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Status of Atlantic Salmon (Salmo salar L.) in Gander River, Notre Dame Bay (SFA 4), Newfoundland, 1993

by

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Abstract

The status of Atlantic salmon in Gander River in 1993 was determined using a count obtained from a counting fence located on the main stem just above head of tide, recreational fishery data, and biological characteristic data. The assessment was conducted in relation to the five-year moratorium on the commercial Atlantic salmon fishery, which entered its second year in 1993. The proportion of target spawning requirement achieved in 1993 was 136%, which compares to 111% in 1992 and 33-36% for the period 1989-91.

Résumé

On a établi l'état des stocks de saumon de l'Atlantique de la rivière Gander en 1993 en se fondant sur des chiffres obtenus à une barrière de dénombrement du bras principal de la rivière, en amont de la limite des eaux de marée, sur les résultats de la pêche sportive et sur des caractéristiques biologiques. Cette évaluation faisait suite à l'adoption du moratoire quinquennal sur la pêche commerciale du saumon de l'Atlantique dans l'île de Terre-Neuve, en vigueur depuis 1992. En 1993, 136 % des besoins-cibles de reproducteurs ont été comblés, comparativement à des taux de 111 % en 1992 et de 33 à 36 % au cours de la période 1989-1991.

Introduction

The Gander River, with a drainage area of 6,398 km_2 (Porter et al. 1974), is the third largest in insular Newfoundland. The river is located in Salmon Fishing Area (SFA) 4 (Notre Dame Bay) (Fig. 1). In addition to being one of the most important Atlantic salmon angling rivers in insular Newfoundland, the river has historically supported a relatively large angler guiding and outfitting industry.

In 1989, in response to concerns from angler groups that returns to the river were declining, the Department of Fisheries and Oceans, in cooperation with the Gander Rod and Gun Club and the Gander Bay-Hamilton Sound Development Association, initiated a 3-year study to determine the status of the Gander River Atlantic salmon population. The results of this study (O'Connell and Ash 1992) showed that for the period 1989-91, Gander River received only 33-36% of target spawning requirement.

In 1992, a major change was introduced in the management of Atlantic salmon. A five-year moratorium was placed on the commercial fishery in insular Newfoundland while in Labrador, fishing continued under quota. In addition, a commercial license retirement program went into effect in both insular Newfoundland and Labrador. In the recreational fishery, a quota on the number of fish that could be retained was introduced in each SFA. The quota was assigned for each SFA as a whole and not administered on an individual river basis. The quota was in effect in each SFA from the beginning of the season until it was caught, following which, only hook-and-release fishing was permitted. In 1993, the quota was split to cover two time periods during the angling season in insular Newfoundland. The first time period, which accounted for most of the quota, was from the beginning of the season until July 31; the remainder of the quota was taken between August 1 and the end of the season. The number of fish assigned to each quota period was done on the basis of the historical proportion of total season catch taken prior to and after July 31. Only hook-and-release fishing was permitted after each portion of the quota was caught.

In this paper, we examine the status of Atlantic salmon in Gander River in 1993. Counts obtained from a counting fence are used in conjunction with recreational fishery data and biological characteristic data to calculate total river returns and spawning escapement. Status of stock is evaluated against a target spawning requirement (calculated in terms of fluvial and lacustrine habitats) derived for Gander River.

Methods

RECREATIONAL AND COMMERCIAL FISHERY DATA

Catch and effort data from the recreational fishery in Gander River were collected by Department of Fisheries and Oceans (DFO) Officers and processed by DFO Science Branch personnel. Procedures for the collection and compilation of recreational fishery data are described by Ash and O'Connell (1987).

BIOLOGICAL CHARACTERISTIC DATA

Biological characteristic information on adult Atlantic salmon in Gander River was obtained by sampling recreational catches. For fish < 63 cm in length (small salmon), mean values for all years combined were used in the calculation of egg deposition for years prior to 1992 (Table 1). For 1992 and 1993, the following female mean weight and proportion of female values were used:

Year	Weight (kg)			Proportion Female (N)
	Mean	SD	N	
1992	1.79	0.43	86	0.60 (86)
1993	1.86	0.39	71	0.70 (75)

For fish ≥ 63 cm in length (large salmon), mean values for all avaliable data for Gander River and Terra Nova River combined were used (Table 1).

Fecundity was determined from ovaries collected in the recreational fishery. Ovaries were stored in Gilson's fluid until ovarian tissue had broken down after which time eggs were transferred to 10% formalin. Eggs, which for the most part were in early stages of development, were counted directly. The relative fecundity value used to calculate egg deposition for both small and large salmon was 1,665 eggs/kg and represented all data combined for the years 1984-87 (N = 173).

TOTAL RIVER RETURNS, SPAWNING ESCAPEMENT, AND EGG DEPOSITION

Calculations were performed for small and large salmon separately. Total egg deposition was obtained by summing depositions for small and large salmon.

Total River Returns

Total river returns (TRR) was calculated as follows:

(1) $$TRR = RC_b + C$$

where,

RC_b = recreational catch below counting fence
C = count of fish at counting fence

A partial count of small and large salmon was obtained at the counting fence in 1992. High water levels caused a delay in counting fence installation until July 1. During the period of delay, fish were counted upriver at the Salmon Brook fishway and also there were some angling catches. The numbers of small and large salmon entering Gander River prior to July 1 in 1989 and 1990 represented on average 5.9% and 7.9% respectively of the total counts. The total counts of small and large salmon for 1992 were estimated using these percentages. The percentage for 1991 was not used because in that year timing of adult migration was later than in 1989 and 1990 (O'Connell and Ash 1992).

Spawning Escapement

Spawning escapement (SE) was calculated as follows:

(2) $$SE = FR - RC_a$$

where,

FR = fish released from counting fence
RC_a = recreational catch above counting fence

Egg deposition

Egg deposition (ED) was calculated as follows:

(3) $$ED = SE \times PF \times RF \times MW$$

where,

SE = number of spawners
PF = proportion of females
RF = relative fecundity (No. eggs/kg)
MW = mean weight of females

The phenomenon of atresia has been reported to occur in Atlantic salmon in the Soviet Union (Melnikova 1964) and in France (Prouzet et al. 1984). Recently, there is evidence to show that it can occur, to varying degrees, in insular

Newfoundland (O'Connell and Dempson, unpublished data). Since the egg deposition calculations above were based on eggs in early stages of development, they should be regarded as potential egg depositions.

TARGET SPAWNING REQUIREMENT

The target spawning requirement for Gander River was developed by O'Connell and Dempson (1991). The egg deposition requirement for classical fluvial parr rearing habitat (Elson 1957) was 240 eggs/100 m^2 (Elson 1975); the requirement for lacustrine habitat was 368 eggs/ha (O'Connell et al. 1991). **It should be noted that Gander Lake was not included in the calculation of the egg deposition requirement.**

Accessible rearing habitat and target spawning requirement for Gander River (O'Connell and Dempson 1991) were as follows:

	Lacustrine	Fluvial	Total
Accessible habitat	21,488 ha	159,560 units	
Eggs (No. x 10^6)	7.917	38.294	46.211
Small salmon (No.)	3,739	18,089	21,828

The target spawning requirement was calculated in terms of small salmon only. Egg deposition from large salmon was considered as a buffer to the estimate of spawning requirement.

Results

Recreational Fishery

Catch and effort data are presented in Appendix 1. Catches for all years prior to 1992 represent retained catch for the entire angling season, when there was no mandatory release of small salmon. Total catch for 1993 (retained plus released fish), associated effort, and catch per unit of effort (CPUE) are compared to years prior to 1992. In 1992, there was no estimate of released fish during the period of retention of catch and hence comparisons with 1993 are not appropriate. The total number of fish retained (both quota periods combined) in 1993 for Gander River and associated effort is also shown; direct comparison with 1992 is not valid since the closure date for retention of fish in that year was different from 1993. Calculation of CPUE in terms of retained fish only was not possible since effort figures apply to both retained and released fish collectively.

Total catch of small salmon (retained plus released fish) in 1993 was the highest since 1985 and CPUE (which included some large salmon) the highest since 1981. The number of small salmon retained (both quota periods combined) in 1993 was similar to 1992; quotas in 1992 and 1993 constrained catches below the means and close to levels observed during the period 1989-91. The quota for retained catch during the first quota period (3360 fish) in SFA 4 in 1993 was reached on July 11; the quota for the second period (1440 fish) was attained on August 12. In comparison, the single season quota for 1992 (4800 fish) was reached on July 24.

The percentage of SFA retained catch of small salmon and effort expenditure up to the time of closure of the first quota period attained by various rivers in SFA 4, are shown in Fig. 2. Gander River accounted for the second highest catch and expenditure of effort.

Counts at Counting Fence and Fishway

In 1993, the counting fence on the main stem of the Gander River operated from June 6 to September 7. Counts for the period 1989-93 were as follows (see also Fig. 3):

Year	Small salmon	Large salmon	% Large
1989	7,743	473	5.5
1990	7,520	508	6.3
1991	6,445	670	9.4
1992	17,306[1] (18,411)	3,850[1] (4,180)	18.2 (18.5)
1993	25,905	1,734	6.2

[1]Partial count (see text)

The values in parentheses for 1992 are estimated total counts and are the ones used below in the calculation of total river returns and spawning escapement. The count of small salmon in 1993 increased by 41% over 1992 while that of large salmon declined by 59%. The proportion of large salmon in 1993 decreased markedly from 1992 and was similar in magnitude to values observed for years prior to the moratorium.

Counts of small and large salmon at the fishway located in Salmon Brook tributary for the period 1974-92 are shown in Table 2 and Fig. 3. The count of small

salmon in 1993 increased over 1992 (34%) while that of large salmon decreased (14%). The count of small salmon increased over both the 1984-89 (31%) and 1986-91 (80%) means; increases for large salmon were 251 and 461%, respectively. The proportion of large salmon for Salmon Brook in 1993 was 5% which compares to 8% in 1992 and 2.0 and 1.8% for the 1984-89 and 1986-91 means, respectively.

Total River Returns, Spawning Escapement, and Percentage of Target Achieved

Total river returns, spawning escapement, and egg deposition for small and large salmon for Gander River in 1989-93 are presented in Table 3. In terms of eggs, as was the case in 1992, there was a surplus to spawning requirement in 1993. The contribution of large salmon to total egg deposition in 1993 was 14%, a substantial decline from 40% observed in 1992 and also below the average for 1989-91 (17%). In contrast to 1992 (-21%), target spawning requirement in terms of small salmon was exceeded in 1993 (14%).

Discussion

The 1984-89 mean used for comparisons of counts at Salmon Brook and for recreational catches, corresponds to years under major management changes in the commercial fishery in the Newfoundland Region (see O'Connell et al. 1992a). In 1990 and 1991, the commercial fishery in all SFAs of the Newfoundland Region was controlled by quota (O'Connell et al. 1992b). The mix of management measures in effect during 1984-89 on the one hand and the imposition of commercial quotas in 1990 and 1991 on the other, should be kept in mind when making evaluations based on the more recent 1986-91 mean. The complete closure of the commercial fishery in 1992 was the most significant management change to date for Atlantic salmon. All the above measures were aimed at increasing river escapements. Also, a moratorium on the northern cod fishery was implemented in early July of 1992 which should have resulted in the elimination of by-catch in cod fishing gear. The cod moratorium continued in 1993.

Counts of small salmon in 1992 and 1993 improved considerably over 1989-91. However, if historical counts at Salmon Brook are indicative of total returns to the river, it is likely that escapements of a magnitude similar to or greater than those observed in 1992 and 1993 entered Gander River in certain pre-salmon moratorium years. The count of large salmon, while lower than in 1992, was still higher than observed prior to 1992 at both counting facilities, which is consistent with expectations resulting from the closure of the commercial salmon and cod fisheries.

Cautions associated with the parameter values used to calculate the target spawning requirement have been discussed previously by O'Connell et al. (1991) and O'Connell and Dempson (1991) and will not be dealt with here in detail. Recent research findings pertaining to the egg-to-smolt parameter, however, warrant mention. This parameter is very sensitive to change in terms of impact on calculations of egg deposition requirement using the model presented in O'Connell and Dempson (1991). There is evidence that egg-to-smolt survival could be substantially lower than used in the model (O'Connell et al. 1992c). However, further substantiation is required. The use of a lower value would increase the target spawning requirement accordingly.

Calculations of smolt production and target spawning requirement assume the locations of spawning substrate and nursery areas are such that, under natural mechanisms of distribution, juveniles will have access to all the specified fluvial and lacustrine rearing habitat. Currently investigations are ongoing to determine if logging operations, both past and present, have negatively affected productive capacity of habitat. The egg deposition requirement value presented above therefore is an interim value which could be subject to change pending the outcome of the habitat assessment.

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Table 1. Biological characteristic data for female small salmon (data for years 1975-87 combined) from Gander River and for female large salmon from Gander River and Terra Nova River (separately and combined).

River	Length of females (cm)				Weight of females (Kg)				River age (yr)				Sex ratio	
	N	$\bar{X}$	SD	Range	N	$\bar{X}$	SD	Range	N	$\bar{X}$	SD	Range	N	% Female
Small salmon														
Gander River	928	52.2	38.6	39.0-62.1	941	1.63	0.37	0.68-3.68	944	3.74	0.57	3.00-6.00	1217	78
Large salmon														
Gander River	8	69.2	80.6	63.0-82.6	8	3.66	1.81	2.38-7.71	8	3.50	0.53	3.00-4.00	10	80
Terra Nova River	6	68.3	38.4	63.0-73.5	6	3.08	0.60	2.27-3.70	6	4.00	0.63	3.00-5.00	6	100
Gander & Terra Nova rivers combined	14	68.8	63.9	63.0-82.6	14	3.41	1.41	2.27-7.71	14	3.71	0.61	3.00-5.00	16	88

Table 2. Counts of small and large salmon at Salmon Brook fishway, 1974-93. Partial counts are in parentheses and are not included in means.

Year	Small salmon	Large salmon
1974	857	9
1975		
1976		
1977		
1978	755	52
1979	(404)	(6)
1980	997	15
1981	2459	33
1982	1425	18
1983	978	12
1984	1081	38
1985	1663	26
1986	1064	12
1987	(493)	(9)
1988	1562	24
1989	596	24
1990	(328)	(7)
1991	245	2
1992	1168	101
1993	1560	87
1984-89		
Mean	1193.2	24.8
95% LCL	658.3	13.3
UCL	1728.1	36.3
N	5	5
1986-91		
Mean	866.8	15.5
95% LCL	-43.6	-1.4
UCL	1777.1	32.4
N	4	4

Table 3. Total river returns, spawning escapement, and egg deposition for small and large salmon for Gander River in 1989-93.

Year	Total returns		Spawning escapement		Egg deposition (No. x 10^6)		Prop. of Target
	Small	Large	Small	Large	Small	Large	
1989	7,743	473	6,570	473	13.909	2.363	0.35
1990	7,740	508	6,585	508	13.940	2.538	0.36
1991	6,745	670	5,565	670	11.781	3.347	0.33
1992	18,411	4,180	17,143	4,180	30.652	20.883	1.11
1993	26,205	1,734	24,934	1,734	54.057	8.663	1.36

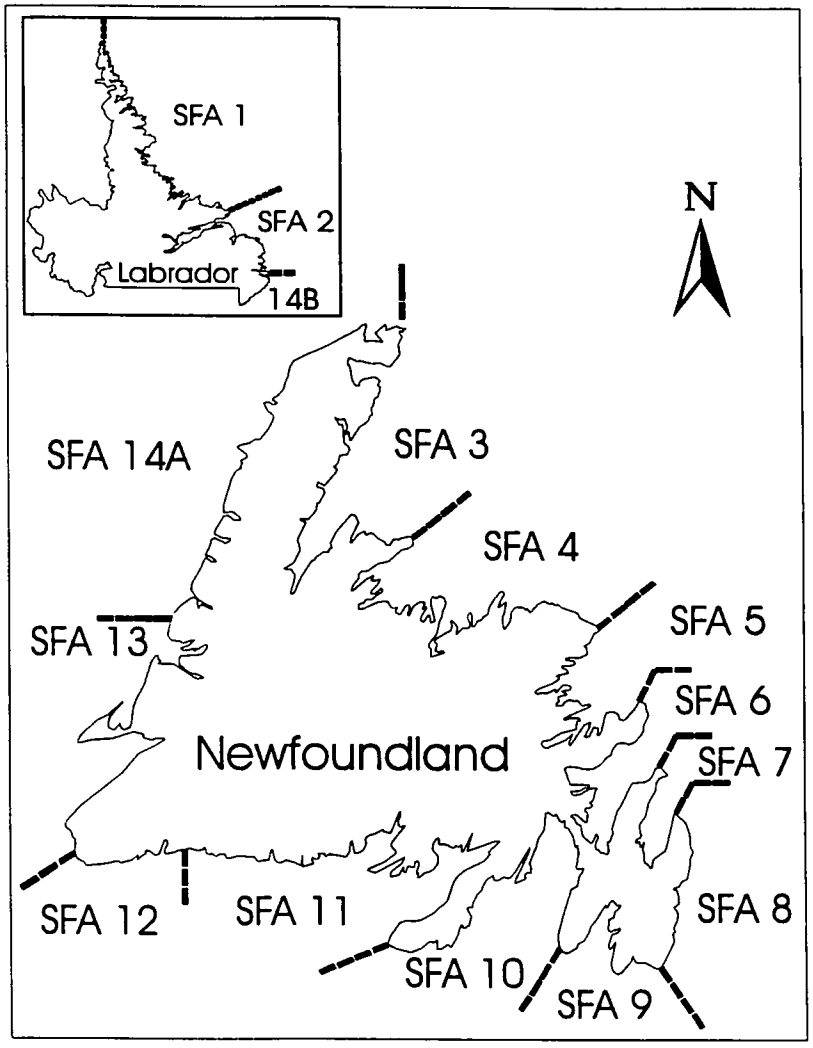

Fig. 1. Map showing the 14 Salmon Fishing Areas of the Newfoundland Region.

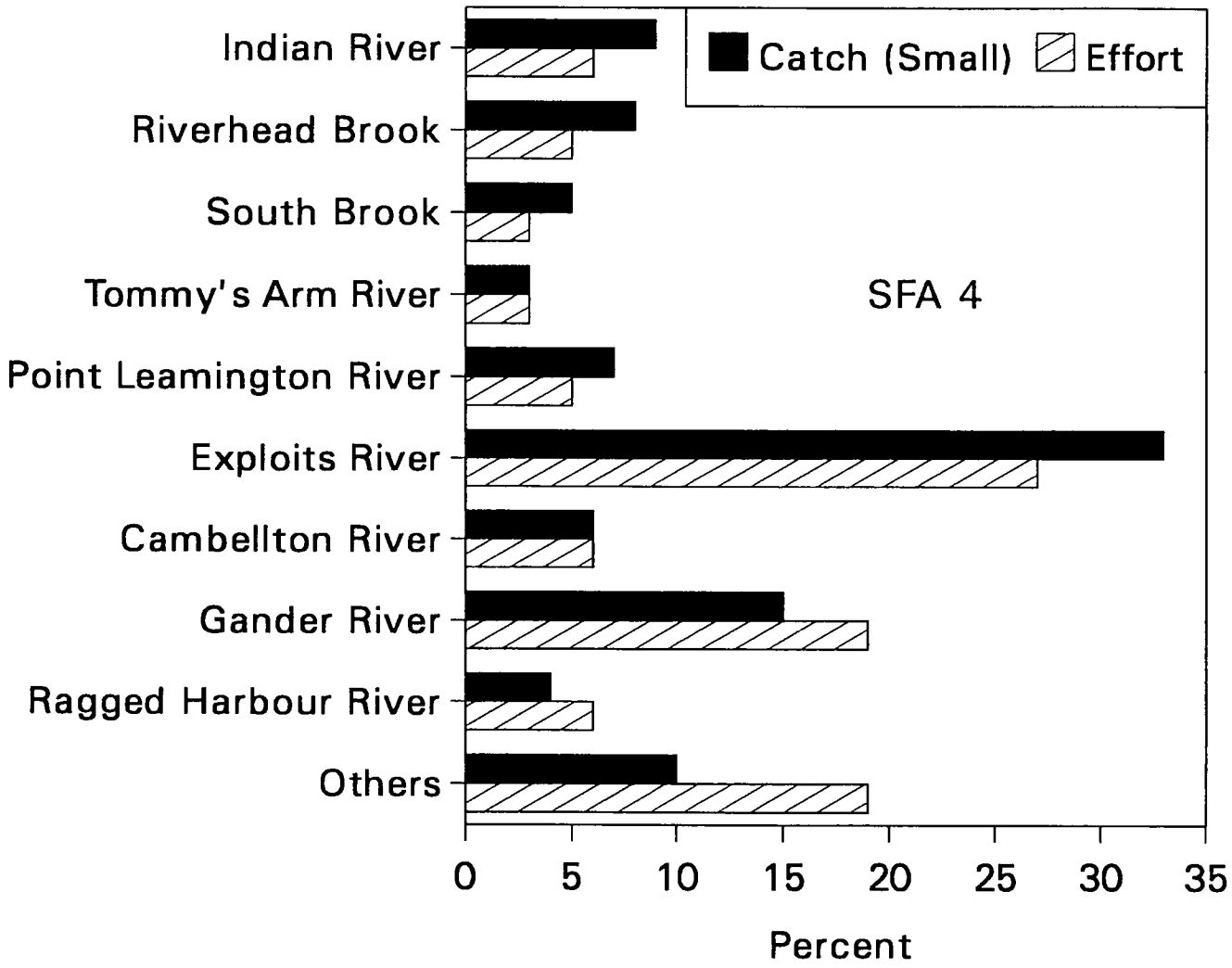

Fig. 2. Percentage of retained SFA catch of small salmon and effort expenditure up to the time of closure of the first quota period attained by various rivers in SFA 4 in 1993.

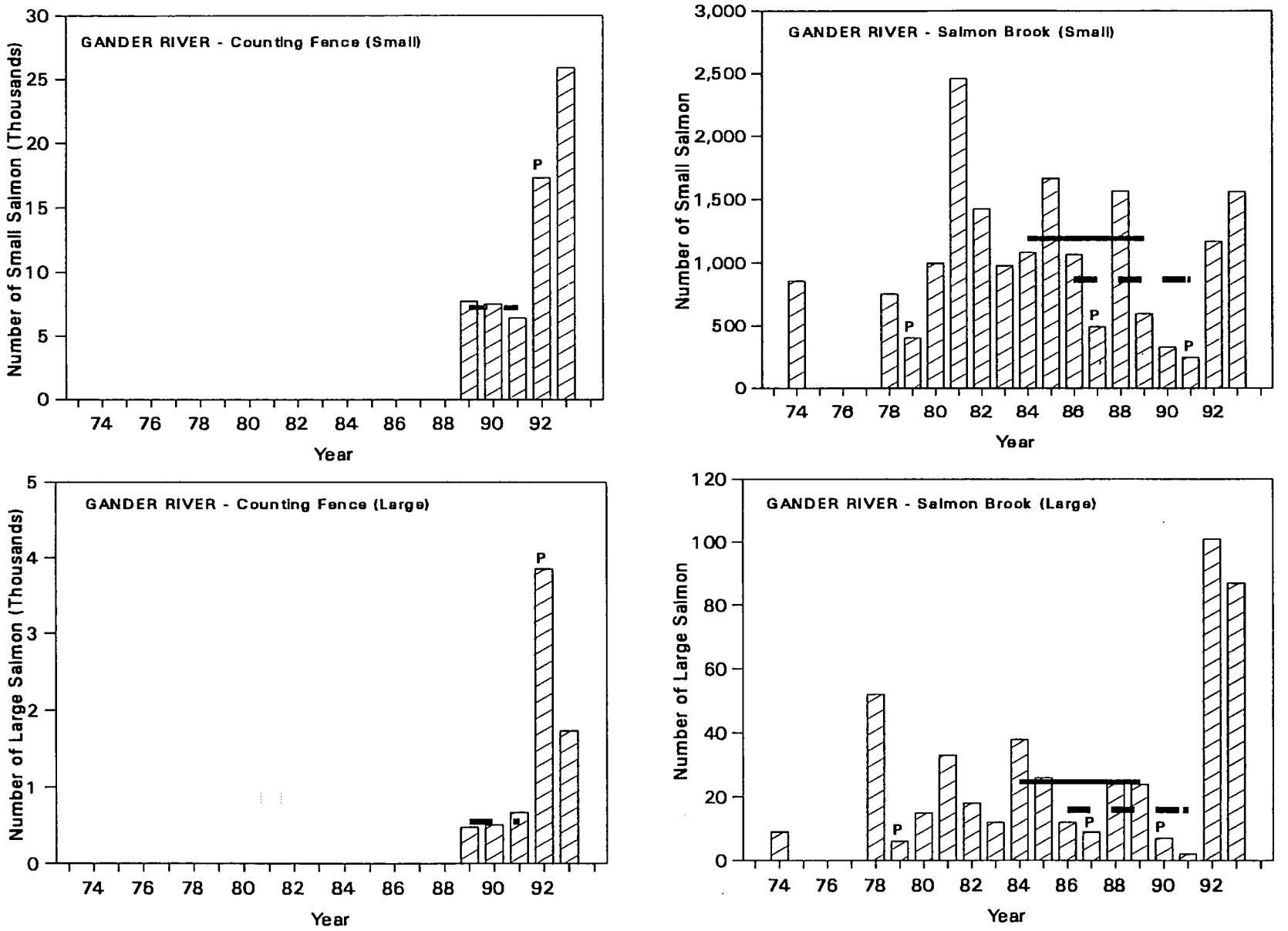

Fig. 3. Counts of small and large salmon at the Gander River counting fence and at the fishway located on the Salmon Brook tributary, 1974-93. The solid horizontal line represents the 1984-89 mean and the broken line the 1986-91 mean. P = partial count, not included in the means.

Appendix 1. Atlantic salmon recreational fishery catch and effort data for Gander River, Notre Dame Bay (SFA 4), 1974-93. Ret. = retained fish; Rel. = released fish.

YEAR	EFFORT ROD DAYS	SMALL (<63CM) RET.	SMALL (<63CM) REL.	SMALL (<63CM) TOT.	LARGE (≥63CM) RET.	LARGE (≥63CM) REL.	LARGE (≥63CM) TOT.	TOTAL (SMALL+LARGE) RET.	TOTAL (SMALL+LARGE) REL.	TOTAL (SMALL+LARGE) TOT.	CPUE
1974	5153	2270	.	2270	19	.	19	2289	.	2289	0.44
1975	6670	2976	.	2976	38	.	38	3014	.	3014	0.45
1976	6633	2374	.	2374	132	.	132	2506	.	2506	0.38
1977	6939	2269	.	2269	927	.	927	3196	.	3196	0.46
1978	8322	3332	.	3332	389	.	389	3721	.	3721	0.45
1979	7217	4199	.	4199	318	.	318	4517	.	4517	0.63
1980	6384	2664	.	2664	268	.	268	2932	.	2932	0.46
1981	10643	4578	.	4578	249	.	249	4827	.	4827	0.45
1982	8026	2176	.	2176	205	.	205	2381	.	2381	0.30
1983	6934	2033	.	2033	239	.	239	2272	.	2272	0.33
1984	7590	2028	.	2028	13	.	13	2041	.	2041	0.27
1985	10207	3358	.	3358	*	*	*	3358	.	3358	0.33
1986	9740	2361	.	2361	*	*	*	2361	.	2361	0.24
1987	6384	1444	.	1444	*	*	*	1444	.	1444	0.23
1988	7943	2686	.	2686	*	*	*	2686	.	2686	0.34
1989	6290	1173	.	1173	*	*	*	1173	.	1173	0.19
1990	7118	1155	.	1155	*	*	*	1155	.	1155	0.16
1991	5853	1180	.	1180	*	*	*	1180	.	1180	0.20
1992	6273	1268	525	1793	0	3	3	1268	528	1796	0.29
1993	9073	1271	1950	3221	0	92	92	1271	2042	3313	0.37
MEANS, 95% CONFIDENCE LIMITS, N'S:											
84-89	8354.0	2321.2	.	2321.2	13.0	.	13.0	2323.8	.	2323.8	0.28
95%CL	1999.0	1003.7	.	1003.7	.	.	.	1002.3	.	1002.3	0.07
N	5	5	0	5	1	0	1	5	0	5	5
86-91	7388.8	1711.0	.	1711.0	.	.	.	1711.0	.	1711.0	0.23
95%CL	1911.0	932.0	.	932.0	.	.	.	932.0	.	932.0	0.09
N	5	5	0	5	0	0	0	5	0	5	5

1987 DATA NOT INCLUDED IN MEAN.
IN THE ABOVE TABLE A PERIOD INDICATES NO DATA FOR THAT YEAR.
CPUE IS BASED ON RETAINED+RELEASED FISH FOR 1992 AND 1993 AND ON RETAINED FISH ONLY PRIOR TO 1992.
* NOT ALLOWED TO RETAIN LARGE SALMON IN INSULAR NEWFOUNDLAND.