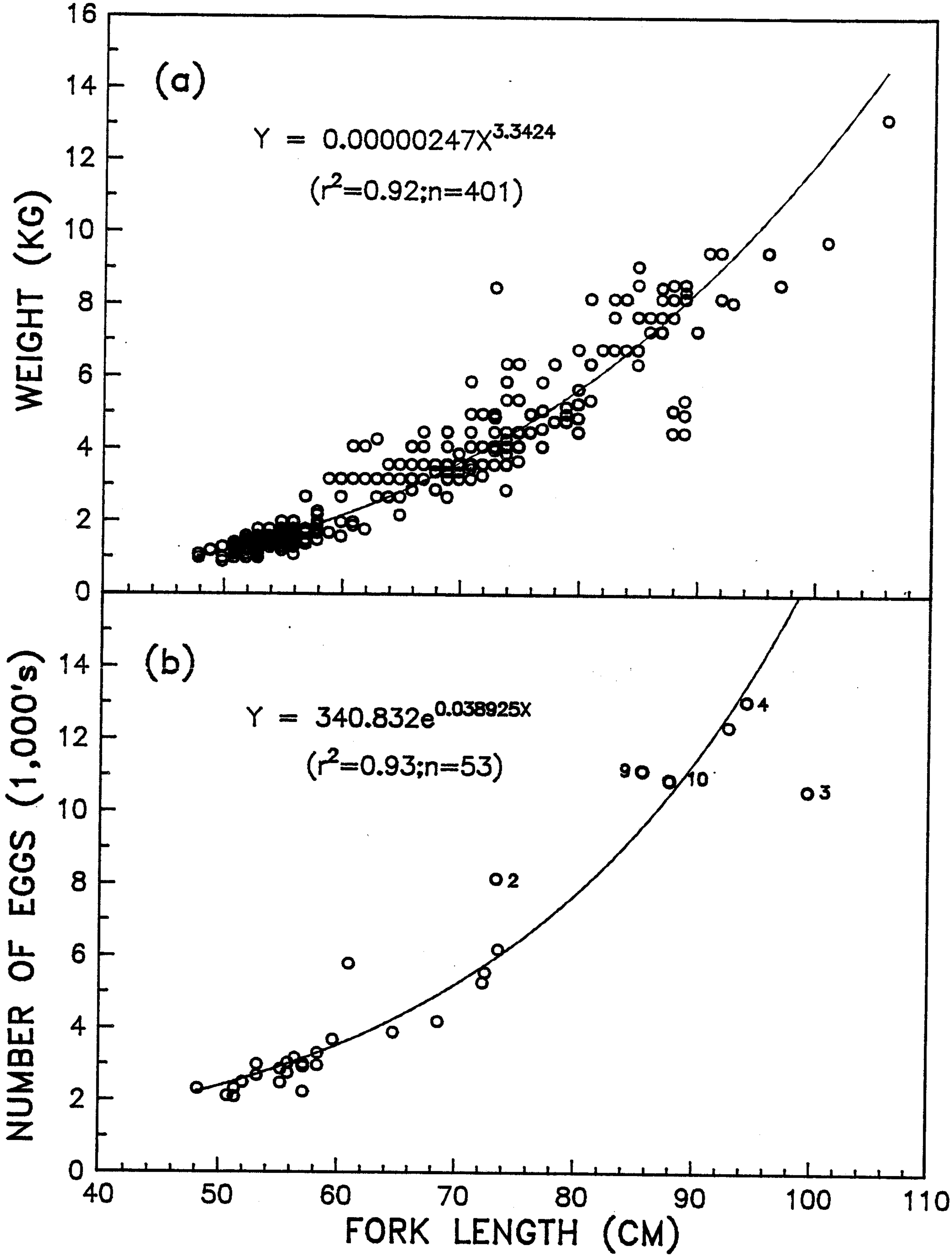

FIG. 2. Relationship between fork length of Atlantic salmon in cm and (a) weight in kg, and (b) egg carrying capacity of females, St. Mary's River, N.S.