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Status of Atlantic Salmon (*Salmo salar* L.) in Gander River, Notre Dame Bay (SFA 4), Newfoundland, 1994

by

M. F. O'Connell, D. G. Reddin, and E.G.M. Ash
Science Branch
Department of Fisheries and Oceans
P.O. Box 5667
St. John's, Newfoundland, A1E 5X1

Abstract

The status of Atlantic salmon in Gander River in 1994 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 third year in 1994. The proportion of target egg deposition requirement achieved in 1994 was 89%, which compares to 111% in 1992, 136% in 1993, and 33-36% for the period 1989-91. Numbers of small salmon spawning during 1989-91 were the lowest recorded since 1974. There was a significant decline in estimated total population sizes of small salmon during the period 1974-94. With the exception of 1993, recruitment during 1989-94 was the lowest in the time series. Anticipated returns of small salmon in 1995 will be below target requirement, without a recreational fishery. For the period July 8 - August 16, 1994, of the small and large salmon sampled, 16.1% and 10%, respectively, possessed net marks.

Résumé

On a évalué l'état des stocks de saumon de l'Atlantique de la rivière Gander en 1994 en se fondant sur les 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, dont c'était la troisième année d'existence en 1994. La proportion de la ponte-cible atteinte en 1994 était de 89 %, comparativement à des taux de 111 % en 1992, de 136 % en 1993 et de 33 à 36 % pour la période 1989-1991. Le nombre de petits saumons frayeurs de 1989 à 1991 était le plus bas enregistré depuis 1974. L'effectif total de la population de petits saumons au cours de la période 1974-1994 a connu un recul important. Sauf en ce qui concerne 1993, le recrutement de 1989 à 1994 a été le plus bas de la série chronologique. On s'attend à ce que les montaisons de petits saumons en 1995 soient inférieurs à la cible, sans pêche sportive. Du 8 juillet au 16 août 1994, 16,1 % et 10 % respectivement des petits et des grands saumons échantillonnés portaient des marques de filet.

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 MS 1992) showed that for the period 1989-91, Gander River received only 33-36% of target spawning requirement.

In this paper we examine the status of Atlantic salmon in Gander River in 1994, the third year of the commercial fishery moratorium. 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. An analysis of trends in the numbers of small salmon recruits and spawners for 1974-94 is provided as well as anticipated adult returns in 1995.

Management Measures

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, in 1992 and 1993, 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. Only hook-and-release fishing was permitted after the quota was caught.

In 1994, recreational fishery quotas were eliminated. In place of quotas, for insular Newfoundland, the season bag limit for retained small salmon was lowered from eight to six fish, three to be caught prior to July 31 and three after that date. After the bag limit of three was reached in each time period, hook-and-release fishing only was permitted. As in previous years, retention of large salmon was not permitted in insular Newfoundland.

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), information used in the calculation of egg deposition was as follows:

Year	Weight (kg)			Proportion Female (N)
	Mean	SD	N	
Prior to 1992	1.63	0.37	1217	0.78 (1217)
1992	1.79	0.43	86	0.60 (86)
1993	1.86	0.39	71	0.70 (75)
1994	1.85	0.51	104	0.72 (104)

For fish ≥ 63 cm in length (large salmon), mean values for all available data for Gander River and Terra Nova River combined were used (female mean weight = 3.41 kg, SD = 1.41, N = 16; proportion of female = 0.88, N = 16).

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:

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

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 4.8% and 7.5% respectively of the total counts. The total counts of small and large salmon for 1992 were adjusted 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 MS 1992). A similar approach was used to adjust the counts of small and large salmon at the Salmon Brook fishway in 1990. In that year, counts were not obtained during the last two weeks of the run prior to cease of counting operations because of extremely low water conditions. The average proportion of small and large salmon counted at the fishway up to August 16 during the period 1984-91 (exclusive of 1987) was 95 and 90%, respectively.

Spawning Escapement

Spawning escapement (SE) was calculated as follows:

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

where,

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

Egg deposition

Egg deposition (ED) was calculated as follows:

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

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 (MS 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.* MS 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.

NUMBER OF RECRUITS AND SPAWNERS, 1974-94, AND ANTICIPATED RETURNS IN 1995

It is possible to retrospectively estimate total population size of small salmon (or total number of small salmon recruits), prior to any exploitation, in rivers with counting facilities and to use the ratio of recruits to spawners to estimate anticipated returns one year in advance. A calculation of anticipated total returns (small plus large salmon) is also possible. Details of the calculations are presented below.

Since the implementation of the commercial fishery moratorium in 1992, the total number of small salmon recruits (TNR) for Gander River was equivalent to TRR (equation 1). Prior to 1992, TNR was calculated using a commercial fishery exploitation rate (μ_c) of 0.60 (Anon. MS 1990) according to the equation

$$TNR = TRR/(1 - \mu_c) \quad (4)$$

For the period 1974-88, i.e., prior to the counting fence, TRR was calculated as the ratio of total recreational catch (RC_t) and the average recreational fishery exploitation rate (μ_r) for the period 1989-91 (prior to recreational quotas) of 0.158, or

$$TRR = RC_t/\mu_r \quad (5)$$

Age composition of Gander River smolts (data for all years combined N = 1543) was adjusted to reflect only the 3+ and 4+ age groups, i.e., the minimal numbers of 2+ and 5+ year old smolts present were not considered; the resultant proportions of 3+ and 4+ smolts were 0.37 and 0.63, respectively. The ratio of recruits to spawners (R/S) was calculated incorporating smolt age composition of small salmon according to the equation

$$R/S = [(TNR_{i+5} \times 0.37) + (TNR_{i+6} \times 0.63)]/SE_i \quad (6)$$

where,

TNR_{i+5} and TNR_{i+6} = small salmon recruits in years i+5 and i+6
SE_i = spawning escapement (small salmon) in year i

Anticipated returns of small salmon (AR_s) in 1995 was calculated as the product of the average R/S and SE for each smolt-age grouping separately and then summed. For small salmon with a smolt age of 3+ years, the average R/S for 1992-94 was used while for 4+ the average was for 1991-93. The equation to derive AR_s was as follows:

$$AR_s = (R/S\_3+_i \times SE_{i-5}) + (R/S\_4+_i \times SE_{i-6}) \quad (7)$$

where,

R/S_3+_i and R/S_4+_i = number of small salmon recruits per spawner with smolt ages 3+ and and 4+ in 1995 (year i)
SE_{i-5} and SE_{i-6} = spawning escapement (small salmon) in years i-5 and i-6

A similar calculation was performed with the minimum and maximum R/S corresponding to the mean for each smolt-age grouping to obtain an estimate of the range of anticipated returns.

Total anticipated returns (AR_t), or the sum of small and large salmon, was determined as follows:

$$AR_t = AR_s/P\_AR_s \quad (8)$$

where,

P_AR_s = mean proportion of small salmon in escapements for 1992-94

A measure of the precision of estimates of anticipated returns of small salmon was obtained by applying the average R/S for each smolt age group (from equation 7) to the appropriate spawning year, summing, and comparing the results to actual returns for 1992, 1993, and 1994.

ANALYSIS TO DETECT RECRUITMENT OVERFISHING

Anon. (MS 1994) defined recruitment overfishing as a level of fishing mortality that reduces the ability of a population to persist, more specifically, the failure of a cohort of spawners to replace itself as a result of fishing. One way to evaluate Atlantic salmon stocks in terms of recruitment overfishing is through the examination of spawner-to-spawner relationships. Estimated numbers of spawners obtained from parental cohorts of small salmon were traced backward, beginning with the estimate of the number of spawners for the current year. Data sets were examined to see if numbers of spawners, which were made up of a range of chronological ages, were sufficient to replace the weighted sum of spawning parents of the same sea age. The appropriate weighting for historical spawners was determined from the average smolt-age distribution. This technique, demonstrating the use of the necessary lags and river-age distributions, is found in Anon. (MS 1994).

NET MARKS

Over the period July 8 - August 16, small and large salmon enumerated at the adult trap installed in the counting fence were examined for net marks. This trap accounted for approximately 14-20% of the total number of adults counted in 1992-94; the remainder were counted through the gate passage in the fence. Therefore, trap results were used as an index of net scarring.

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 1994 (retained plus released fish), effort, and catch per unit of effort (CPUE) are compared to years prior to 1992, 1992 and 1993. In 1992, there was no estimate of released fish during the period of retention of catch and hence comparisons with 1994 are open to question. The

total number of fish retained in 1994 is also shown. Comparison of 1994 retained catch and effort with 1992 and 1993 provides an indication of the effectiveness of the elimination of quotas in 1994 on maintaining catch and effort at 1992 and 1993 levels. 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 1994 decreased from 1993 (20%), effort increased (24%), and CPUE decreased (38%). CPUE in 1994 was identical to the mean for 1986-91 but lower than the mean for 1984-89 (18%). The number of small salmon retained in 1994 increased by 67% over 1992 and 1993, was only 9% below the 1984-89 mean, and increased over the 1986-91 mean (24%).

Counts at Counting Fence and Fishway

In 1993, the counting fence on the main stem of the Gander River operated from June 22 to September 5. Counts for the period 1989-94 were as follows (see also Fig. 2):

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	18,179[1]	4,162[1]	18.6[1]
1993	25,905	1,734	6.2
1994	18,080	1,072	5.6

[1]Adjusted count (see text)

The count of small salmon in 1994 decreased by 30% from 1993 and was similar to that of 1992, the first year of the commercial fishery moratorium. The count of large salmon declined by 38% from 1993 and was the lowest of the moratorium years. The proportion of large salmon in 1994 decreased from 1993 (10%) and remained similar 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 1974-94 are shown in Table 1 and Fig. 2. The count of small salmon in 1994 decreased from 1993 (38%) as did that of large salmon (5%). The count of small salmon decreased from the 1984-89 mean (11%) but increased over the 1986-91 mean (34%); counts of large salmon increased over both means (274 and 530%, respectively). The proportion of large salmon for Salmon Brook in 1994 was 8% which compares to 8% in 1992 and 5% in 1993; the 1984-89 and 1986-91 means were and 2.0 and 1.8%, respectively.

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

Total river returns, spawning escapements, and potential egg depositions for small and large salmon for Gander River in 1989-94 are presented in Table 2. In terms of eggs, there was a deficiet to spawning requirement in 1994 (-11%). The relative contribution of large salmon to total egg deposition in 1994 was 13%, which was similar to 1993 (14%), but represented a substantial decline from 40% observed in 1992 and was also below the average for 1989-91 (17%). In contrast to 1993, target spawning requirement in terms of small salmon was not met in 1992 (-17%) and 1994 (-16%).

Trends in Total Numbers of Recruits and Spawners

The outcome of calculations of estimated total numbers small salmon recruits, numbers of spawners, and ratios of recruits to spawners are shown in Table 3. Since 1974, there was a significant decline ($r^2 = 0.39$; df = 19; $P < 0.01$) in the total number of small salmon recruits for Gander River (Fig. 3). Except for 1993, the lowest recruitment for the entire time series was encountered during the period 1989-94. There was no identifiable trend in numbers of small salmon spawners (Fig. 4). Expressing target spawning requirement in terms of small salmon adults (horizontal line in Fig.4), it is evident that target was achieved in 1979, 1981, and 1992. Numbers of spawners in 1992-94 compare well with higher values in the past, particularly the late 1970s and early 1980s, and represent a substantial improvement over the lows observed for 1989-91. The ratio of total number of small salmon recruits to spawners (Fig. 5) showed a significant decline ($r^2 = 0.40$; df = 13; $P < 0.01$). The number of small salmon recruits and corresponding number of spawners for each year-class are shown in Fig. 6. There was a lot of variability in recruitment from a given spawning escapement.

Anticipated Returns in 1995

The estimated number of small salmon recruits anticipated for 1995, based on the average R/S for each smolt-age groupings and should natural survival rates remain the same, is approximately 14,000; corresponding low and high values are approximately 9,700 and 21,000, respectively (Table 3 and Fig. 3). Assuming no recreational fishery, spawning escapement in 1995 is equivalent to the number of recruits, and as shown in Fig. 4, the average anticipated returns is below the target requirement for small salmon; the high anticipated is just below target. An idea of the precision of these estimates for small salmon is shown in Table 3 (mean difference between estimated and observed for 1992-94 was -14%). The variability described in Fig. 6 must be kept in mind with respect to estimates of anticipated returns.

Recruit Overfishing

During the commercial fishery moratorium years 1992-94, estimated numbers of small salmon spawners in Gander River were above the replacement (diagonal) line (Fig. 7) but remained below target requirement in 1992 and 1994. The three years immediately preceeding the moratorium, 1989-91, were well below the replacement line and target requirement.

Net Marks

A total of 223 small salmon was examined. Of these, 36 (16.1%) bore net marks. Also, 10 large salmon were examined and of these, 1 (10%) had net scarring.

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.* MS 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 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 1994.

In 1992, the first year of the commercial fishery moratorium, workers at the counting fence and those involved in sampling recreational catches, observed very few net-marked fish. In 1993, the incidence of net marks appeared to increase. This led to an attempt to quantify the incidence of net marks in 1994. The results are indicative of a significant illegal fishery and by-catch in the marine environment and possibly the lower river below the counting fence (illegal removals). Adult returns to the river were diminished accordingly.

Compared to the late 1970s and early 1980s, since 1989, the total population size of Gander River small salmon has been quite low. Had there been a commercial fishery in 1992-94, total river returns and spawning escapements would probably have continued at the low level indicative of the period 1989-91. Anticipated returns of small salmon (based on the mean R/S) in 1995, without a recreational fishery, are below target. Target egg deposition will not be met even if the contribution of large salmon (Table 3, large = total - small) is included. Because spawning escapement in 1990 and 1991 was similar to that of 1989, it is possible that returns in 1996 and 1997 will also be below target. Increased returns arising from increased spawning escapements due to the closure of the commercial fishery in 1992, are not expected until 1997 or 1998 (depending on the strength of the 3+ smolt component). The above analysis was based on fixed parameter values (smolt-age composition and commercial and recreational fishery exploitation rates) and assumes constant natural survival rates both in freshwater and in the sea. The use of constants in the prediction of adult returns entails risk since parameters are most likely subject to annual variability. For instance, smolt-adult survival has been shown to be variable in Northeast Brook, Trepassey (SFA 9) and Conne River (SFA 11) (O'Connell *et al.* MS 1995). Corroborative support for the above predictions, rooted in

an index of smolt production from the Northwest Gander River tributary, is provided by Ryan *et al.* (MS 1995).

In 1992 and 1993, quotas constrained the retention of small salmon in the recreational fishery to around 1,200 each year. By comparison, in 1994, the number of small salmon retained increased to 2123, in spite of the decrease in total returns. The angling exploitation rate in 1994 was 0.116 compared to 0.070 and 0.049 in 1992 and 1993, respectively. This was most likely a function of the removal of the quota.

Cautions associated with the parameter values used to calculate the target spawning requirement have been discussed previously by O'Connell *et al.* (MS 1991) and O'Connell and Dempson (MS 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 (MS 1991). There is evidence that egg-to-smolt survival could be substantially lower than used in the model (O'Connell *et al.* MS 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. Counts of small and large salmon at Salmon Brook fishway, 1974-94. Partial counts are in parentheses and are not included in means. Adjusted counts are bold and in italics.

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	***345***	***8***
1991	245	2
1992	1168	101
1993	1560	87
1994	963	83
1984-89		
Mean	1076.5	22.2
95% LCL	572.9	11.2
95% UCL	1580.1	33.2
N	6	6
1986-91		
Mean	717.5	13.2
95% LCL	190.5	3.7
95% UCL	1244.5	22.6
N	6	6

Table 2. Total river returns, spawning escapements, and potential egg deposition for small and large salmon for Gander River in 1989-94.

Year	Total returns (No.)		Spawning escapement (No.)		Egg deposition (No. x 10^6)		% of Target (eggs)
	Small	Large	Small	Large	Small	Large	
1989	7,743	473	6,570	473	13.909	2.363	35
1990	7,740	508	6,585	508	13.940	2.538	36
1991	6,745	670	5,565	670	11.781	3.347	33
1992	18,179	4,180	17,143	4,180	30.652	20.883	112
1993	26,205	1,734	24,934	1,734	54.057	8.663	136
1994	18,273	1,072	16,151	1,072	35.836	5.356	89

Table 3. Data used to estimate total recruits and anticipated returns in 1995 for Gander River.
Smolt age distribution is 37% 3+ & 63% 4+. Recruit years are in brackets (3+ & 4+).

Spawning Year i	Total river escapement i	Total recruits i	Spawning escapement i	Recruits 3+ i+5	4+ i+6	Total 3+4	No. of recruits per spawner 3+ i+5	4+ i+6	Total ratio	R/S ratio Return yr
74 (79 & 80)	14367	35918	12100	24583	26556	51139	2.0317	2.1947	4.2264	3.1779
	18835	47088	15863	15596	45636	61232	0.9832	2.8769	3.8601	4.9949
76 (81 & 82)	15025	37563	12654	26802	21691	48493	2.1180	1.7141	3.8322	2.7674
	14361	35903	12095	12739	20266	33005	1.0533	1.6756	2.7288	2.3457
78 (83 & 84)	21089	52723	17761	11902	20215	32117	0.6701	1.1382	1.8083	1.6686
	26576	66440	22382	11872	33473	45346	0.5304	1.4955	2.0260	2.8799
80 (85 & 86)	16861	42153	14200	19659	23535	43194	1.3844	1.6574	3.0418	2.2238
	28975	72438	24403	13822	14394	28216	0.5664	0.5898	1.1563	1.3187
82 (87 & 88)	13772	34430	11599	8454	26775	35229	0.7288	2.3084	3.0373	3.7595
	12867	32168	10837	15725	12195	27920	1.4511	1.1254	2.5765	1.7880
84 (89 & 90)	12835	32088	10810	7162	12191	19353	0.6626	1.1277	1.7903	1.5277
	21253	53133	17899	7160	10623	17783	0.4000	0.5935	0.9935	1.0893
86 (91 & 92)	14943	37358	12585	6239	11453	17692	0.4958	0.9100	1.4058	1.7839
	9139	22848	7697	6726	16509	23235	0.8739	2.1449	3.0188	2.8221
88 (93 & 94)	17000	42500	14317	9696	11512	21208	0.6772	0.8041	1.4813	1.8331
	7743	19358	6570	6761			1.0291			
90 (95 & 96)	7740	19350	6585							
	6745	16863	5565							
92 (97 & 98)	18179	18179	16911							
	26205	26205	24934							
94 (99 & 00)	18273	18273	16157							
96 (01 & 02)										
98 (03 & 04)										

Anticipated returns 95

S+L/S= 1.13

Moratorium	R/S ratios 3+	4+	Number of small 3+	4+	Total small	Total (S+L)
Mean	0.8601	1.2863	5663	8451	14115	15912
Hi	1.0291	2.1449	6776	14092	20869	23526
Low	0.6772	0.8041	4459	5283	9742	10983

Comparison of observed & expected in 92-94 (uses moratorium years only)

Year	R/S ratio 3+	4+	Number of small 3+	4+	Estimated small	Observed small	Difference (Obs-Est)	% Difference
92	0.8601	1.2863	6620	16189	22808	18179	-4629	-25
93	0.8601	1.2863	12314	9901	22215	26205	3990	15
94	0.8601	1.2863	5651	18417	24068	18273	-5795	-32
							Mean diff	-14

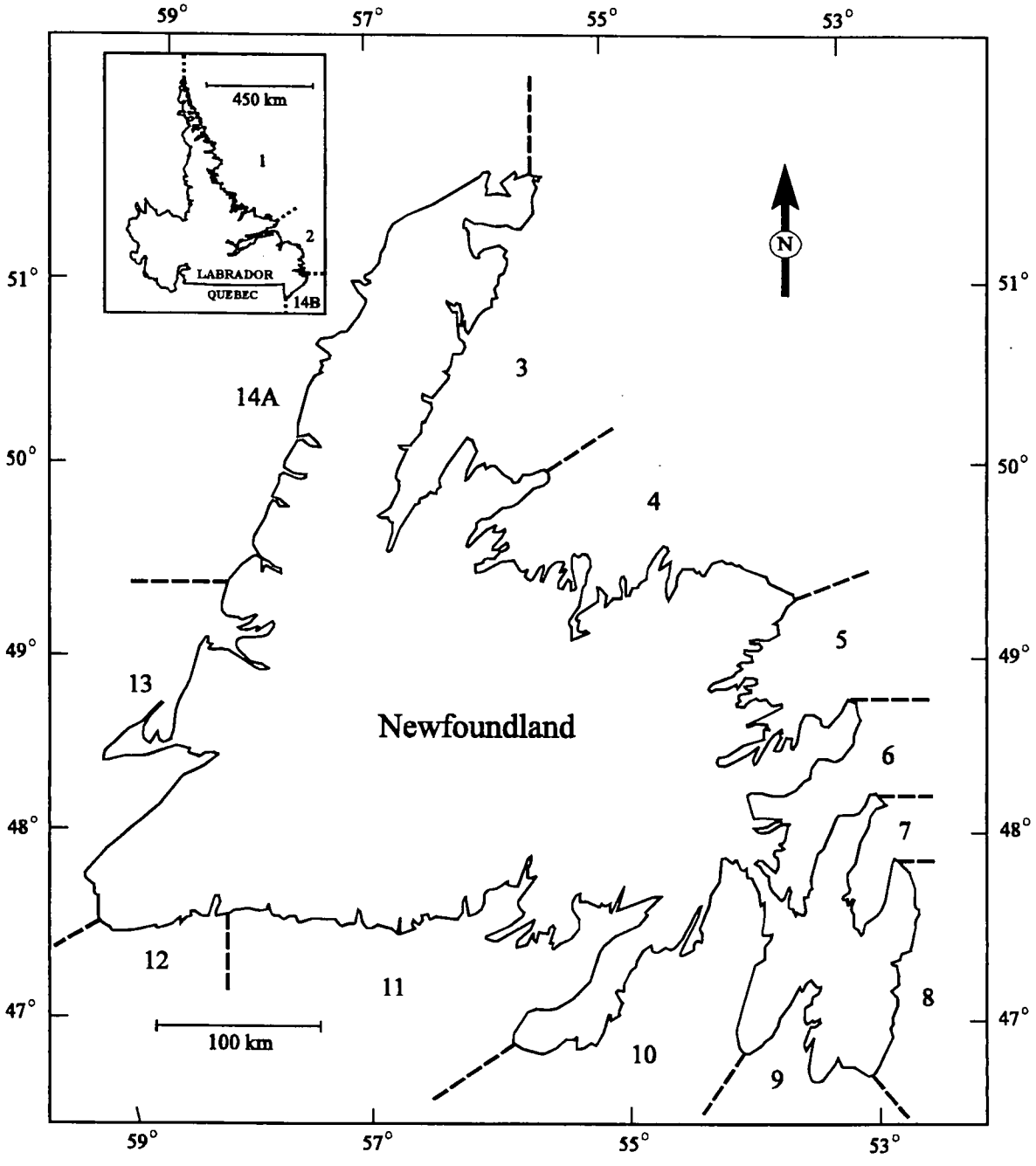

Fig. 1. Map showing the 14 Salmon Fishing Areas of the Newfoundland Region.

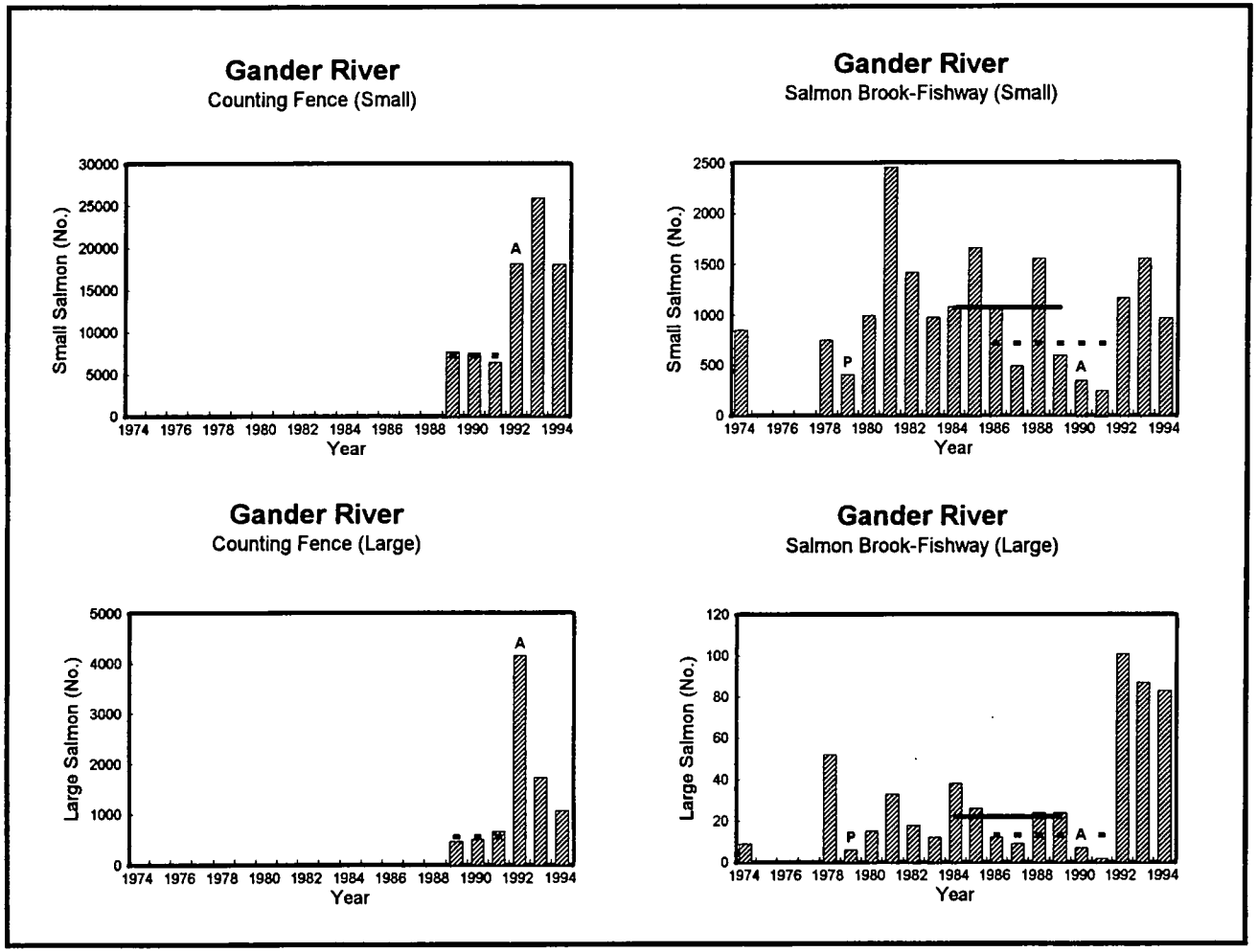

Fig. 2. Counts of small and large salmon at the Gander River counting fence and at the fishway located on the Salmon Brook tributary, 1974-94. The solid horizontal line represents the 1984-89 mean and the broken line the 1986-91 mean. A = adjusted count; P = partial count, not included in the means.

Total number of small salmon recruits for Gander River

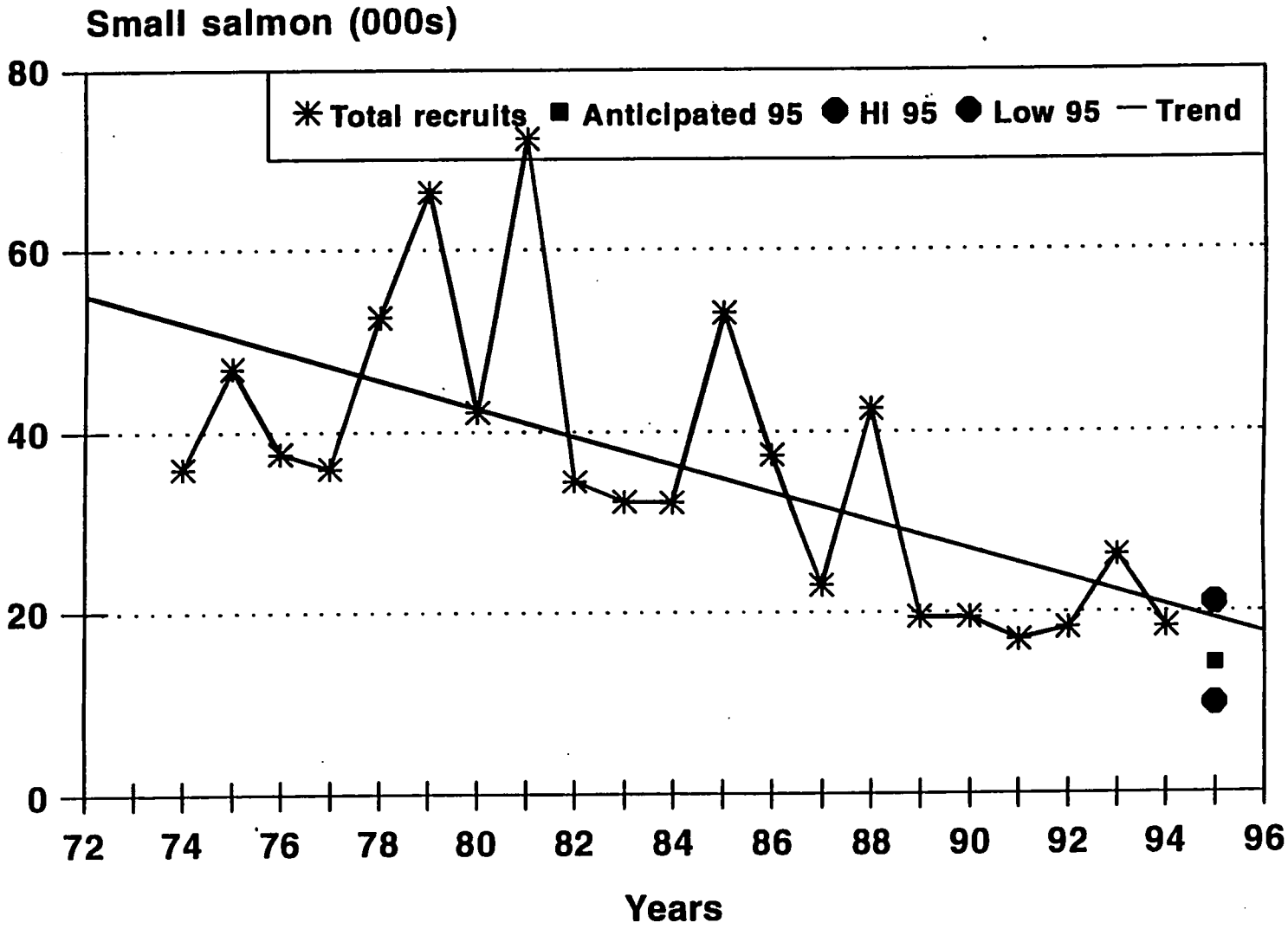

Fig. 3. The total number of small salmon recruits for Gander River, 1974-94, and anticipated returns for 1995.

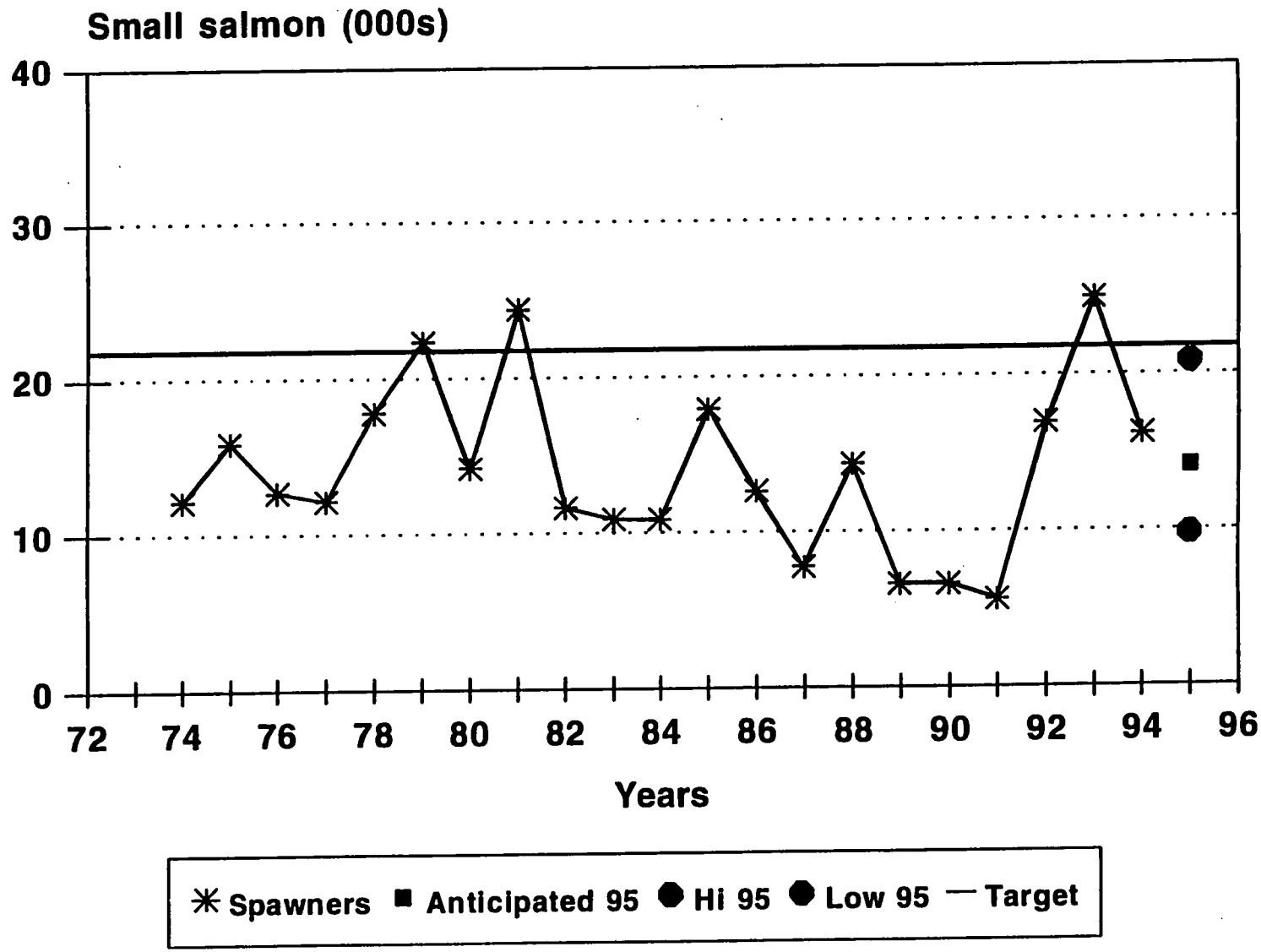

Fig. 4. The number of small salmon spawners in Gander River for the period 1974-94, anticipated spawners for 1995, and target number of small salmon spawners.

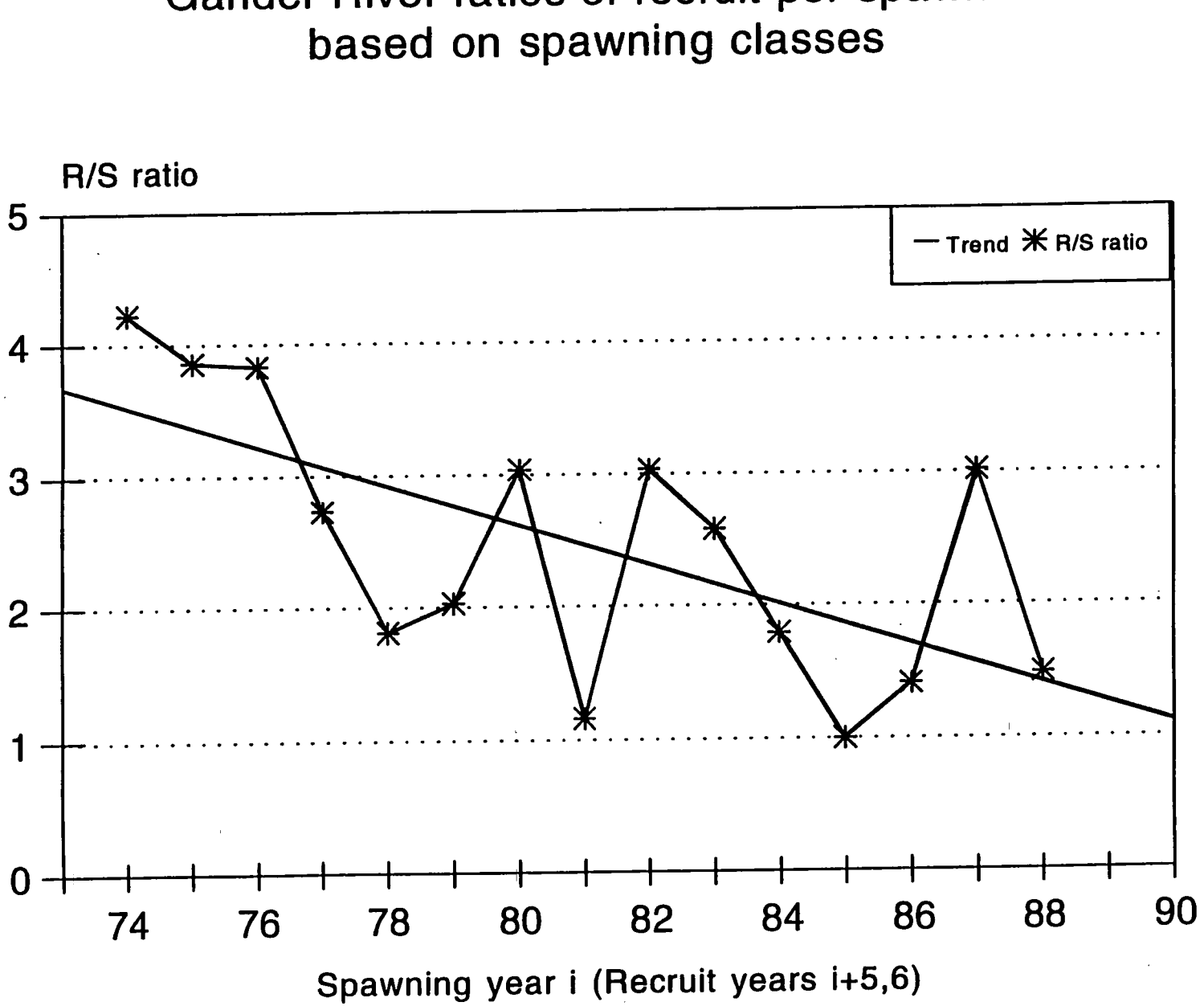

Fig. 5. The ratio of number of recruits (years 1+5, 6) to number of spawners (year i) for Gander River for spawner years 1974-88.

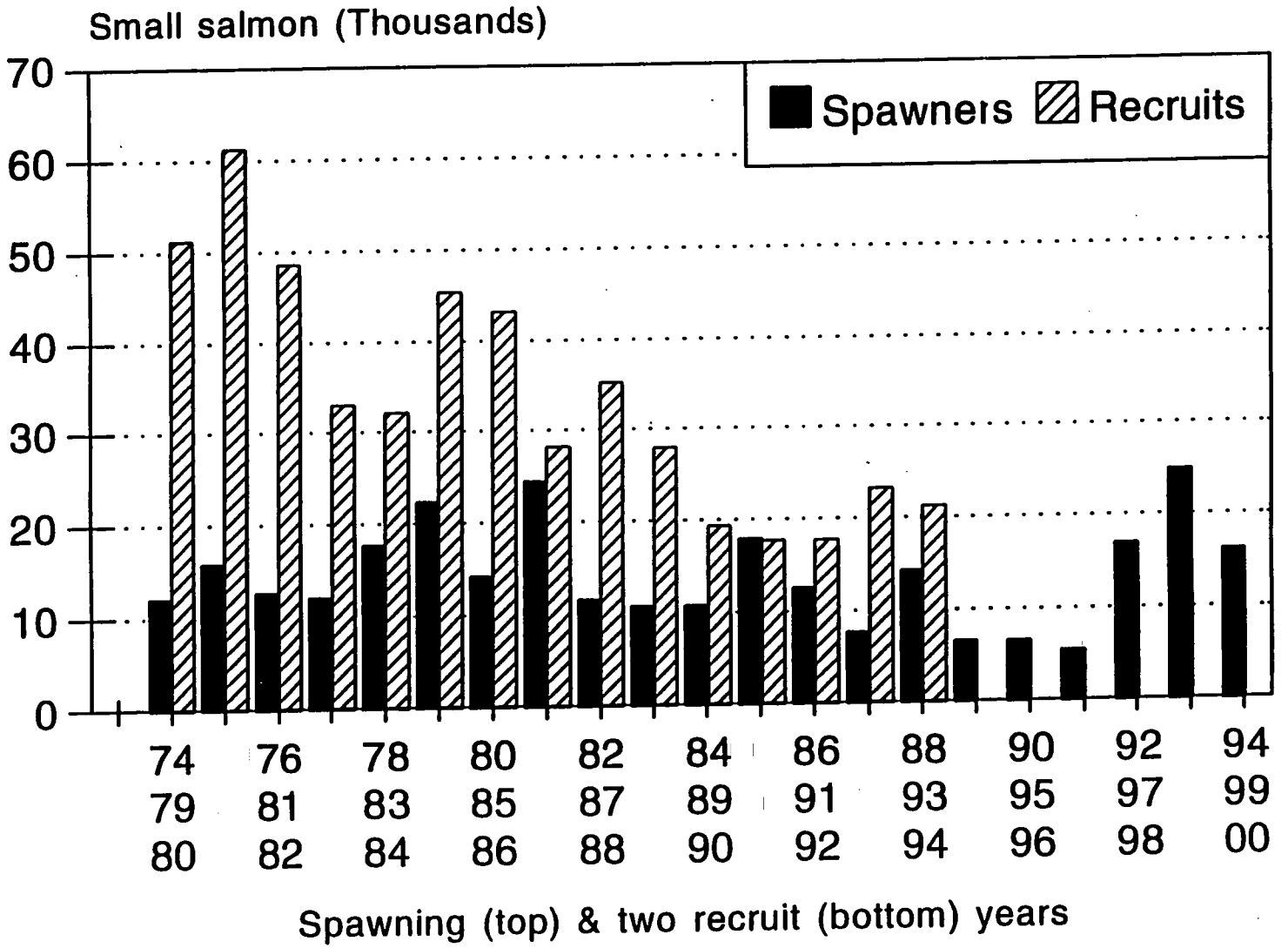

Fig. 6. Number of spawners and recruits (lagged and totalled according to smolt age) for Gander River.

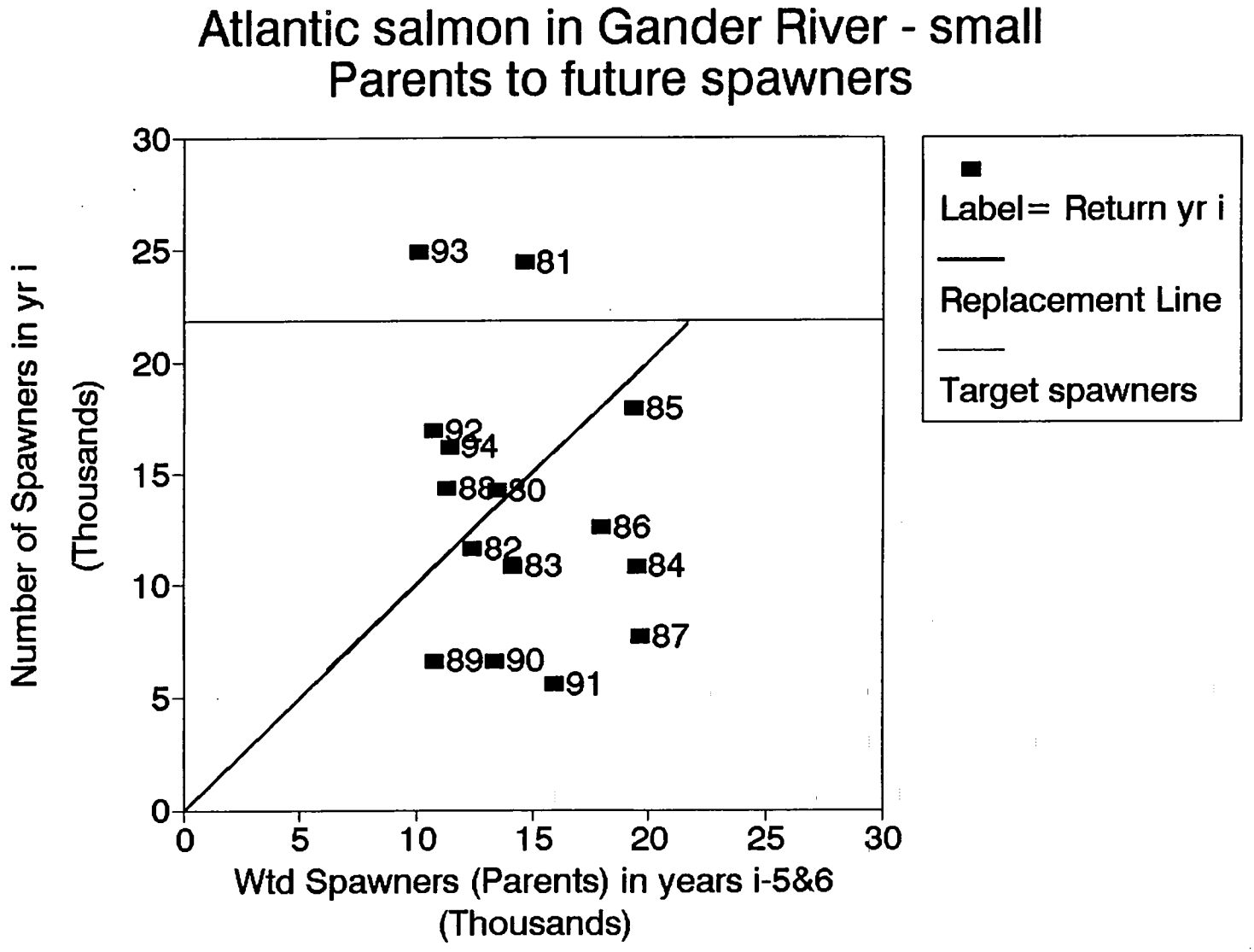

Fig. 7. The relationship between parents and spawners (after exploitation), the replacement line (diagonal), and target spawning requirement for Gander River, 1980-94..

Appendix 1. Atlantic salmon recreational fishery catch and effort data for Gander River, Notre Dame Bay (SFA 4), 1974-1994. Ret. = retained fish; Rel. = released fish.

	Effort	Small (<63 cm)			Large (>= 63 cm)			Total (Small + Large)			
Year	Rod Days	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	Ret.	Rel.	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	*	3	3	1268	528	1796	0.29
1993	9073	1271	1950	3221	*	92	92	1271	2042	3313	0.37
1994	11287	2122	448	2570	*	39	39	2122	487	2609	0.23
Means, 95% Confidence Limits, N's:											
84-89 $\bar{X}$	8354	2321	.	2321	.	.	.	2324	.	2324	0.28
95% CL	1999	1004	.	1004	.	.	.	1002	.	1002	0.07
N	5	5	0	5	0	0	0	5	0	5	5
86-91 $\bar{X}$	7389	1711	.	1711	.	.	.	1711	.	1711	0.23
95% CL	1911	932	.	932	.	.	.	932	.	932	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.