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Status of Atlantic Salmon (Salmo salar L.) in Gander River, Notre Dame Bay (SFA 4), Newfoundland, 1992

by

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Abstract

The status of Atlantic salmon in Gander River in 1992 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 response to major management changes which were introduced in 1992. Specifically, there was a moratorium on the commercial Atlantic salmon fishery in insular Newfoundland and a quota was placed on recreational catch in each Salmon Fishing Area. The proportion of target spawning requirement achieved in 1992 was 111% which compares to 33-36% for the period 1989-91.

Résumé

On a déterminé l'état des stocks de saumon de l'Atlantique de la rivière Gander en 1992 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 d'importantes modifications apportées au régime de gestion en 1992, plus précisément à l'adoption d'un moratoire sur la pêche commerciale du saumon de l'Atlantique dans l'île de Terre-Neuve et à l'établissement d'un quota de prises sportives dans chaque zone de pêche du saumon. On a atteint 111 % des besoins-cibles de reproducteurs en 1992, alors qu'au cours de la période 1989-1991 on avait comblé de 33 à 36 % seulement de ces besoins.

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). On average, for the period 1984-89, Gander River accounted for 25% of the total recreational catch of Atlantic salmon for SFA 4 and 10% of the total catch for the insular Newfoundland portion of the Newfoundland Region. 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 recent years there has been a general concern that the Gander River is underproducing. In 1989, 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 in the Newfoundland Region. 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 a quota was introduced in each SFA for the first time. The quota was assigned for each SFA as a whole and not administered on an individual river basis. The recreational fishery in each SFA closed to the retention of grilse when the quota was caught and from that point until the closure of the angling season, hook and release fishing only was permitted.

In this paper we examine the status of Atlantic salmon in Gander River in relation to the management measures adopted in 1992. 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 (grilse), mean values for all years combined were used in the calculation of egg deposition for years prior to 1992 (Table 1). For 1992, new female mean weight (1.79 kg, SD = 0.43, N = 86) and proportion of female (0.60, N = 86) values were used. 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 grilse 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 grilse and large salmon separately. Total egg deposition was obtained by summing depositions for grilse 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 grilse 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 grilse 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 grilse 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
Grilse (No.)	3,739	18,089	21,828

The target spawning requirement was calculated in terms of grilse 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. These figures represent retained fish for the entire angling season for all years prior to 1992. As stated earlier, the recreational fishery for the retention of grilse in 1992 closed when the quota for SFA 4 was caught (July 24). The values in Appendix 1 labelled "After Quota" are estimates of the number of fish hooked and released **after** the quota was caught. No grilse were caught below the counting fence in Gander River in 1992. The catch in 1992 at the time of closure of the fishery was better than for the previous three years when no restrictions on recreational catch applied.

Counts at Counting Fence and Fishway

Counts obtained from the counting fence on the main stem of the Gander River for 1989-92 were as follows (see also Fig. 2):

Year	Grilse	Large salmon	% Large
1989	7,743	473	5.5
1990	7,520	508	6.3
1991	6,445	670	9.4
1992	17,296[1] (18,316)	3,850[1] (4,154)	18.2 (18.5)

[1]Partial count (see text)

The values in parentheses are estimated total counts and are the ones used below in the calculation of total river returns and

spawning escapement. Total counts of grilse and large salmon in 1992 increased markedly over previous years as did the proportion of large salmon.

Counts of grilse and large salmon at the fishway located in Salmon Brook tributary for the period 1974-92 are shown in Table 2 and Fig. 2. The count of grilse in 1992 improved substantially over 1991 (377%), was similar to the 1984-89 mean (-2%), and increased over the 1987-91 mean (35%). The count of large salmon increased markedly over 1991 (4,950%) and also improved over the means (307% and 552%, respectively). It should be noted that counts of grilse and large salmon at the Salmon Brook fishway in 1991 were the lowest on record.

Total River Returns and Spawning Escapement

Total river returns, spawning escapement, and egg deposition for grilse (G) and large salmon (LS) for Gander River in 1989-92 were as follows:

Year	Total returns		Spawning escapement		Egg deposition (No. x 10^6)		Proportion of target
	G	LS	G	LS	G	LS	
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	18,316	4,154	17,048	4,154	30.482	20.753	1.11

There was a small surplus to target spawning requirement in 1992. It is important to point out that the relative contribution to total spawning requirement by large salmon in 1992 increased to 40% from an average of 17% for 1989-91.

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.

Even though the count of grilse in 1992 improved considerably over 1989-91, if historical counts at Salmon Brook are any indication, escapements of a similar magnitude entered Gander River in the past, and in these years returns were subject to marine exploitation. Smolt-to-adult survival back to the river in 1992 for Northeast Brook, Trepassey (SFA 9) and Conne River (SFA 11) was lower than for pre-salmon moratorium years (O'Connell et al. 1993), suggesting that heavy natural mortality occurred at sea. Environmantal conditions at sea in the spring and early summer of 1991 were the worst on record (Narayanan et al. 1993) which suggests that severe mortality could have occurred at the smolt/post-smolt stage.

Most of the fish classified as large salmon in Gander River are repeat (successive) spawning grilse. The count of large salmon at Salmon Brook in 1992 was the highest on record. This was most likely the result of the cessation of marine exploitation.

The average proportion of total recreational catch in Gander River represented by the number of retained fish up to the time the quota was reached in SFA 4 for the period 1984-91 was 0.46. Had angling occurred for the entire season as in previous years, the spawning escapement in 1992 could have been diminished accordingly.

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.

For Gander River, calculations of smolt production and target spawning requirement assume that 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 grilse (data for years 1975–87 combined) from Gander River and for female large salmon from Gander River and Terra Nova River (separately and combined).

Year	Length of females				Weight of females (kg)				River age				Sex ratio	
	N	$\bar{X}$	SD	Range	N	$\bar{X}$	SD	Range	N	$\bar{X}$	SD	Range	N	% Female
Grilse														
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	1,217	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 and 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 grilse and large salmon at Salmon Brook fishway, 1974-91.

Year	Grilse	Large salmon
1974	857	9
1975		
1976		
1977		
1978	755	52
1979	404[1]	6[1]
1980	997	15
1981	2,459	33
1982	1,425	18
1983	978	12
1984	1,081	38
1985	1,663	26
1986	1,064	12
1987	493[1]	9[1]
1988	1,562	24
1989	596	24
1990	328[1]	7[1]
1991	245	2
1992	1,168	101

[1]Partial count: not included in mean.

1984-89		
Mean	1,193.2	24.8
95% LCL	658.3	13.4
UCL	1,728.1	36.2
N	5	5
1986-91		
Mean	866.7	15.5
95% LCL	-43.7	-1.4
UCL	1,777.1	32.4
N	4	4

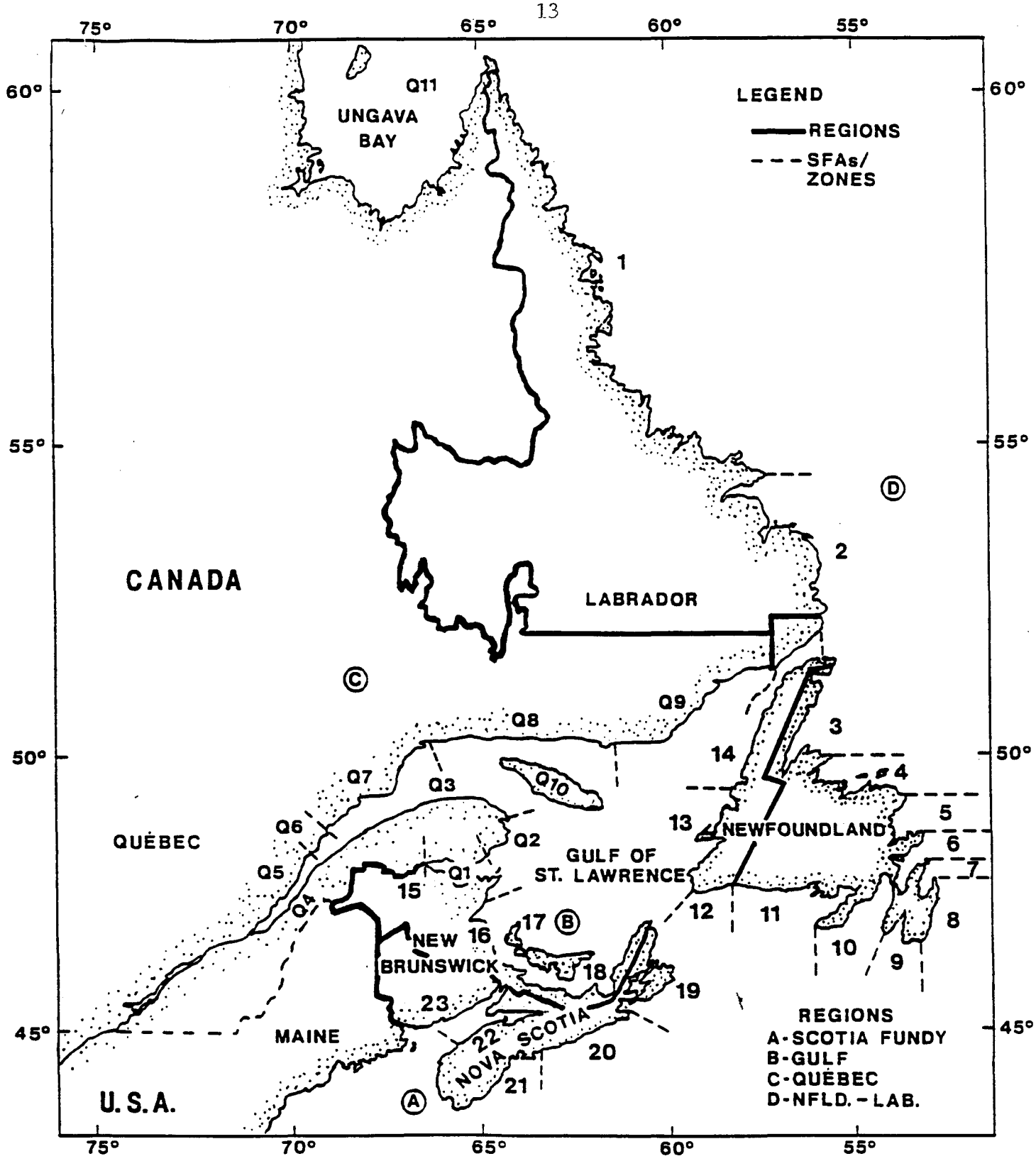

Fig. 1. Map of Atlantic Provinces of Canada showing Salmon Fishing Areas (SFAs) 1-23, Salmon Management Zones of Quebec (Qs) 1-11, and regional boundaries. The Newfoundland Region is comprised of SFAs 1-11.

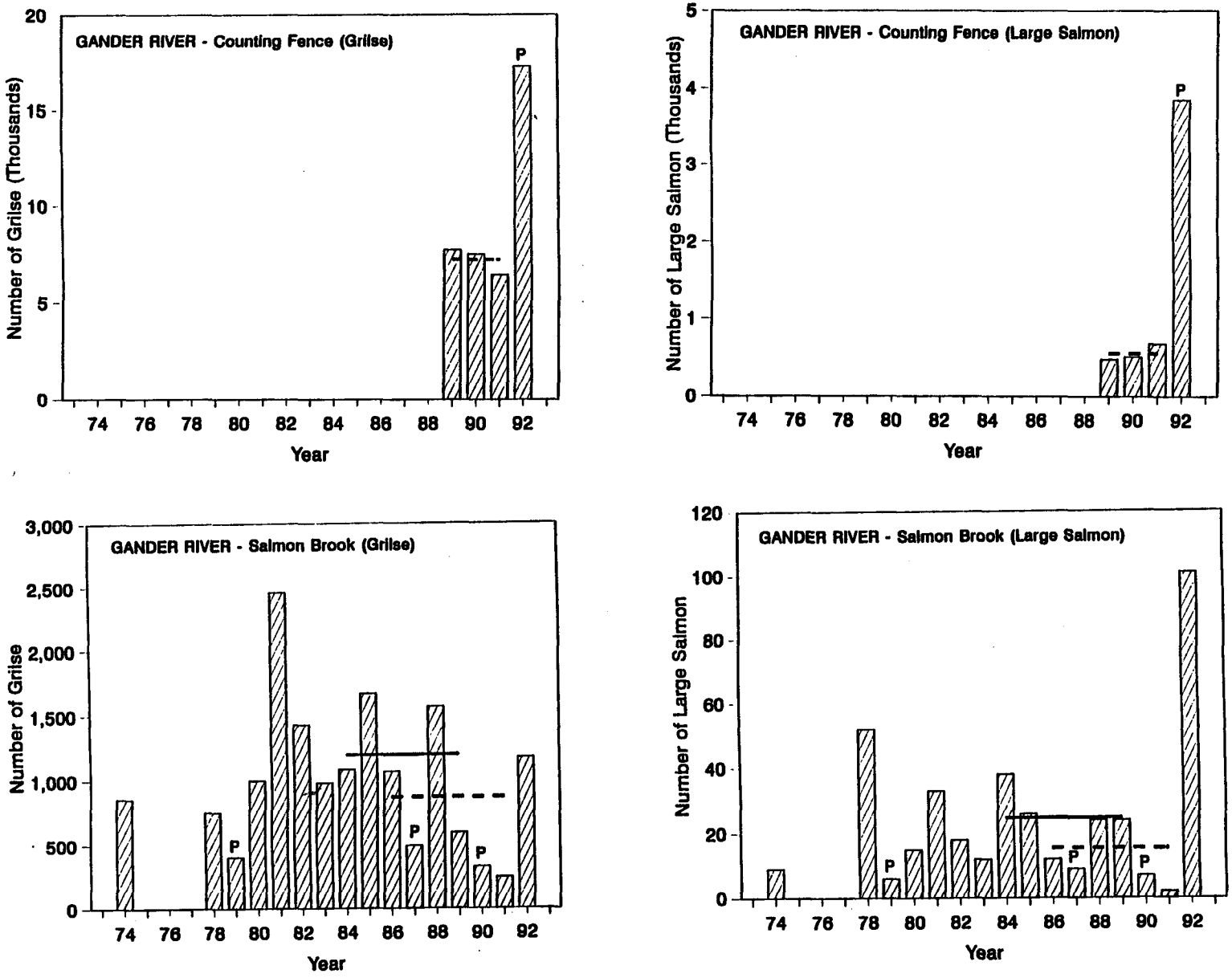

Fig. 2. Counts of grilse and large salmon at the Gander River counting fence and at the fishway located on the Salmon Brook tributary,1974-92. The solid horizontal line represents the 1984-89 mean and the broken line the 1986-91 mean. P = partial count.

Appendix 1. Atlantic salmon recreational fishery catch and effort data for Gander River, Notre Dame Bay (SFA 4), Newfoundland, 1953-1992.

RIVER: GANDER RIVER CODE: 09086100

YEAR	EFFORT ROD DAYS	GRILSE <63 CM	SALMON ≥63 CM	TOTAL CATCH	CPUE	PERCENT GRILSE
1953	2430	976	382	1358	0.56	.
1954	1831	370	207	577	0.32	83
1955	1010	738	206	944	0.93	64
1956	2250	1647	303	1950	0.87	71
1957	2815	2374	473	2847	1.01	78
1958	2751	1950	417	2367	0.86	85
1959	2391	2273	409	2682	1.12	83
1960	2466	1785	368	2153	0.87	86
1961	1794	1035	107	1142	0.64	94
1962	2042	1847	345	2192	1.07	75
1963	1972	1044	167	1211	0.61	92
1964	2762	2731	436	3167	1.15	71
1965	2310	1171	253	1424	0.62	92
1966	2322	2034	127	2161	0.93	90
1967	2096	1348	32	1380	0.66	98
1968	1981	1130	64	1194	0.60	95
1969	2680	858	3	861	0.32	100
1970	2388	1308	3	1311	0.55	100
1971	2142	1048	33	1081	0.50	98
1972	3197	1267	3	1270	0.40	100
1973	3047	1837	0	1837	0.60	100
1974	5153	2270	19	2289	0.44	99
1975	6670	2976	38	3014	0.45	98
1976	6633	2374	132	2506	0.38	96
1977	6939	2269	927	3196	0.46	72
1978	8322	3332	389	3721	0.45	85
1979	7217	4199	318	4517	0.63	91
1980	6384	2664	268	2932	0.46	94
1981	10643	4578	249	4827	0.45	91
1982	8026	2176	205	2381	0.30	96
1983	6934	2033	239	2272	0.33	90
1984	7590	2028	13	2041	0.27	99
1985	10207	3358	*	3358	0.33	100
1986	9740	2361	*	2361	0.24	100
1987	6384	1444	*	1444	0.23	100
1988	7943	2686	*	2686	0.34	100
1989	6290	1173	*	1173	0.19	100
1990	7118	1155	*	1155	0.16	100
1991	5853	1180	*	1180	0.20	100
1992	4123	1268	*	1268	0.31	100
(AFTER QUOTA)		525	*	528		
MEANS, 95% CONFIDENCE LIMITS, N'S:						
84-89	8354.0	2321.2	13.0	2323.8	0.28	100
$\bar{X}\pm$95%CL	±1999.0	±1003.7	.	±1002.3	±0.07	±0.32
N	5	5	1	5	5	5
86-91	7388.8	1711.0	.	1711.0	0.23	100
$\bar{X}\pm$95%CL	±1911.0	±932.0	.	±932.0	±0.09	±0.00
N	5	5	.	5	5	5

1987 DATA NOT INCLUDED IN MEAN.
PERCENT GRILSE IS CALCULATED BY SMOLT CLASS.
IN THE ABOVE TABLE A PERIOD INDICATES NO DATA FOR THAT YEAR.
* NOT ALLOWED TO RETAIN LARGE SALMON IN INSULAR NEWFOUNDLAND.