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Status of Atlantic salmon in Salmon Fishing Area 22, for 1994, with emphasis on inner Bay of Fundy stocks.

by

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Abstract

Assessment of the status of Atlantic salmon (*Salmo salar*) stocks of Salmon Fishing Area 22, the Bay of Fundy area of Nova Scotia and those stocks of SFA 23 east of the Saint John River, known as inner Bay of Fundy salmon stocks, indicated escapements in 1994 were less than conservation requirements. Stocks of the inner Bay of Fundy, characterized by their high rate of maturity after one winter at sea, high repeat-spawning component and late river entry, have been low since 1990. Average age-1+ parr densities, the principal pre-smolt age, in the Stewaicke River reached a record low level of 2.9 parr 100^{-1} m^2 in 1994. Because escapements have been below conservation requirements for at least three years, and likely since 1990, a continued closure to harvests is recommended in 1995.

Résumé

D'après l'évaluation sur l'état du stock de saumon de l'Atlantique (*Salmo salar*) de la zone de pêche du saumon 22 (partie néo-écossaise de la baie de Fundy) et des stocks de la ZPS 23 à l'est de la rivière Saint-Jean, connus sous le nom de stocks de l'arrière-baie de Fundy, les échappées de reproducteurs de 1994 étaient inférieures au nombre requis pour la conservation. Les stocks de l'arrière-baie de Fundy, caractérisés par leur fort taux de maturité après un hiver en mer, leur nombre élevé de géniteurs à pontes antérieures et leur arrivée tardive dans les rivières, sont bas depuis 1990. Les densités moyennes de tacons d'âge -1+, âge principal des présaumoneaux, dans la rivière Stewiacke ont atteint un seuil record de 2,9 tacons 100^{-1} m^2 en 1994. Comme les échappées ont été inférieures au nombre requis pour la conservation pendant au moins trois ans, et vraisemblablement depuis 1990, on recommande le maintien de la fermeture de la pêche en 1995.

Summary Sheets

STOCK: Stewiacke River, N.S.
TARGET: 3.1 million eggs, 1061 adult salmon all ages

Year	1988	1989	1990	1991	1992	1993	1994	MIN[1]	MAX[1]	MEAN[1]
First Nations Catch										
In-river										
Angling catch										
Small	247	1323	0	0	0	0	0	0	1323	221
Large	119	223	0	0	0	0	0	0	223	37
Broodstock (Small + Large)	14	19	18	13	12	30	14			
Count at fence										
Small					37	178	211	37	211	142
Large					119	47	10	10	119	58
% Hatchery in the returns					1	4	14			
Efficiency estimate					0.65	0.55	1			
Population estimate					240	409	221			
% of Adults required					23%	39%	21%			
Salmon parr densities										
# of sites	29	31	31	34	37	35	34	29	37	33
Age-0+	16.85	21.17	18.70	8.35	14.91	1.28	9.74	1.28	21.17	13.00
Age-1+	18.54	16.46	19.75	12.27	5.03	12.65	2.89	2.89	9.75	13.90
Age-2+	6.97	6.31	3.31	4.08	1.96	2.52	3.68	1.96	6.97	4.12

[1] Angling 1989-1995; all other data for periods shown.

Harvests: The angling fishery has been closed since 1990.

Research data and assessment: A partial fence has been operated since 1992.

State of the stock: This river serves as an index for inner Bay of Fundy Atlantic salmon stocks. Spawning escapement has been documented below requirement since 1992 and has likely been below requirement since 1989.

Introduction

This document reviews the status of Atlantic salmon (*Salmo salar*) stocks during 1994 for Salmon Fishing Area 22. Salmon Fishing Area 22 consists of twenty eight rivers in Nova Scotia (Fig. 1.) Because stocks of salmon east of the Saint John River are more similar to most of the SFA 22 rivers (Amiro, 1987), with the exception of Annapolis and Gaspereau rivers in N.S., rivers east of the Saint John River have been included in the SFA 22 assessments. Atlantic salmon assessments for this area in 1993 were reported by Cutting et al. (1993) and in similar documents listed there.

Stocks are assessed using counts at a salmon trapping facility in the Stewiacke River; a smolt counting fence in Little River, a tributary of Stewiacke River; counts by divers and shore counts conducted by the New Brunswick Department of Natural Resources and Energy personnel; and electrofishing in the Stewiacke and Big Salmon rivers. Required spawning escapement for the Stewiacke River is reported by Amiro (1990) and by Marshall et al. (1992) for the Big Salmon River.

Based on low returns to all rivers of the inner Bay of Fundy, the 1989 management measure to close all salmon fisheries until sufficient indication that spawning escapement would be met at Big salmon River and/or the Stewiacke River, was in place throughout most of SFA 22 and the portion of SFA 23 east of Saint John River in 1994.

Description of the fisheries

First Nations

No harvests of salmon by First Nations people were reported for SFA 22 in 1994. No harvests of salmon by First Nations people were reported from rivers east of the Saint John in SFA 23.

Commercial

There was no commercial salmon fishery in SFA 22 in 1994 and no commercial salmon fishing licenses remain in the area.

Angling

The salmon angling season was closed by variation order for most inner Bay of Fundy rivers in SFA 22 and SFA 23 in 1994. The exception was the Gaspereau River where the season was May 15 to August 15, 1994. Due to low returns and low water condition an in-season variation order closing the Gaspereau River on July 13, 1994, was issued.

Spawning targets

The target spawning escapement for Stewiacke River was estimated at 1061 salmon (of all ages) by Amiro (1990) which included 772 recruit grilse. Because of the complexity of the repeat spawning component, Marshall et al. (1992) rounded the grilse requirement to 800 and the repeat component to 310. Management is based on 1,100 salmon.

The spawning escapement for Big Salmon River is 280 one-sea winter and 420 multi-sea winter of which the majority are repeat-spawning grilse.

Fishery data

No fishery opened in 1994.

Research Data

Stewiacke River

Fence counts

The smolt counting fence in Little River operated continuously from May 12 to July 1, 1994. The total count of Atlantic salmon smolts was 4,098 or 314% of the 1993 count.

The counting fence in the main Stewiacke River, located just above the head of tidal influence, operated from September 16 to November 2, 1994, when the temporary portion of the fence washed out and water flowed down the diversion channel as well as the main channel. The count of adult salmon at the fence totalled 215 small salmon <63 cm and 5 large salmon ≥63 cm and 1 of unknown length or age (Table 1.)

Electrofishing

A total of 35 electrofishing sites, covering 21,378 m^2 or 0.82% of the fluvial surface area of the river, of the 44 established electrofishing sites (Fig. 2.) was electrofished in 1994. Average parr density (100^{-1} m^2) was 9.7 age-0+ parr, 2.9 age-1+ parr and 3.7 age-2+ parr (Fig 3.) Estimates were derived by mark and re-capture techniques at sites established beginning in 1984. Ages were determined from scale samples selected by size-stratified sampling of parr in 0.5 cm intervals. Populations were estimated from the adjusted Petersen (Ricker 1975, p.78) and variance of the population was determined by the large-sampling variance formulation (Table 2.) Age-0+ densities were estimated using catch efficiency from the age-1+ population estimate and the count of age-0+ from the marking sweep.

Big Salmon River

Adult salmon counts

Shore counts of salmon on September 27 and October 19, 1994, indicated about 225 fish in the river. About 60% of these fish were classified as grilse ie. <63 cm.

Electrofishing

Densities (100^{-1} m^2) of Atlantic salmon were determined by the removal method at four barriered sites (locations 2,11,13 and 15 in Figure 4.). Ages were determined from scale samples selected by size-stratified sampling of parr in 0.5 cm intervals. Populations were estimated from Junge and Libosvarsky's (1965) exact solution for three sweeps and by an iterative solution to Zippin's (1956) maximum likelihood technique for four or more sweeps (Fig. 5).

Assessment results

Stewiacke River

Smolt counts

The 1994 count of 4,098 smolts was the highest recorded in the 1990 - 1994 series (Fig. 6.).

Adult salmon counts

The summer drought of 1994 extended to October 22, 1994. The first catches of salmon at the fence commenced October 23, 1994. Catches were erratic and culminated in a large catch November 2, 1994 (Fig. 7.). Attempts to re-

capture adult salmon up-river were unsuccessfully and therefore no estimate of escapement could be derived. The operation of the fence and water levels in 1994 were so dissimilar from previous years the fence operated that estimation of an escapement based on previous efficiency was not warranted. Operators and observers were of the opinion that few, if any, fish ascended the river prior to October 23, 1994 and that the 41 fish observed below the fence in the last week of October moved through the fence on November 2, 1994 (39 fish) prior to the washout occurring at the end of the days fishing. If this were the case, then the 221 salmon that escaped to the river would account for only 21% of the required spawning escapement. The 1994 escapement was similar to the 1992 estimated escapement of 240 salmon (Fig. 8).

Electrofishing

The density of age-1+parr reached a record low in 1994. This density, 2.9 age-1+ parr, was significantly ($p<0.03$) lower than all years prior to 1990 and less than 1992 ($p<0.05$) (One Way ANOVA)(Table 3.).

Big Salmon River

Adult counts

Counts of salmon from the shore on September 27, 1994, indicated approximately 225 salmon were in the river (T. Pettigrew pers. comm.)[1]. Observers classified about 60% as grilse, based on relative size. A large beaver dam located below the King Pool (requiring diver observation and assumed to contain proportional counts when conducting shore observations) on October 19, 1994, led to the conclusion that the actual escapement was less than estimated in September.

In addition to this escapement, 197 female and 182 male, Big Salmon River stock cage-reared mature one-sea-winter grilse were released into the river. Distribution and spawning activity were documented and it was concluded at least 150 of these females spawned. Inter-mixing of wild and cage-reared fish was documented. Spawning success and juvenile populations resultant of this experiment are to be conducted in 1995 and later in areas above natural barriers.

Electrofishing

Average density of age-0+ parr increased to 10.4 from 2.3 in 1993 while average density of age-1+ parr decreased to 6.7 from 12.5 in 1993 (Fig.5.).

Discussion of results

Both the Stewiacke and Big Salmon rivers indicate little change in recruitment survival of either smolts or repeat spawning adults in 1994. The wild component of the spawning escapement was well below requirement, 80% below in the Stewiacke River and 72% below in the Big Salmon River. Low returns and late entry of salmon into the rivers were reported from Fundy National Park rivers (Alma and Point Wolf, D. Clay pers. comm.)[2]. No fish were reported using the Peticodiac causeway fishway trap in 1994.

Stakeholders generally agree with the assessments and hold varying opinions as to the correct course of action. In SFA 22 the practice of enhancement utilizing hatchery smolts is being questioned and a review of the status of the

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[2] D. Clay, Biologist, Fundy National Park, Alma, New Brunswick.

hatchery program is planned for 1995. The utilization of cage-reared salmon of local stock is being conducted in an agreement among the Big Salmon River Salmon Association, NBDNRE and DFO. The utility of this technique to maintain juvenile population and genetic integrity until marine survival improves is the objective of this program. While measures to monitor the first objective are in place, measures to monitor the second are not.

Ecological considerations

Analysis and searching for significant interaction between smolt survival and environmental conditions, fisheries and/or status of prey and predator populations of the Bay of Fundy is ongoing. These enquiries are hampered by direct evidence of the location of the over-wintering area for inner Fundy stocks of salmon and a reliable index of survival. Attempts to capture post-smolts, both from fixed gear and mobile gear have met with marginal success. Capture is so irregular that efficient and useful sampling has not occurred. Analysis of the few fish caught indicate no disease problem and inconclusive stomach contents. Because standardized sampling has not occurred and because of the paucity of samples, growth and condition indices have not been established. Historical records of these stocks indicate that periodic downturns or collapses have occurred at least as frequently in the 1880's, 1914, 1923 and 1950's (Huntsman 1937,1952,1958).

Future prospects

Juvenile salmon populations may have reached their recent low in 1994. The age-1+ parr resultant of the low escapements in 1992 will contribute substantially to the 1995 smolt run. Although monitoring of fry populations does not provide the best indication of subsequent parr levels (observe the lagged 0+ to 1+ densities) in the Stewiacke, the age-0+ densities were not the lowest of record and this perhaps indicates that juvenile production is beginning to improve. The increase in smolt numbers out of Little River in 1994 is likely the result of lower egg deposition, lower juvenile densities, higher growth and increased survival and therefore greater proportion of age two smolts. Analysis of these data will contribute to our understanding of the population dynamics of these stocks. A substantial improvement in marine survival is required before these populations will be above conservation levels. If history is a fair indicator of the fate of these stocks, then recovery will come, but it's arrival will be unannounced.

Management considerations

There is little positive information that would change advice to fisheries management. The closures in effect since 1989 should remain in place.

Acknowledgements

This status report was made possible through the cooperation of many individuals and organizations. The authors thank the field crews in Stewiacke and Big Salmon rivers who conducted the electrofishing. Mr. Ralph "Bud" Stephens for allowing us to operate and operating the smolt counting facility adjacent to his property in Brentwood. The Stewiacke River Counting Fence Steering Committee, composed of the Indian Brook First Nation, Cobequid Salmon Association, Nova Scotia Salmon Association, Atlantic Salmon Federation for making funds available to operate the trap and assisting Leander "Lefty" Paul and Louis Stalk in the operation of the fence. The New Brunswick Department of Natural Resources and Energy for providing the adult salmon counts for Big Salmon River.

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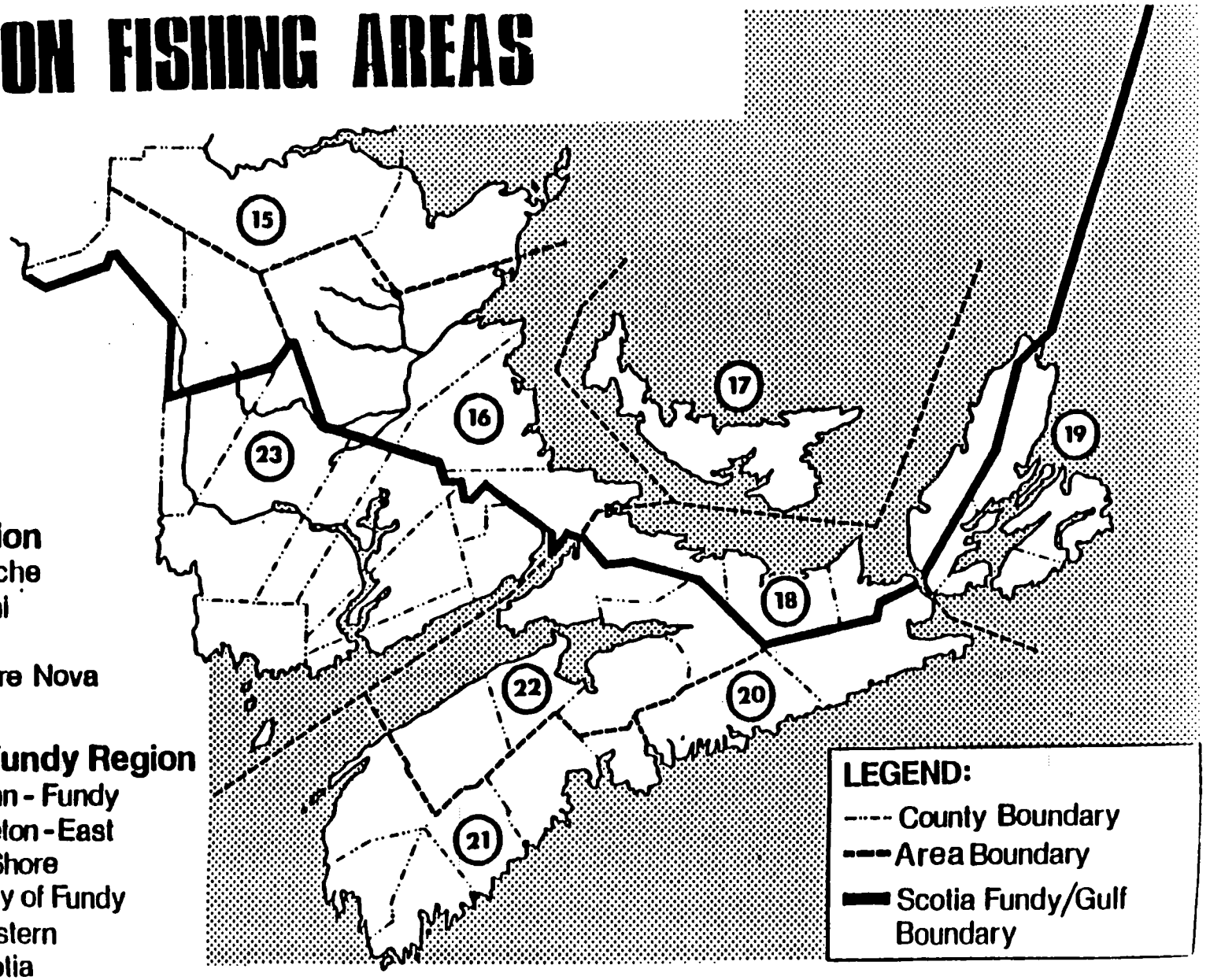
SALMON FISHING AREAS



Gulf Region

15. Restigouche
16. Miramichi
17. P.E.I.
18. Gulf Shore Nova Scotia

Scotia-Fundy Region

23. Saint John - Fundy
19. Cape Breton - East
20. Eastern Shore
22. Upper Bay of Fundy
21. Southwestern Nova Scotia

Figure 1. Map of Salmon Fishing Areas of the Gulf and Scotia-Fundy Regions.

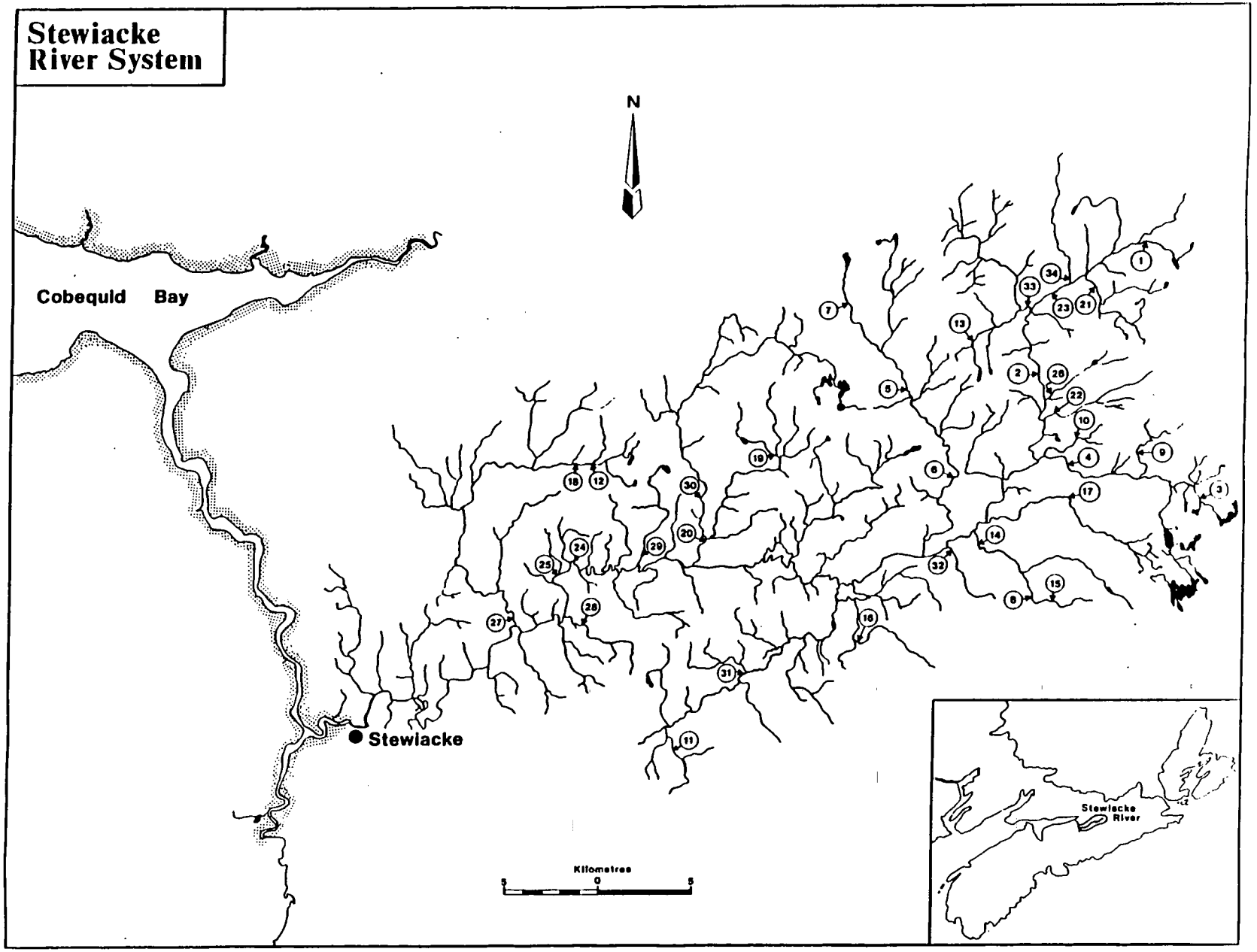


Figure 2. Map of Stewiacke River and tributaries showing locations of electrofishing site established since 1984.

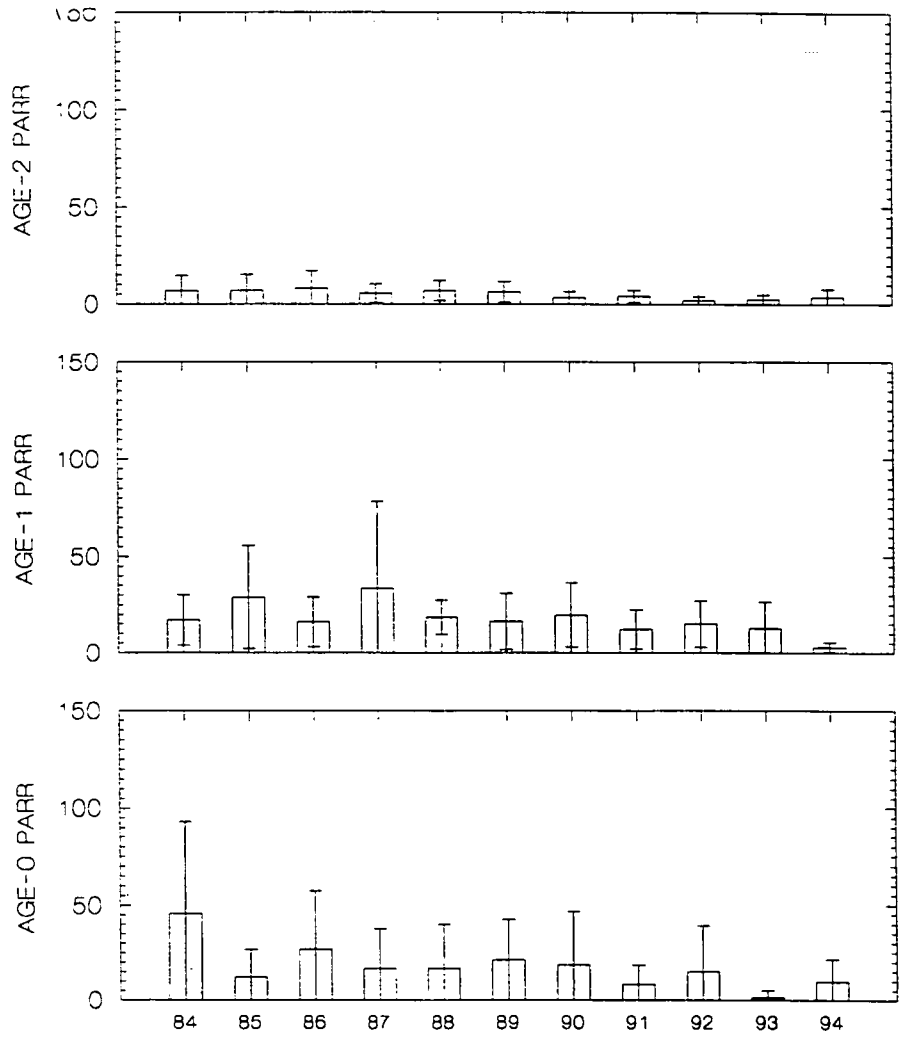


Fig. 3 Mean annual density (100^{-1} * m^2) and standard deviation (error bars) of Atlantic salmon parr age-0+, 1+ and 2+ at 29-44 sites in the Stewiacke River 1984-1994.

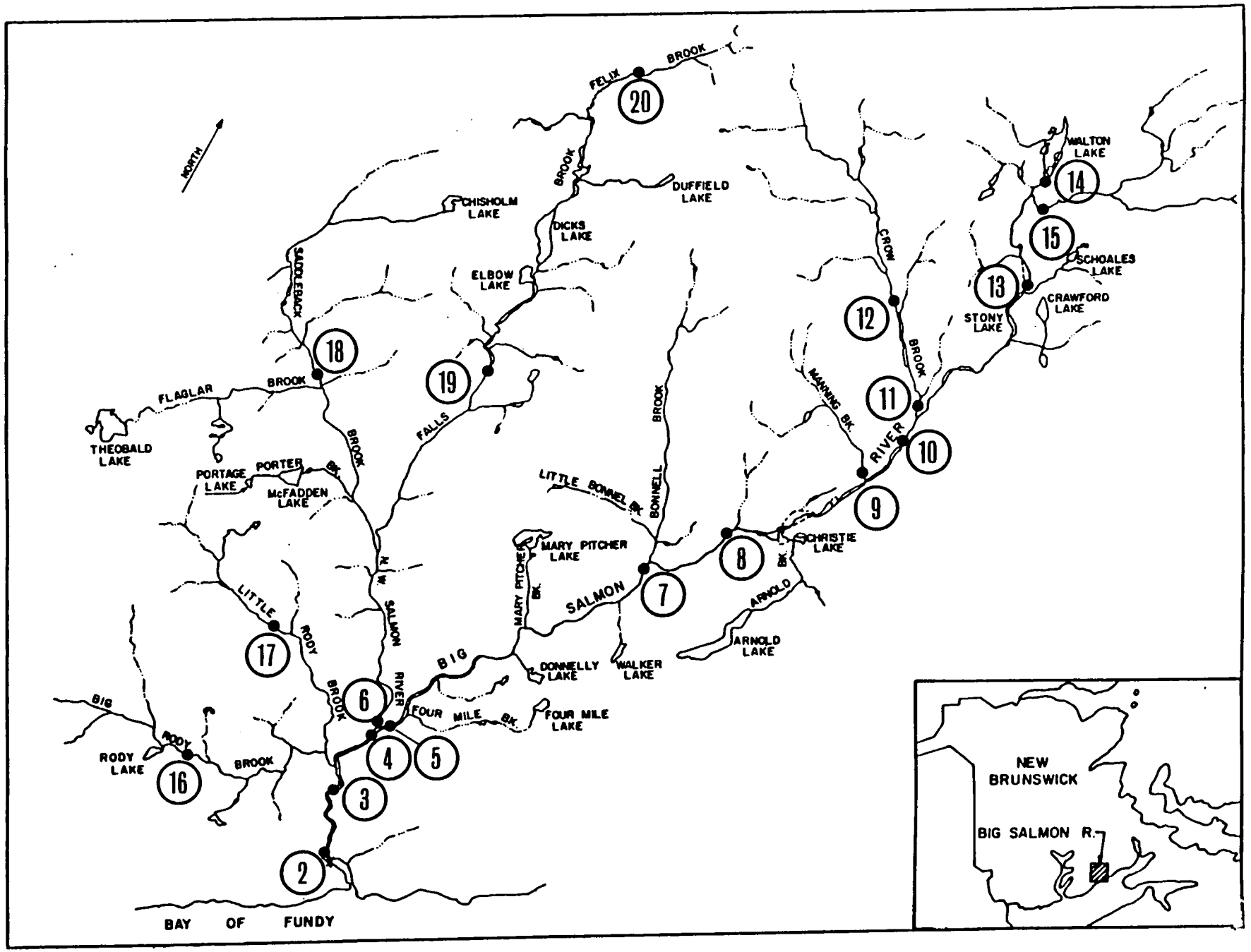


Figure 4. Map of Big Salmon River and tributaries showing locations of electrofishing sites fished from 1968 to 1994.

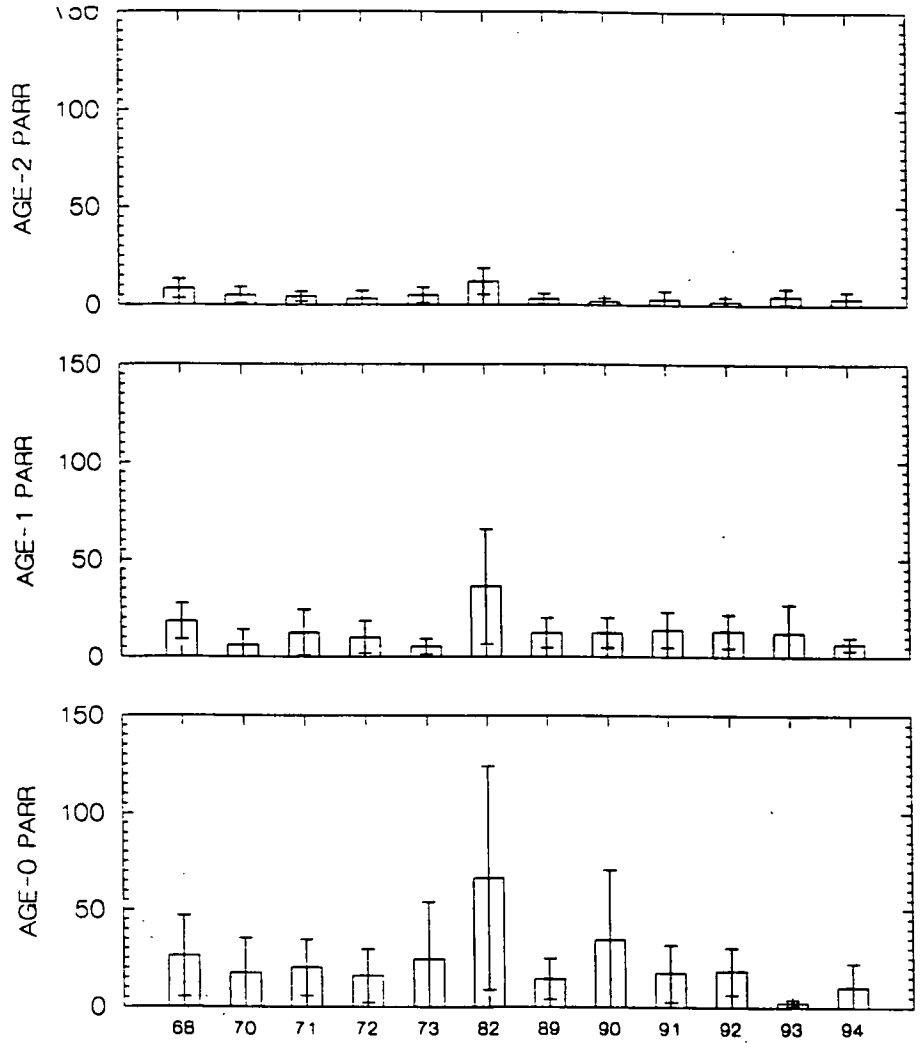


Fig. 5 Mean annual density (100^{-1} * m^2) and standard deviation (error bars) of Atlantic salmon parr age-0+, 1+ and 2+, as determined by electrofishing at 3-11 sites in the Big Salmon River 1968-1994.

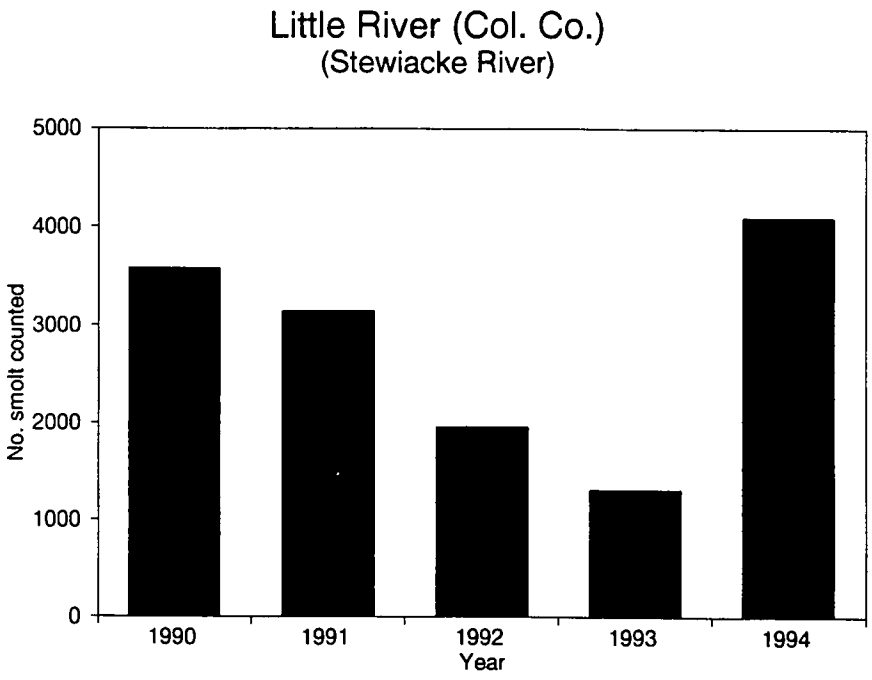


Figure 6 .Annual count of Atlantic salmon smolts through the Little River smolt counting facility 1990 - 1994.

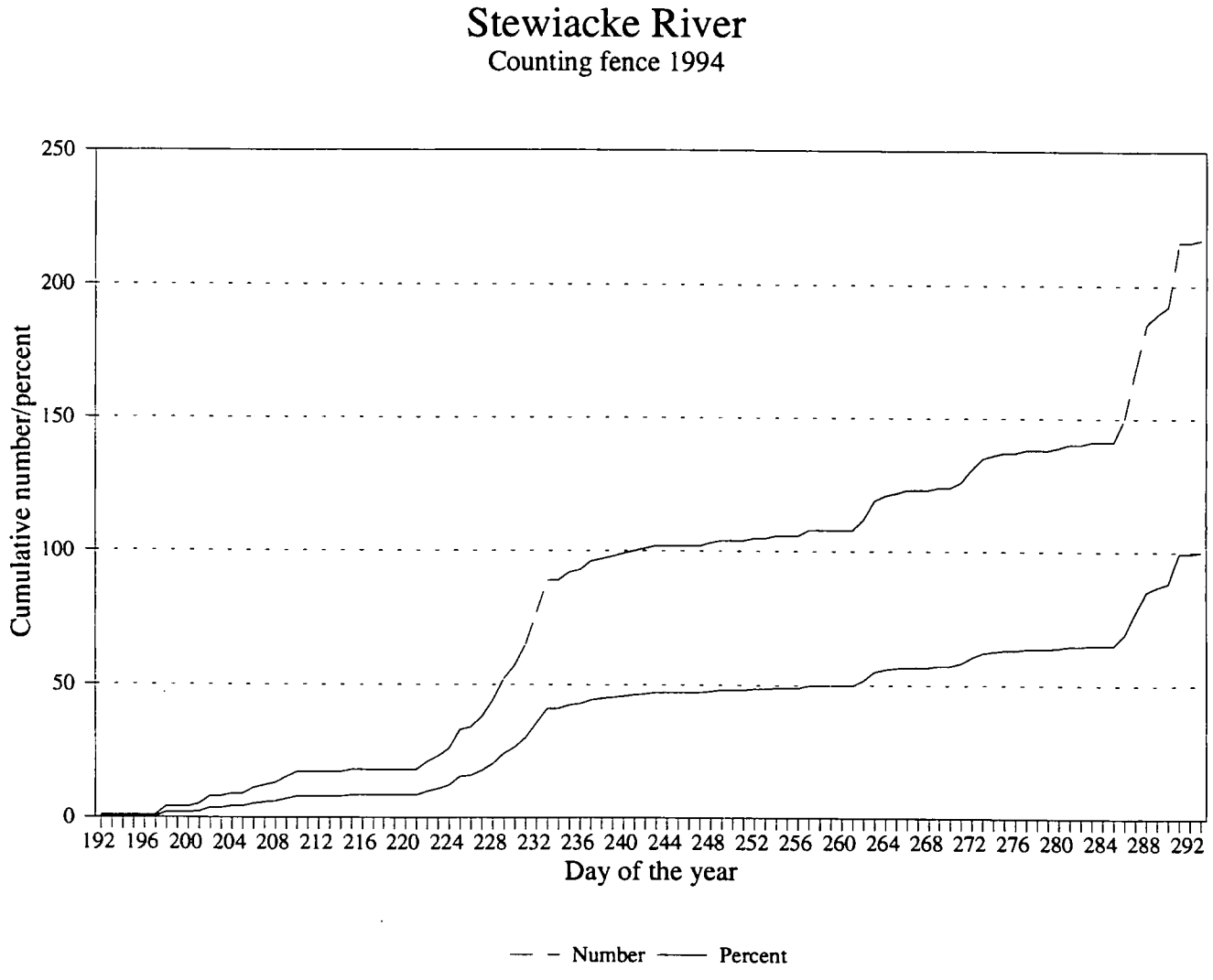


Figure 7. Cumulative daily catch of adult Atlantic salmon in the Stewiacke River fence trap, 1994.

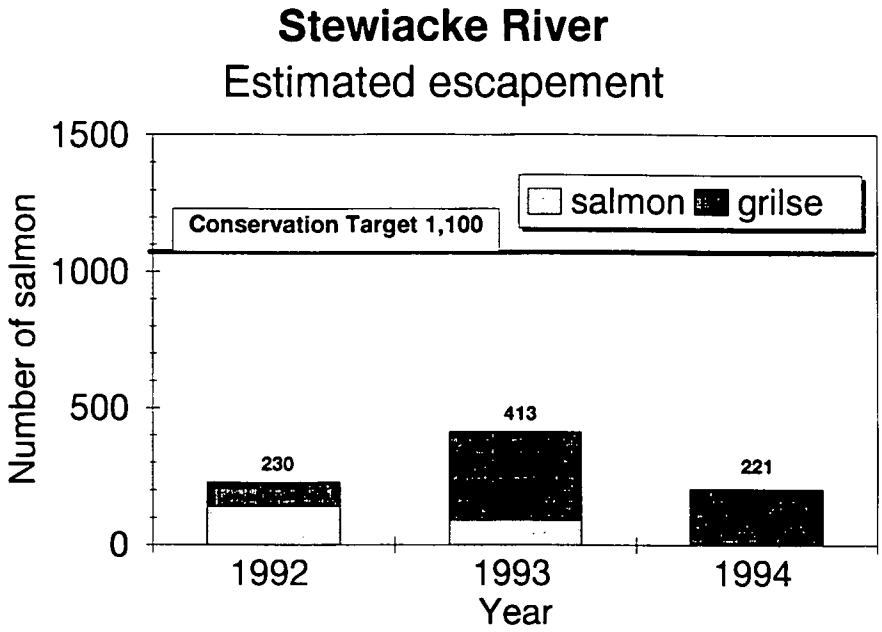


Fig. 8. Annual estimates of escapement of Atlantic salmon to Stewiacke River 1992-1994.

Table 1. Post-smolt age, spawning history, number caught, length and weight statistics of Atlantic salmon trapped in the Stewiacke River counting fence in 1994.

Post smolt (years)	Caught	Length (cm.)				
		n	mean	min.	max.	sd
1	152	152	54.7	47.0	63.0	3.17
1 hatch.	27	27	54.1	48.0	59.0	2.98
2 sp.1	21	21	60.9	57.0	66.0	2.62
2 sp.1 hatch	1	1	61.0			
3 sp.1,2	1	1	70.0			
4 sp.1,3	1	1	87.0			
4 sp.1,2,3	3	3	75.3	73.0	78.0	2.05
total grilse	205	205	55.8	47.0	87.0	4.97
3 sp.2	1	1	76.0			
5 sp.2,4	1	1	90.0			
total salmon	2	2	83.0	76.0	90.0	7.00

Origin	Length	Age
wild	50	?
wild	50	?
wild	51	?
wild	52	?
wild	54	?
wild	54	?
wild	56	?
wild	59	?
wild	61	?
wild	71	?
wild	80	?
wild	NA	?
hatchery	59	?

Table 2. Location, date, area, capture data a., density estimates by age classes and coefficient of variation, of Atlantic salmon electrofished in the Stewiacke River in 1994.

Location .site	Date dd/mm	Area m^2	Capture data: Age-0+ marks count	Age-1+ M	Age-1+ C	Age-1+ R	Age-1+ Mort	Age-2+ M	Age-2+ C	Age-2+ R	Age-2+ Mort	Parr .m^-2.10^2: age-1+	age-2+	total	age-0+	Coefficient of variation: age-1+	age-2+
1.1	18/07	304	40	3	1	1		8	8	2		1.3	8.9	10.2	17.5	0.0	40.8
1.2	18/07	234	22	1	0	0		2	4	2		0.4	1.3	1.7	**	****	31.6
1.1+2	18/07	538	62	4	1	1		10	12	4		0.9	5.3	6.2	14.4	0.0	32.0
4.10	26/07	482	88	6	3	1		5	3	1		2.9	0.4	3.3	42.6	40.8	40.8
4.11	26/07	472	92	12	13	8		8	7	3		4.3	1.1	5.3	32.8	18.9	31.6
4.12	26/07	907	75	9	11	6		11	4	3		1.9	1.7	3.5	15.8	22.8	20.0
4.10+11+12		1,861	255	27	27	15		24	14	7		2.6	2.5	5.2	24.9	15.9	22.8
8.1	27/07	984	29	12	11	8		45	37	22		1.8	7.7	9.5	4.3	15.8	12.8
8.2	27/07	761	0	7	6	3		47	40	27	2	1.8	9.5	11.3	0.0	29.3	10.2
15.1	19/07	567	18	6	10	6		24	17	9		1.9	7.9	9.9	5.8	21.3	20.1
15.2	19/07	388	30	3	4	3		26	19	11		1.3	11.6	12.9	12.9	20.0	17.5
15.3	19/07	379	46	6	2	1		17	11	8		2.8	6.3	9.1	21.2	33.3	15.8
15.1+2+3	19/07	1,334	94	15	16	10		67	47	28		1.9	8.4	10.3	11.6	17.1	11.5
16.1	01/08	283	0	18	19	11	2	5	3	1		11.9	4.2	16.1	0.0	16.5	40.8
18.1	28/07	380	0	3	4	1		31	31	16		2.6	15.9	18.5	0.0	44.7	16.1
18.2	28/07	368	0	0	0	0		26	25	14	1	0.0	13.0	13.0	0.0		15.9
18.1+2	28/07	748	0	3	4	1		57	56	30	1	1.3	14.4	15.7	0.0	44.7	11.8
19.1	13/07	273	0	0	0	0		3	1	0		0.0	1.5	1.5	0.0		****
19.2	13/07	210	0	0	0	0		4	3	1		0.0	1.0	1.0	0.0		40.8
19.1+2	13/07	483	0	0	0	0		7	4	1		0.0	1.7	1.7	0.0		44.7
27.10	06/07	1,302	0	5	4	0		0	0	0		0.7	0.0	0.7	0.0	****	
27.4	06/07	1,251	2	22	23	8		0	0	0		4.9	0.0	4.9	0.4	25.0	
28.1	11/07	408	0	no recapture				3	no recapture								
28.8	11/07	246	0	no recapture				0	no recapture								
28.1+8	11/07	654	0	no recapture				3	no recapture								
29.1	05/07	450	24	10	10	4		6	6	3		5.4	2.7	8.1	12.9	30.2	29.3
29.2	05/07	447	34	7	13	6		2	3	1		3.6	1.3	4.9	17.4	25.0	40.8
29.4	05/07	317	38	8	10	4		5	7	5		6.2	2.5	8.8	29.7	30.2	18.9
29.1+2+4	05/07	1,214	96	25	33	14		13	16	9		4.9	2.0	6.8	18.6	18.7	19.3
30.1	22/07	904	25	25	20	9		18	17	9		6.0	3.8	9.8	6.0	21.8	20.1
30.2	22/07	1,009	8	10	21	5		11	10	4		4.0	2.6	6.6	3.2	32.2	30.2
30.3	22/07	562	40	13	7	4		18	14	8	3	4.0	6.2	10.2	12.3	25.0	18.3
30.1+2+3	22/07	2,475	74	48	48	18		47	41	21	3	5.1	3.8	8.9	7.9	17.5	13.9
31.1	01/08	985	0	0	3	0		0	0	0		0.3	0.0	0.3	0.0	****	
31.2	01/08	858	0	5	3	1		0	0	0		1.4	0.0	1.4	0.0	40.8	
32.2	01/08	453	41	11	9	4		0	0	0		5.3	0.0	5.3	19.7	28.9	
33.1	18/07	791	59	14	11	6		16	10	7		3.3	3.0	6.2	13.7	22.8	17.4
33.2	18/07	1,112	42	16	14	4		9	7	4		4.6	1.4	6.0	12.0	33.3	25.0
34.4	12/07	643	32	8	7	4		5	6	4		2.2	1.3	3.5	9.0	25.0	21.8
34.5	12/07	565	5	4	3	1		17	11	4		1.8	7.6	9.4	2.2	40.8	31.2
34.6	12/07	695	0	4	3	2		9	9	4		1.0	2.9	3.8	0.0	25.0	28.9
34.4+5+6	12/07	1,903	37	16	13	7		31	26	12		1.6	3.5	5.1	3.6	21.8	19.2
35.1	11/07	478	1	6	4	1		0	0	0		3.7	0.0	3.7	0.6	44.7	
36.1	13/07	809	89	23	33	12		2	2	1		7.8	0.6	8.3	30.0	21.0	33.3

a. Counts at the mark run (M)
Total count at the capture run (C)

Table 3. Annual least squares estimates of mean annual density of age-1+ Atlantic salmon parr from 27-44 electrofishing sites in the Stewiacke River with probability of no difference between annual means and the 1994 mean.

Year	LS Mean	Std. Error	N	p. of no diff. from 1994 mean
1984	17.02955	2.90324	44	0.01105
1985	28.86667	3.70619	27	0.00000
1986	16.01579	3.12405	38	0.03058
1987	33.63056	3.20966	36	0.00000
1988	18.54828	3.57611	29	0.01119
1989	16.46129	3.45883	31	0.03548
1990	19.74516	3.45883	31	0.00391
1991	12.26875	3.40436	32	0.27611
1992	15.02703	3.16599	37	0.05878
1993	12.64857	3.25519	35	0.21442
1994	2.88857	3.25519	35	1.00000