STATUS OF ATLANTIC SALMON IN THE MIRAMICHI RIVER DURING 1989

by

R.G. Randall, D.M. Moore and P.R. Pickard
Science Branch, Gulf Region
Department of Fisheries & Oceans
P.O. Box 5030
Moncton, New Brunswick, E1C 9B6

ABSTRACT

Total returns of Atlantic salmon to the Miramichi River in 1989, based on Millbank trap data, were 17,200 multi-sea-winter salmon (MSW) and 75,200 one-sea-winter salmon (1SW). Mark-recapture data in 1989 (tagging at Millbank and recaptures from anglers) indicated total returns that were about 20% higher than estimates of returns from Millbank trap data. Both estimates indicated that returns of 1SW and MSW salmon in 1989 were less than in 1988, when 21,700 MSW salmon and 121,900 1SW salmon were estimated to have returned to the river. Harvests of 1SW salmon by anglers and native fishermen were also less in 1989 (20,435) than in 1988 (31,564). Target egg deposition requirements were almost achieved in 1989 (94%), although a relatively large proportion of eggs came from 1SW salmon (28%). Target egg deposition levels have apparently been achieved or nearly achieved in the past 5 years in the Miramichi River, and electrofishing surveys indicate that average densities of juvenile salmon have apparently increased accordingly. Returns of 1SW and MSW salmon in 1990 are expected to be at least average.

RESUME

Les remontées totales de saumon de l'Atlantique dans la rivière Miramichi en 1989 auraient été de 17 200 redibermarins et de 75 200 unibermarins, selon les données relevées au piège de Millbank. Toutefois, d'après les expériences d'étiquetage-recapture réalisées (étiquetage à Millbank et recapture par les pêcheurs à la ligne), les remontées totales seraient supérieures d'environ 20 % à ces chiffres. Quoi qu'il en soit, les estimations des deux sources révèlent que les remontées d'unibermarins et de redibermarins de 1989 ont été inférieures à celles de 1988 (21 700 redibermarins et 121 900 unibermarins). Les prises d'unibermarins par les pêcheurs à la ligne et les autochtones ont également été plus basses en 1989 (20 435) que l'année précédente (31 564). La ponte a presque atteint l'objectif-cible en 1989 (94 %), quoique une part importante des oeufs (28 %) provenait de saumons unibermarins. Il apparaît d'ailleurs que la ponte-cible ait été atteinte ou presque atteinte au cours des cinq dernières années dans la rivière Miramichi, comme le confirme l'augmentation correspondante des densités moyennes de juvéniles constatée lors des relevés à la pêche électrique. En 1990, on s'attend à ce que les remontées d'unibermarins et de redibermarins soient au moins égales à la moyenne.

INTRODUCTION

During 1989, Atlantic salmon that returned to the Miramichi River, New Brunswick, were exploited by native fishermen in Miramichi Bay and upper tidal waters, and by anglers throughout all major tributaries. Regulations controlling the harvest of salmon were similar to regulations in 1988. Commercial fishing for salmon in Miramichi Bay and estuary was prohibited. Possession or sale of salmon caught in non-salmon gear (by-catch) was also prohibited. Anglers were allowed to keep only one-sea-winter salmon (1SW) (<63 cm in fork length), with season, possession and daily bag limits of 10,6 and 2 fish, respectively. Native fisheries at Burnt Church (Miramichi Bay), and Eel Ground and Red Bank (tidal waters of the Northwest Miramichi) were not restricted by quota.

The objective of this report is to evaluate the status of Atlantic salmon in the Miramichi River in 1989. Preliminary catch and effort data from the angling and native fisheries are summarized. Spawning escapement in 1989 is estimated using Millbank trap data, and mark-and recapture data from anglers.

METHODS

1. Angling catch, effort and harvests

Angling catches of 1SW salmon in the Miramichi River were provided monthly by DFO Fishery Officers. Catch and effort data were collected from angling camp log records, from Crown Reserve records, and from personal observations and interviews for public waters. Estimates of angling catches from public waters (Crown open water) are less accurate than estimates from camps and Crown Reserve areas. Angling data from the upper Southwest Miramichi River above Boiestown (York and Carleton counties) were not available. As in previous assessments, angling catches from these two counties were estimated from the average proportion of the total angling catch from these two counties from 1969 to 1983. Angling seasons in 1989 were the same as in 1988 for most Miramichi tributaries (Appendix I).

The New Brunswick Department of Natural Resources and Energy (DNRE) also estimate angling catches and total effort in the Miramichi River each year. DNRE estimates are based on a license stub reporting system, whereby a random proportion of anglers (30%) are asked to return records of their angling catch and the number of days spent fishing. Total angling catches are then estimated from the subsample of returns submitted. For the Miramichi River, DNRE estimates of angling data are judged to be more accurate than DFO estimates, and they have been used in past assessments to estimate angling harvests (Randall and Chadwick 1983). Unfortunately, DNRE estimates of angling catches in 1989 were not yet available. Therefore, DNRE angling catches were estimated from a significant correlation between DFO and DNRE estimates, 1969 to 1988 (Table 1).

The numbers of multi-sea-winter salmon (MSW) caught and released by anglers were estimated from the average MSW/1SW salmon ratio in the DNRE catch for the last five years (0.48, range 0.33 to 0.57) times the estimated catch of 1SW salmon in 1989. A reasonable estimate of the numbers MSW salmon caught and released in 1988 was obtained using this method (ratio estimate of 9449 versus a DNRE estimate of 10095). The numbers of MSW salmon caught and released by anglers were not used as an index of abundance in this assessment; they were used to estimate the numbers of salmon lost to catch and release mortality only.

2. Native harvests of salmon

Numbers of salmon landed by native fishermen at Burnt Church and Eel Ground were reported by the Band Councils on a daily basis to DFO Resource Allocation Section. For Red Bank, numbers of 1SW and MSW salmon harvested were estimated by DFO Conservation and Protection staff.

3. Biological sampling

Adult Atlantic salmon entering the Miramichi River during 1989 were monitored at the Millbank trap site (Fig. 1) from 15 May to 15 October. Most MSW (n=209) and at least 1 in 5 1SW salmon (n=287) captured at the trap were sampled: scales for aging, fork lengths (nearest 0.1 cm) and externally sexed after 1 September. Prior to 1 September, one in ten 1SW salmon were sacrificed for internal sexing; sacrificed fish were also weighed (nearest 0.1 kg). MSW salmon were identified as being male or female fish after 1 September on the basis of external characteristics. During the salmon run, a total of 833 1SW salmon and 206 MSW salmon were tagged (Carlin tags with stainless steel ties).

Adult salmon were also counted at several counting fences within the Miramichi watershed during 1989: Bartholomew River, Rocky Brook, and at headwaters of three tributaries, Dungarvon River, North Branch of the Main Southwest Miramichi, and the Northwest Miramichi (Fig. 1). Counts of salmon have been available for the Dungarvon and SW Miramichi barriers since 1981, and at Bartholomew River since 1977 (Bartholomew has been a major enhancement project on the Miramichi since 1977; Chadwick et al. 1985). Counts of salmon at the NW Miramichi barrier are available for only two years, and salmon were counted at Rocky Brook for the first time in 1989.

4. Recruitment

Electrofishing surveys were conducted at 15 headwater sites within the Miramichi watershed during late June and July of 1989. Densities of juvenile Atlantic salmon (age 0 and age 1 parr) were determined by the removal method (Zippin 1956). Densities of salmon have been estimated at the same 15 sites on the Miramichi River since 1970.

5. Spawning escapement in 1989

Two methods were used to estimate the numbers of 1SW and MSW salmon that spawned in the Miramichi during 1989:

Method 1. Millbank trap efficiency. For 1989, a trap catch efficiency of 0.015 (95% confidence limits: 0.012-0.20) was used. This trap catch efficiency was determined by mark-recapture data from 1SW salmon for the period 1985 to 1987 (Randall et al. 1989). Total returns to Millbank were determined by dividing the trap count by the catch efficiency. Spawning escapement was then estimated as returns to Millbank minus known removals of salmon above Millbank (harvests by native and recreational fishermen, losses to poaching and disease (PAD), broodstock removals, trap mortalities and sampling mortalities).

Method 2. Angling exploitation rate. Exploitation rate of salmon by anglers was estimated during 1989 from tag recaptures of fish tagged at Millbank trap. River returns of 1SW salmon was determined by dividing the angling catch by the exploitation rate. Spawning escapement was then determined as total returns minus known removals of fish above Millbank (as indicated above). The numbers of MSW salmon spawners were estimated by applying the proportion of MSW salmon at Millbank in 1989 (0.19) to the estimate of 1SW returns for 1989. Historically, the proportions of MSW salmon at Millbank were significantly correlated (R^2 = 0.91) with proportions of MSW salmon in the angling catches (Randall et al. 1989), suggesting that the proportion observed at Millbank is representative of the entire population.

Two adjustments were made to the number of tag recaptures before the angling exploitation rate was estimated. First, an estimate of the numbers of tags that will be returned late (i.e., after 1 November when this assessment was done) was made based on the proportion of late returns that were received during the 1988 tagging project. Second, a tag reporting rate by anglers was determined. Tagged to untagged ratios in the Miramichi system were determined accurately at four counting facilities and at five angling camps (Fig. 1). Reporting rate was then estimated as the difference between this tagging ratio and the tagging ratio from the angling fishery.

For both Methods 1 and 2, salmon mortalities from disease and poaching (PAD) were assumed to be 1,000 MSW salmon and 4,000 1SW salmon, as in previous assessments. Mortality rate attributed to the stress of catch and release of MSW salmon was assumed to be 0.03 (Currie 1985).

6. Egg deposition requirements

Total egg deposition requirements for the Miramichi River, assuming a required egg deposition rate of 2.4 eggs per square meter, are 132 million eggs (Randall 1985). Based on the average reproductive potential of Miramichi salmon, 23,600 MSW salmon are required to produce these egg requirements. An additional 22,600 1SW salmon are needed to ensure a 1:1 sex ratio at spawning. For 1989, the reproductive potential of Miramichi salmon was estimated from a length-fecundity relationship determined for Miramichi salmon (Randall 1989) and the

average fork lengths and sex ratios of salmon as determined from preliminary samples collected at Millbank. Total egg deposition in 1989 was calculated as the product between reproductive potential (eggs per spawner) and the estimated numbers of 1SW and MSW spawners.

7. Forecast of salmon returns in 1990

A new regression model was used to estimate the numbers of MSW salmon expected to return to the Miramichi River in 1990 (Randall and Chadwick 1990). MSW salmon (year i) were predicted from a multiple regression with two regressors: catch per unit effort for male 1SW salmon at Millbank trap in (year i-1; CPVG), and landings (metric tons) of small salmon at Labrador (Zone 2) in (year i-1). Catch per unit effort indices for both MSW salmon and 1SW salmon at Millbank were used because effort (i.e., the number of trap visits) has been variable from one year to the next at the trap. Landings at Labrador were used as a second independent variable in the regression model because they were positively correlated with negative residuals between expected and observed returns of MSW salmon for the years 1981, 1983 and 1987 (Randall and Chadwick 1990).

In addition to the above regression model, returns of MSW and 1SW salmon were predicted from previous five year averages. Indices of spawning escapement (densities of age 1 parr) in years that will contribute to 1SW and MSW salmon returns in 1990 were also considered.

RESULTS

1. Angling catch and effort data

The angling season for salmon kelts (post-spawning salmon) in the Miramichi River occurs from 15 April to 15 May each year. During 1989, effort during the kelt fishery increased from the 1988 season by 37% (Table 2). Total catches of kelts also increased from 4066 fish in 1988 to 5819 fish in 1989, an increase of 43%. Angling catch per unit of effort (CPUE) during the kelt fishery was high for both years (average of about 0.8 fish per rod day of fishing), particularly when the angling season first opened in April (Table 2). The numbers of 1SW kelts angled during 1989 reflected the greater than average abundance of 1SW salmon that returned to the Miramichi River in 1988 (Randall et al. 1989).

In contrast to the kelt fishery, both angling effort and catches of bright 1SW salmon decreased in 1989 from 1988, by 16% and 8% respectively. Total landings of 1SW salmon in 1989, as estimated by DFO fishery officers, was 12665 fish (Table 2). Angling catches were distributed over the months from June to October in about the same proportions as observed in 1988. CPUE during the bright angling season was about half of the CPUE during the kelt fishery. Angling camp managers reported that although many fish were observed in pools, angling quality was relatively poor during June and July, possibly because water levels were

lower than average (Fig. 2). Angling success increased later in the season, particularly in September (Table 2) when water temperatures decreased. Catches late in the season were apparently mainly early-run salmon, judging from the coloration of the fish (dark colour, indicating the fish had been in freshwater for an extended period of time).

As in previous assessments, the numbers of bright 1SW salmon landed by anglers as estimated by DFO officers were adjusted upwards using a correlation between DFO catches and DNRE catches, 1969 to 1988 (Table 1). The adjusted DNRE catch was 18170 1SW salmon, which was considerably below the 1988 DNRE catch of 30620 fish, but was about equal to the long term average (Table 1).

The numbers of MSW salmon caught and released by anglers were estimated to be about 8722 fish (Table 1).

2. Native harvests of salmon in 1989

Reported harvests of 1SW and MSW salmon by native fishermen at Red Bank, Eel Ground and Burnt Church are summarized in Table 3. Two estimates of landings were available from Red Bank; landings as reported from the Band Office, and field estimates from DFO fishery officers. Estimates of total catch from the fishery officers was considerably higher than the reported catch (Table 3). Officers enumerated the numbers of salmon being landed each day during 8 hour shifts (usually from 2000 h to 0400 h) from 19 June to 7 July. Numbers of fish landed during the latter part of July and August were estimated from periodic field observations of the fishery. Estimates by DFO officers of the total catch at Red Bank were judged to be conservative (F. Butler, pers. comm.), but a more realistic estimate of total harvest than the reported landings. Total harvests by all native fishermen in the Miramichi system were 1160 MSW salmon and 2265 1SW salmon (Table 3).

Total harvests of salmon in the Miramichi River in 1989 (native and angling fisheries) were estimated to be 1422 MSW salmon and 20435 1SW salmon (Table 4). Landings of Atlantic salmon in the Miramichi over the long term (1951 to 1989) are given in Table 5.

3. Counts of salmon at Millbank trap and at headwater protection barriers

During the early run (May to August), counts of both 1SW and MSW salmon at Millbank trap increased in 1989 from 1988 (Table 6). Counts of early-run 1SW salmon were about equal to the previous five year average, but counts of MSW salmon in 1989 were 18% below the previous five year average. In contrast, counts of late-run fish at Millbank were much lower in 1989 than in 1988 (Table 6 and Fig. 3). Only 18% of MSW salmon and 6% of 1SW salmon returned late in the season in 1989, compared to about 50% of the total returns in 1988 (Fig. 4). The proportion of early-run versus late-run salmon in the Miramichi River during 1989 was similar to the proportions observed each year since about 1978 (except 1988). Apparently there were few late-run salmon which entered the Miramichi River in 1989. For both early-run and late-run fish combined, total counts of 1SW salmon

in 1989 were 38% less than in 1988, while counts of MSW salmon were 21% less.

Reductions in the numbers of 1SW salmon from 1988 to 1989 were also evident at the Dungarvon and SW Miramichi barriers (Table 7 and Fig. 5). Counts of MSW salmon also decreased at the SW Miramichi barrier, but increased slightly at the Dungarvon barrier from 1988 to 1989. Counts of 1SW salmon and MSW salmon at both barriers were above the long term averages (1981 to 1988) (Table 7).

4. Biological sampling

During the 1989 salmon run, a total of 496 salmon (287 1SW salmon and 209 MSW salmon) were sampled for age composition and fork lengths, and subsamples of these were sexed (Table 8). The percent female salmon in the 1989 spawning run was 78.7% for MSW salmon and 22.0% for 1SW salmon. Based on the length-fecundity relationship for Miramichi salmon and the average fork lengths and sex ratios of salmon in 1989, reproductive potential (average eggs per spawner) was estimated to be 6068 eggs for MSW salmon and 699 eggs for 1SW salmon. Fewer of the 1SW salmon that returned in 1989 had smoltified at age 2 (30.4%) than in 1988 (54.7%) (Table 8). Age 1SW salmon that returned in 1989 were predominantly from the 1985 year class (year of fry emergence).

5. Recruitment

Mean densities of age 0 salmon parr decreased by 24% from 1988 to 1989, but they were above long term mean densities (Fig. 6). Densities of age 1 parr averaged 0.18 fish per square metre, which was the highest density recorded at the 15 Miramichi sites to date (Fig. 6). Note however that counts of salmon vary substantially from one site to the next, indicating that the distribution of age 0 and age 1 parr is highly contagious. The usefulness of juvenile salmon densities as an indication of spawning escapement in the Miramichi River is presently being investigated.

6. Spawning escapement in 1989

Spawning escapement in the Miramichi River in 1989 was estimated as returns to Millbank minus known removals of salmon above Millbank. In addition to the recorded harvests of salmon (Table 4), additional salmon mortalities which were subtracted from the total returns were:

	1SW	MSW
Broodstock	22	137
Trap mortalities	13	13
Samples	120	3
Total	155	153

Method 2 for estimating spawning escapement was based on mark-recapture data. During 1989, a total of 833 tags were applied to 1SW salmon at Millbank, which was 74% of the 1SW salmon captured (Table 9). For MSW salmon, 206 of 257 (80%) fish were tagged at Millbank.

To date (1 November 1989) a total of 76 tags have been returned by anglers. During the 1988 tagging program, 12% of the total tag returns from early-run salmon were returned after 1 November, and 22% of tag returns from late-run fish were returned after November (Table 10). Returns of tags in 1989 were therefore adjusted upwards based on these percentages (Table 9). The adjustment for potential late returns of tags increased the number of tags in 1989 to 86. Because few 1SW salmon returned to the Miramichi during the late-run in 1989 (Fig. 3), few tags were applied during this period and only one late-run salmon tag was returned.

Data used to estimate the reporting rate of tags by anglers in 1989 are summarized in Table 11. Tagged to untagged ratios at the four counting facilities and in angling catches at five index camps were similar, and indicated that about 1% of 1SW salmon were tagged. The ratio of tagged to untagged fish from the total angling fishery, however, indicated a much lower ratio. Reporting rate by anglers was calculated to be 0.5 (0.0047/0.0096; Table 11). The tagging ratio for MSW salmon at the four counting facilities was estimated to be 1.4% (Table 12).

Angling exploitation rate for 1SW salmon in 1989, assuming a tag reporting rate of 0.5, was estimated to be 0.21 (Table 13).

Spawning escapement as estimated by Methods 1 (Millbank trap efficiency of 0.015) and 2 (angling exploitation rate) are summarized below:

MSW salmon	Method 1	Method 2
1. Total returns	17211	20681
2. Harvest below Millbank	78	78
3. Returns to Millbank	17133	20603
4. Harvest above Millbank	1344	1344
5. PAD	1000	1000
6. Broodstock/trap mort.	153	153
7. Spawners	14636	18106
8. Required spawners	23600	23600
% achieved	62%	77%

1SW salmon	Method 1	Method 2
1. Total returns	75231	87863
2. Harvest below Millbank	31	31
3. Returns to Millbank	75200	87832
4. Harvest above Millbank	20404	20404
5. PAD	4000	4000
6. Broodstock/trap mort.	155	155
7. Spawners	50641	63273
8. Required spawners	22600	22600
% achieved	224%	280%
% egg deposition	94%	117%

[1] PAD is poaching and disease

Numbers of spawners as estimated by Method 1 and 2 (assuming a tag reporting rate of 0.5) were similar. Total returns were estimated to be 17,200 to 20,700 MSW salmon and 75,200 to 87,900 1SW salmon. Spawning escapements were estimated to range between 14,600 and 18,100 MSW salmon and between 50,600 and 63,300 1SW salmon. Given that the reproductive potential of 6068 eggs per MSW spawner and 699 eggs per 1SW spawner (Table 8), the above spawning escapements indicate total egg depositions ranging between 94% and 117% of the target egg depositions for the Miramichi River.

6. Egg deposition levels, 1970 to 1989

Returns and spawning escapements of 1SW and MSW salmon in the Miramichi River from 1970 to 1989, as estimated from Millbank trap data (Method 1), are summarized in Table 14. Numbers of spawners as estimated from Millbank data were positively correlated with other indices of spawning escapement in the Miramichi River, including angling catches of MSW salmon (bright fish and kelts) and juvenile densities (Table 15). Total egg deposition rates (number of eggs deposited per square metre) were calculated as the product of spawners and average eggs per spawner divided by the total rearing area of the Miramichi River (55 million square metres). Egg deposition rate in 1989 was estimated to be 2.3 eggs per m^2; MSW salmon contributed 72% of the total egg contribution (Fig. 7).

Correlations between estimated egg deposition levels in the Miramichi River, and resulting age 0 and age 1 parr densities were significant (Fig. 8).

7. Forecast for 1990

Data used in the regression model to predict MSW salmon returns to the Miramichi River in 1990 are summarized in Table 16. Estimated catch of MSW salmon at Millbank, based on catch of male 1SW salmon in 1989, and preliminary landings of small salmon in Labrador (Lab), are:

Model	Dependent variable	R^2	F	Pred	Returns (90% CL)
1.	1SW	0.55	16.1	355	23667 (0-49400)
2.	1SW, Lab	0.69	13.6	430	28667 (6133-51200)

Note that the landings from Labrador used in this regression to predict MSW salmon returns in 1990 were preliminary. If final Labrador landings are higher, the above forecast from model 2 would be an overestimate.

Assuming average returns of salmon in 1990, returns could be about 22,100 MSW salmon and 92,100 1SW salmon (based on the previous five year averages of total returns as calculated in Table 14). For the past five years, the coefficient of variation in total returns was 25% for MSW salmon, and 29% for 1SW salmon. Long term (1971 to 1989) averages were 26,200 MSW salmon (CV = 38%) and 61,100 1SW salmon (CV = 48%).

Indices of spawning escapement (age 1 parr) and adult survival in years that will produce 1SW and MSW salmon returns in 1990 were also considered. As a possible index of sea survival of the smolt group that will return as MSW salmon in 1990, returns of 1SW salmon in 1989 were compared to the previous five year average. Also, average age 1 parr densities for 1986 were compared to the previous five year average as a possible index of recruitment strength. A similar index was used for 1SW salmon:

	Spawning or survival index	
	1SW returns	Age 1 parr
MSW salmon (1990) (index years)	- 9% (1989)	+ 57% (1986)
1SW salmon (1990) (index year)		+ 49% (1987)

The spawning/survival indices suggest that both MSW salmon and 1SW salmon returns in 1990 should be at least average.

DISCUSSION

Judging from counts of salmon at Millbank trap and mark-recapture data from the angling fishery, total returns of both 1SW and MSW salmon in the Miramichi River were less in 1989 than in 1988. Total returns in 1989 were estimated to be about 17,200 MSW salmon and 75,200 1SW salmon, compared to 21,700 MSW salmon and 121,900 1SW salmon in 1988. Preliminary estimates of total harvest of 1SW salmon in 1989 was also less (20,435 fish) than the harvest in 1988 (31,564 fish). Because of the management plan in effect which restricts the harvest of MSW salmon, the percentage of total returns that survived to spawn in 1989 was high (85%), as it has been in recent years. Egg deposition requirements were close to being met in 1989 (94%; Fig. 7), although a significant proportion of the total egg deposition came from 1SW salmon (28%). Target egg deposition rates have apparently been achieved or nearly achieved in the last five years in the Miramichi River (Fig. 7). Average fry and parr densities of salmon in headwater electrofishing sites seem to reflect the increases in egg deposition (Fig. 6).

Estimates of total returns of salmon in 1989 as calculated from Millbank trap data and from mark-recapture data were similar (within about 20%). As in the 1988 assessment, mark-recapture data were useful for providing an estimate of returns which was independent of the Millbank trap counts. The tag reporting rate from anglers was apparently very low (Table 11), however, and the estimate of angling exploitation rate and spawning escapement is very sensitive to this rate. A reporting rate of about 50% was also calculated from an earlier tagging study (Randall et al. 1990). The exploitation rate by anglers in the Miramichi River in 1989, as estimated assuming this low reporting rate, was about 0.21, and this was within the range of exploitation rates estimated in other years; from 1966 to 1987, exploitation rates for 1SW salmon ranged between 0.17 to 0.46, and averaged 0.28 (Randall et al. 1990). In view of these comparisons, the reporting rate of 0.50 used in this assessment was probably reasonable. An attempt will be made to try to improve the reporting rate (and therefore the number of tags returned) in 1990. In addition, it would be desirable to try to increase the proportion of total fish tagged in future years (i.e., increase the tagged to untagged percentage from 1%).

The regression model that is used to forecast MSW salmon returns to the Miramichi River one year in advance needs to be improved. Preliminary attempts to incorporate data on salmon landings in areas where Miramichi salmon are known to be intercepted (Table 16) are encouraging. However, much more information is needed to determine both spatial and temporal aspects of Miramichi salmon migration routes at sea. Research on the marine phase of the life cycle of Atlantic salmon from the Miramichi River will continue to be a high priority.

ACKNOWLEDGEMENTS

We thank P. Cronin and B. Dubee (Department of Natural Resources and Energy) for providing counts of salmon at provincial barriers. Adult salmon counts and tagging data from Bartholomew River were provided by N. Stewart. R. Freeze and S. Sturgeon provided data from Rocky Brook. R. Claytor and S. Courtenay reviewed the document and provided many helpful comments.

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Table 1. Angling statistics for MSW and 1SW salmon in the Miramichi River as estimated by DNRE and DFO, 1969 to 1989.

Year	MSW salmon		1SW salmon	
	DFO	DNRE	DFO	DNRE
1969	2,827	3,804	26,715	24,284
1970	2,057	3,268	19,662	19,610
1971	1,247	1,792	8,464	13,727
1972	5,456	8,933	15,472	19,101
1973	4,881	5,977	9,033	13,857
1974	5,895	7,184	17,957	18,232
1975	3,756	6,288	9,730	15,598
1976	5,319	7,374	14,749	27,182
1977	14,344	11,617	8,244	13,590
1978	4,196	4,893	5,353	8,265
1979	2,422	2,656	7,625	14,508
1980	5,422	6,546	7,533	11,997
1981	1,602	3,238	7,031	22,716
1982	2,642	4,608	9,217	21,402
1983	1,646	2,240	3,897	8,390
1984	----	[4,692]	9,892	10,397
1985	----	[9,622]	11,926	18,439
1986	----	[14,266]	28,299	26,163
1987	----	[11,932]	11,363	20,765
1988	----	[10,095]	13,732	30,620
1989	----	[8,722][1]	12,665	[18,170][2]
Mean (69-88)	----	[6,551]	12,295	17,942

[1] MSW salmon caught and released in 1989 was based on the average ratio of MSW/1SW salmon, 1984-1988 (0.48) times the 1SW catch in 1989.

[2] 1SW salmon catch (DNRE) in 1989 was estimated from a correlation between DFO salmon (x) and DNRE salmon (y) from 1969 to 1988; $y = 10,393.9 + 0.61\ (x)$, $r=0.64$, $P<0.0001$.

Table 2. Angling catch and effort data for 1SW salmon in the Miramichi River in 1989 and 1988, as estimated by DFO fishery officers. Data for 1989 are preliminary.

	1989				1988			
	Kelts	Brights	Rod-days	CPUE	Kelts	Brights	Rod-days	CPUE
April	4076		4161	0.98	3147		3268	0.96
May	1743		3158	0.55	919		2058	0.45
Total	5819		7319	0.80	4066		5326	0.76
June		754	2902	0.26		798	4693	0.17
July		2536	9146	0.28		2014	8969	0.22
August		2689	7632	0.35		2948	8262	0.36
September		6158	9399	0.66		7369	12898	0.57
October		528	2032	0.26		603	2023	0.30
Total		12665	31111	0.41		13732	36845	0.37

Table 3. Estimated harvest of 1SW and MSW salmon in the Miramichi River and bay in 1989 by native fishermen.

		1989		1988	
		1SW	MSW	1SW	MSW
Red Bank	reported	800	400	450	175
	estimated[1]	(1980)	(1020)		
Eel Ground		254	62	442	95
Burnt Church		31	78	52	78
Total		(2265)	(1160)	944	348

[1] Red Bank harvest as estimated by DFO Conservation and Protection Staff.

Table 4. Preliminary salmon harvests in the Miramichi River and Bay, 1989. Harvests in 1988 are given fom comparison.

	1989		1988	
	1SW	MSW	1SW	MSW
Native	2265	1160	944	348
Angling	18170[1]	(262)[2]	30,620	(303)[2]
	20435	1422	31,564	651

[1] Angling landings from DNRE (Table 1).
[2] Assuming a catch-and-release mortality rate of 0.03.

Table 5. Recorded catches of salmon in all fisheries, Miramichi River and Bay, 1951-89 (includes commercial, by-catch, recreational and Native). Kelts angled in year i are added to landings in year i-1. 1989 data are preliminary. All data are numbers X 10^3.

				ANGLING										
	COMMERCIAL			Kelts (yr i+1)			Bright (yr 1)				NATIVE			
Year	1SW	MSW	Total	1SW	MSW	Total	1SW	MSW	Total	Total	1SW	MSW	Total	GRAND TOTAL
1951		27.6	27.6			12.0			9.6	21.6				49.2
1952		27.3	27.3			11.3			15.9	27.2				54.5
1953		24.4	24.4			10.1			18.2	28.3				52.7
1954		50.6	50.6			11.2			23.5	34.7				85.3
1955		15.3	15.3			8.9			14.7	23.6				38.9
1956		24.7	24.7			9.3			28.9	38.2				62.9
1957		29.9	29.9			8.4			19.5	27.9				57.8
1958		25.2	25.2			10.2			36.7	46.9				72.1
1959		37.3	37.3			9.5			10.3	19.8				57.1
1960		30.8	30.8			5.6			4.5	10.1				40.9
1961		30.0	30.0			9.5			11.0	20.5				50.5
1962		41.6	41.6			7.3			10.3	17.6				59.2
1963		40.7	40.7			5.2			50.9	56.1				96.8
1964		69.8	69.8			9.0			35.1	44.1				113.9
1965		69.5	69.5			16.0	38.7	3.9	42.6	58.6				128.1
1966		72.9	72.9			20.0	51.7	5.9	57.6	77.6				150.5
1967		102.2	102.2			14.1	41.8	4.1	45.9	60.0				162.2
1968		48.5	48.5			6.9	7.0	1.5	8.5	15.4				63.9
1969		41.3	41.3	3.7	1.6	5.3	24.3	3.8	28.1	33.4				74.7
1970		39.7	39.7	2.4	1.4	3.8	19.6	3.3	22.9	26.7				66.4
1971		18.3	18.3	1.5	0.5	2.0	13.7	1.8	15.5	17.5				35.8
1972		2.5	2.5	1.5	3.0	4.5	19.1	8.9	28.0	32.5				35.0
1973		0.9	0.9	1.5	3.0	4.5	13.9	6.0	19.9	24.4				25.3
1974		1.0	1.0	1.8	3.1	4.9	18.2	7.2	25.4	30.3				31.3
1975	0.4	0.7	1.1	2.3	1.4	3.7	15.6	6.3	21.9	25.6	0.4	0.2	0.6	27.3
1976	1.8	0.9	2.7	2.4	2.2	4.6	27.2	7.4	34.6	39.2	0.2	0.2	0.4	42.3
1977	0.4	6.9	7.3	1.4	2.1	3.5	13.6	11.6	25.2	28.7	0.5	0.4	0.9	36.9
1978	1.2	8.4	9.6	1.5	1.7	3.2	8.3	4.9	13.2	16.4	0.4	0.4	0.8	26.8
1979	5.5	1.7	7.2	2.2	1.5	3.7	14.5	2.7	17.2	20.9	0.1	0.2	0.3	28.4
1980	2.7	10.9	13.6	1.7	2.1	3.8	12.0	6.5	18.5	22.3	-	-	-	35.9
1981	1.6	7.8	9.4	2.7	1.4	4.1	22.7	3.2	25.9	30.0	1.0	0.5	1.5	40.9
1982	2.3	12.5	14.8	2.1	1.0	3.1	21.4	4.6	26.0	29.1	0.7	0.4	1.1	45.0
1983	1.6	17.1	18.7	0.9	0.7	1.6	8.4	2.2	10.6	12.2	0.4	0.2	0.6	31.5
1984	0.0	0.0	0.0	2.4	0.0	2.4	10.4	0.0	10.4	12.8	0.4	0.3	0.7	13.5
1985	0.0	0.0	0.0	2.5	0.0	2.5	18.4	0.0	18.4	20.9	0.5	0.3	0.8	21.7
1986	0.0	0.0	0.0	2.7	0.0	2.7	26.2	0.0	26.2	28.9	2.0	0.6	2.6	31.5
1987	0.0	0.0	0.0	4.2	0.0	4.2	20.8	0.0	20.8	25.0	1.3	0.9	2.2	27.2
1988	0.0	0.0	0.0	---	0.0	---	30.6	0.0	30.6	30.6	0.9	0.3	1.2	31.8
1989	0.0	0.0	0.0	---	0.0	---	18.1	0.0	18.1	18.1	2.3	1.2	3.5	21.6

Table 6. Counts of 1SW and MSW salmon at Millbank, 1970 to 1989. Counts are divided into early (May-August) and late periods (September-November).

Year	Early		Late		Total		Proportion early	
	1SW	MSW	1SW	MSW	1SW	MSW	1SW	MSW
1970	1826	125	658	120	2484	245	0.74	0.51
1971	1849	375	113	24	1962	399	0.94	0.94
1972	2377	934	166	217	2543	1151	0.93	0.81
1973	1490	478	960	654	2450	1132	0.61	0.42
1974	2948	864	1090	927	4038	1791	0.73	0.48
1975	2954	628	594	580	3548	1208	0.83	0.52
1976	4072	641	867	302	4939	943	0.82	0.68
1977	1249	1189	256	745	1505	1934	0.83	0.61
1978	1150	535	118	158	1268	693	0.91	0.77
1979	2157	257	343	61	2500	318	0.86	0.81
1980	1802	837	337	256	2139	1093	0.84	0.77
1981	2020	173	154	26	2174	199	0.93	0.87
1982	2593	392	72	16	2665	408	0.97	0.96
1983	770	226	40	19	810	245	0.95	0.92
1984	879	257	131	76	1010	333	0.87	0.77
1985	901	287	11	24	912	311	0.99	0.92
1986	1324	345	439	124	1763	469	0.75	0.74
1987	1146	223	126	68	1272	291	0.90	0.77
1988	884	173	944	152	1828	325	0.48	0.53
1989	1062	211	66	46	1128	257	0.94	0.82
Five Year Mean 84-88	1027	257	330	89	1357	346	0.80	0.75

Table 7. Numbers of MSW and 1SW salmon counted at barriers in two tributaries of the Miramichi River, 1981 to 1989.

Tributary	Year	MSW	1SW	Total	Dates Operated	No. of Days
North Branch of SW Miramichi R.	1981	54	671	725	Jul. 5 - Oct. 4	92
	1982	282	621	903	Jun. 30 - Oct. 8	101
	1983	219	290	509	Jul. 4 - Oct. 10	99
	1984	297	230	527	Jul. 10 - Oct. 16	99
	1985	604	492	1,096	Jul. 1 - Oct. 20	112
	1986	1,138	2,072	3,210	Jun. 30 - Oct. 19	112
	1987	1,266	1,175	2,441	Jul. 2 - Oct. 19	110
	1988	929	1,092	2,021	Jun. 30 - Oct. 24	116
	Mean	599	830	1,429		105
	1989	731	969	1,700	Jul. 1 - Oct. 4	116
Dungarvon R.	1981	112	550	662	Jun. 24 - Oct. 8	107
	1982	120	489	609	Jun. 28 - Oct. 15	110
	1983	126	330	456	Jun. 27 - Oct. 14	110
	1984	93	315	408	Jul. 5 - Oct. 12	100
	1985	162	536	698	Jun. 25 - Oct. 10	108
	1986	174	501	675	Jun. 25 - Oct. 21	119
	1987	202	744	946	Jun. 25 - Oct. 14	112
	1988	277	851	1,128	Jun. 2 - Oct. 25	146
	Mean	158	540	698		114
	1989	315	579	894	May. 30 - Oct. 10	134

Table 8. Biological characteristics of adult Atlantic salmon sampled at Millbank trap, 1989.

1. Fork lengths, sex ratio and reproductive potential.

Sea age	n	FL	SD	n	% female	eggs/spawner
1SW	287	53.5	2.90	127	22.0	699
MSW	209	77.7	7.42	61	78.7	6068

2. Smolt ages

		% at age		
	n	2	3	4
1SW (1989)	283	30.4	66.1	3.5
1SW (1988)	201	54.7	42.8	2.5

Table 9. Number of 1SW salmon tagged and number of 1SW tags returned by anglers during 1989.

	early	late	total
Trap count	1062	66	1128
Tagged	789	44	833
Eligible tags	784	44	828
Proportion tagged	0.74	0.67	0.74
Recapture	75	1	76
Late recaptures[1]	10	-	10
Total	85	1	86

[1] 12% of total potential recaptures (Table 10).

Table 10. Number and percentage of 1SW tags returned by anglers before and after November, 1988.

	Number of recaptures		
Period	by November	total	% late returns
early	91	103	12
late	64	82	22
Total	155	185	16

Table 11. Estimated tagged to untagged ratio of 1SW salmon in the Miramichi River, 1989.

	Location	Count or catch	Recaptures	Proportion
A.	Counting fences			
	1. Bartholomew	475	1	0.0021
	2. Rocky Brook	240	5	0.0208
	3. Dungarvon	579	9	0.0155
	4. NW Miramichi	966	8	0.0083
	Total	2260	23	0.0102
B.	Angling			
	1. Rocky Brook	592	5	0.0084
	2. Miramichi Club	176	0	
	3. Wades	199	0	
	4. Halfway	87	0	
	5. Black Brook	239	6	0.0251
	Total	1293	11	0.0085
A. and B.	Total	3553	34	0.0096
C.	Total Angling	18170	86	0.0047

Table 12. Estimated tagged to untagged ratio of MSW salmon in the Miramichi River, 1989.

	Count	Recaptures	Proportion
1. Bartholomew	134	2	0.0149
2. Rocky Brook	174	5	0.0287
3. Dungarvon	315	2	0.0063
4. NW Miramichi	287	4	0.0139
Total	910	13	0.0143

Table 13. Summary of mark-recapture data from the angling fisheries in the Miramichi River, 1989. Exploitation rates and estimated total returns are also calculated.

1. Mark-recapture data and assumed tag reporting rate.

Reporting rate	Number tagged		Correction factor	Angling catch	Number of recaptures	
	early	late			early	late
0.5	784	44	1.10	18170	170.0	2.0
0.6	784	44	1.10	18170	141.7	1.7
0.7	784	44	1.10	18170	121.4	1.4
1.0	784	44	1.10	18170	85.0	1.0

2. Angling exploitation

Reporting rate	Exploitation rate
0.5	0.21 (0.18; 0.24)
0.6	0.17 (0.15; 0.20)
0.7	0.15 (0.12; 0.18)
1.0	0.10 (0.08; 0.13)

3. Total returns

Reporting rate	
0.5	87,832 (75,656; 101,970)
0.6	105,399 (89,505; 124,116)
0.7	122,965 (103,068; 146,707)
1.0	175,664 (142,267; 216,911)

Table 14. Estimates of spawning escapement (S) and total returns (R) of MSW salmon (upper) and 1SW salmon (lower) in the Miramichi River, 1971 to 1989.

YR	HE1	HE2	HR	MIL	PAD	E1	MILR	S	R	SR
MSW salmon										
71	15,128	3,140	1,792	399	1,000	0.043	9,279	3,347	24,407	0.14
72	2,282	163	8,933	1,151	1,000	0.043	26,767	16,671	29,049	0.57
73	866	0	5,977	1,132	1,000	0.043	26,326	19,349	27,192	0.71
74	941	22	7,184	1,791	1,000	0.043	41,651	33,445	42,592	0.79
75	724	19	6,626	1,208	1,000	0.043	28,093	20,448	28,817	0.71
76	871	7	7,591	943	1,000	0.043	21,930	13,332	22,801	0.58
77	6,865	0	12,060	1,934	1,000	0.043	44,977	31,917	51,842	0.62
78	8,377	0	5,287	693	1,000	0.043	16,116	9,829	24,493	0.40
79	1,659	0	2,854	318	1,000	0.043	7,395	3,541	9,054	0.39
80	10,899	0	6,546	1,093	1,000	0.043	25,419	17,873	36,318	0.49
81	7,137	699	3,738	199	1,000	0.022	9,045	3,608	16,182	0.22
82	12,213	298	4,989	408	1,000	0.022	18,545	12,258	30,758	0.40
83	16,788	269	2,409	245	1,000	0.022	11,136	7,458	27,924	0.27
84	1	0	449	333	1,000	0.022	15,136	13,687	15,137	0.90
85	5	0	611	311	1,000	0.015	20,733	19,122	20,738	0.92
86	18	0	1,051	469	1,000	0.015	31,267	29,216	31,285	0.93
87	21	0	1,344	291	1,000	0.015	19,400	17,056	19,421	0.88
88	78	0	687	325	1,000	0.015	21,667	19,980	21,745	0.92
89	78	0	1,497	257	1,000	0.015	17,133	14,636	17,211	0.85
1SW salmon										
71	0	0	13,727	1,962	4,000	0.055	35,673	17,946	35,673	0.50
72	39	0	19,101	2,543	4,000	0.055	46,236	23,135	46,275	0.50
73	0	0	13,857	2,450	4,000	0.055	44,545	26,688	44,545	0.60
74	0	0	18,232	4,038	4,000	0.055	73,418	51,186	73,418	0.70
75	393	0	16,040	3,548	4,000	0.055	64,509	44,469	64,902	0.69
76	1,780	39	27,381	4,939	4,000	0.055	89,800	58,380	91,580	0.64
77	379	28	14,089	1,505	4,000	0.055	27,364	9,247	27,743	0.33
78	1,232	2	8,700	1,268	4,000	0.055	23,055	10,353	24,287	0.43
79	5,510	2	14,605	2,500	4,000	0.055	45,455	26,848	50,965	0.53
80	2,697	0	11,997	2,139	4,000	0.055	38,891	22,894	41,588	0.55
81	1,332	296	23,716	2,174	4,000	0.034	63,941	35,929	65,273	0.55
82	1,997	314	22,068	2,665	4,000	0.034	78,382	52,000	80,379	0.65
83	1,360	229	8,746	810	4,000	0.034	23,824	10,849	25,184	0.43
84	1	0	10,777	1,010	4,000	0.034	29,706	14,929	29,707	0.50
85	0	0	18,985	912	4,000	0.015	60,800	37,815	60,800	0.62
86	16	0	28,135	1,763	4,000	0.015	117,533	85,398	117,549	0.73
87	16	0	22,023	1,272	4,000	0.015	84,800	58,777	84,816	0.69
88	52	0	31,589	1,828	4,000	0.015	121,867	86,278	121,919	0.71
89	31	0	20,559	1,128	4,000	0.015	75,200	50,641	75,231	0.67

HE1 = harvest in estuary below Millbank
HE2 = harvest in estuary above Millbank
HR = harvest in river
MIL = Millbank trap count
PAD = poaching and disease
E1 = Millbank catch efficiencies
MILR = returns to Millbank
S = spawners
R = returns.

Table 15. Indices of spawning escapement in Miramichi River, 1970 to 1989.

1 Year (i)	2 Kelt (i)	3 Bright (i-1)	4 0+ (i)	5 1+ (i+1)	6 Spawners (i-1)
1970	1,647	3,804	35.3	7.9	--
1971	1,352	3,268	20.1	8.3	--
1972	547	1,792	9.8	3.0	3,347
1973	2,970	8,933	24.9	11.0	16,671
1974	3,037	5,977	34.2	12.8	19,349
1975	3,111	7,184	40.0	11.7	33,445
1976	1,446	6,288	25.1	8.4	20,448
1977	2,156	7,374	51.8	10.7	13,332
1978	2,126	11,617	36.4	9.0	31,917
1979	1,668	4,893	19.7	8.3	9,829
1980	1,504	2,656	34.5	7.0	3,541
1981	2,118	6,546	53.6	9.8	17,873
1982	1,368	3,238	15.0	6.7	3,608
1983	960	4,608	44.5	6.5	12,258
1984	666	2,240	19.1	8.9	7,458
1985	3,771	4,692	56.4	12.2	13,687
1986	6,856	9,622	55.4	13.1	19,122
1987	5,099	14,266	74.5	13.9	29,216
1988	6,700	11,932	95.1	18.4	17,056
1989	--	10,095	72.2	--	19,980

Correlations:

	n	r	P
2 with 3	19	0.76	0.001
2 with 4	19	0.80	0.001
2 with 5	19	0.88	0.001
2 with 6	17	0.45	0.068
3 with 4	20	0.74	0.001
3 with 5	19	0.75	0.001
3 with 6	18	0.77	0.001
4 with 5	19	0.81	0.001
4 with 6	18	0.43	0.073
5 with 6	17	0.53	0.029

Table 16. Data used in the Miramichi River regression to predict MSW salmon returns. CPVS is catch per unit effort of salmon at Millbank, CPVG is catch per unit effort of grilse, LAB is landings (wt) in Zone 2 of Labrador.

Year (i)	CPVS (i)	CPVG (i-1)	LAB (i-1)
1975	4.83	12.25	82
1976	4.25	10.30	134
1977	7.22	16.87	107
1978	3.03	4.34	92
1979	1.49	3.47	28
1980	4.84	8.48	65
1981	0.84	7.64	168
1982	1.86	6.87	204
1983	1.22	8.58	126
1984	1.81	2.85	71
1985	1.86	4.30	32
1986	2.66	4.22	54
1987	1.77	7.81	102
1988	1.90	5.01	143
1989	1.63	8.36	123
1990	--	5.57	64

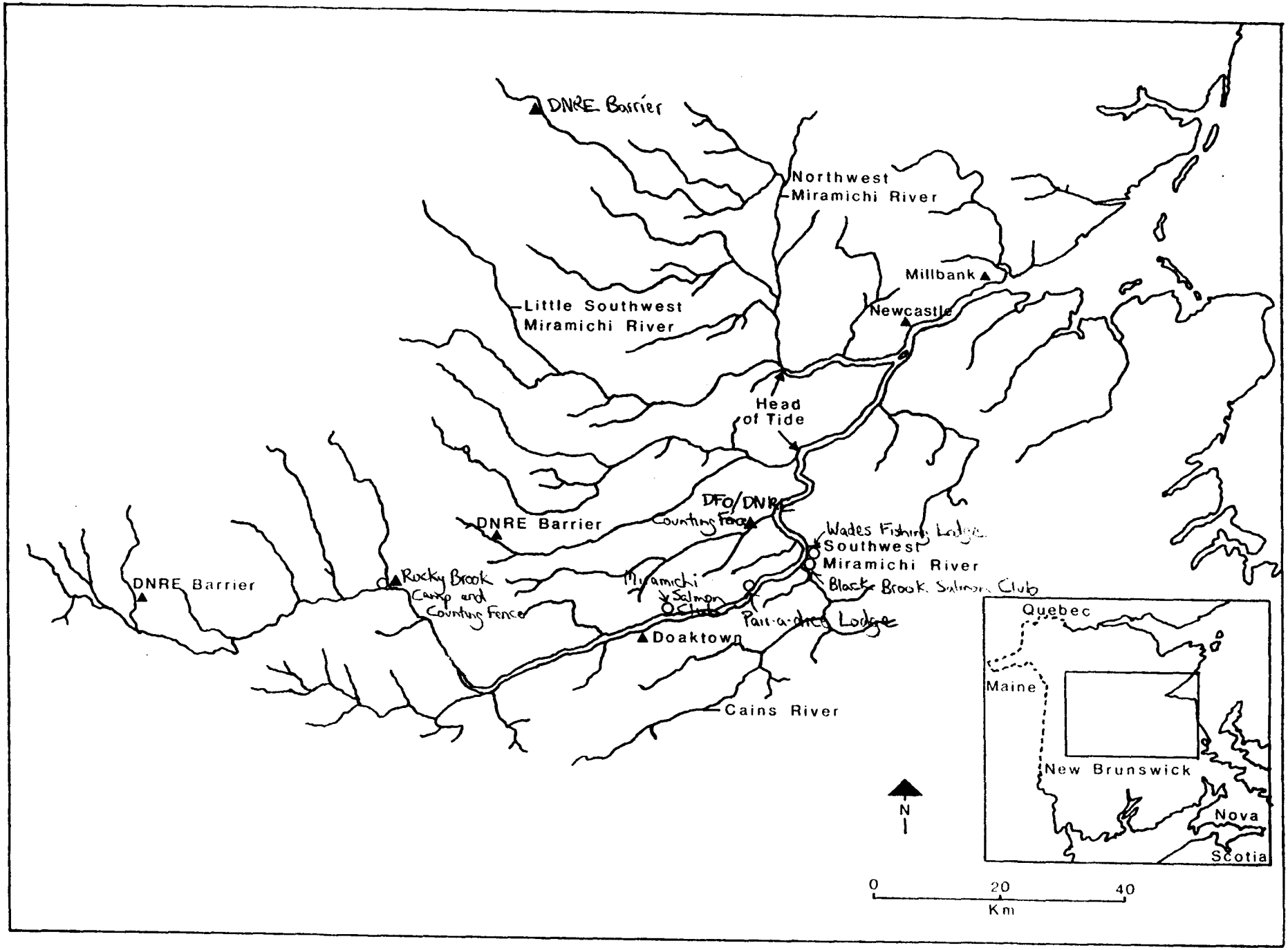
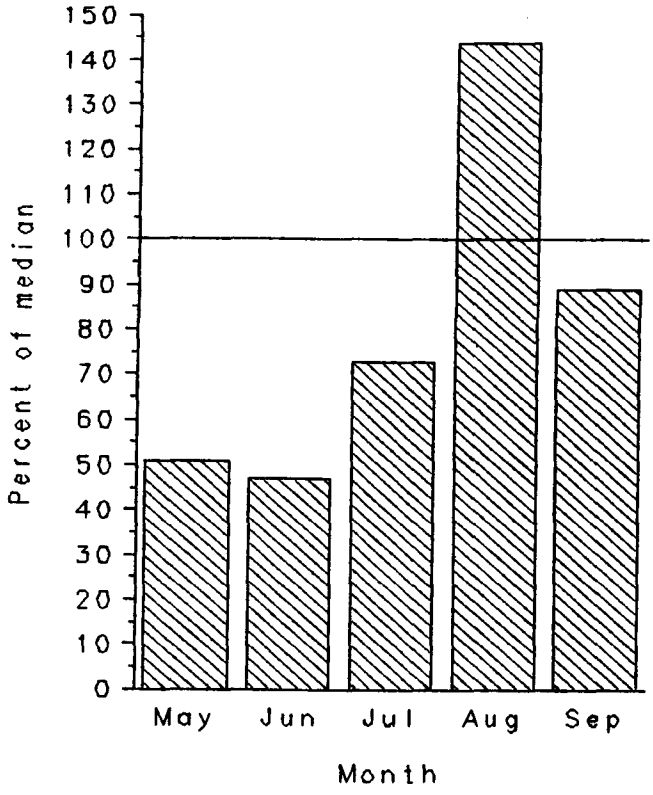


Fig. 1. Map of the Miramichi River showing the location of counting fences and angling camps which provided data for the 1989 assessment.

1988



1989

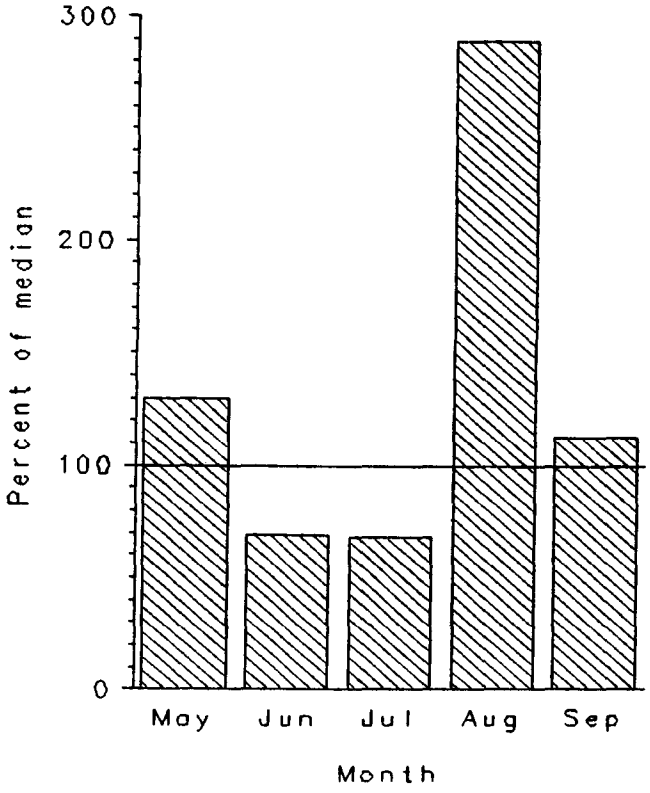
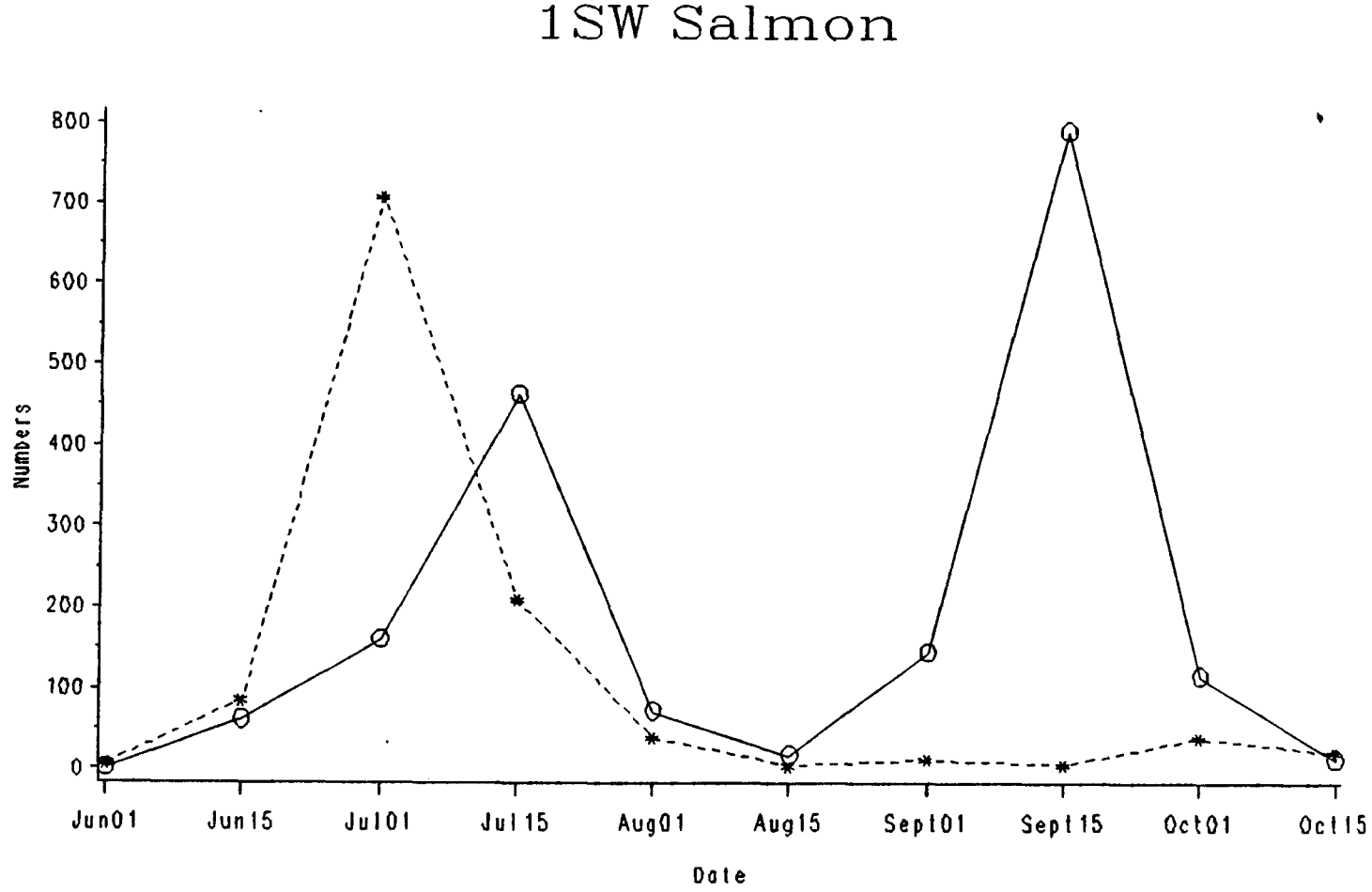


Fig. 2. Mean monthly discharge rates (% of long term medians) at the Blackville gauging station, 1988 and 1989.



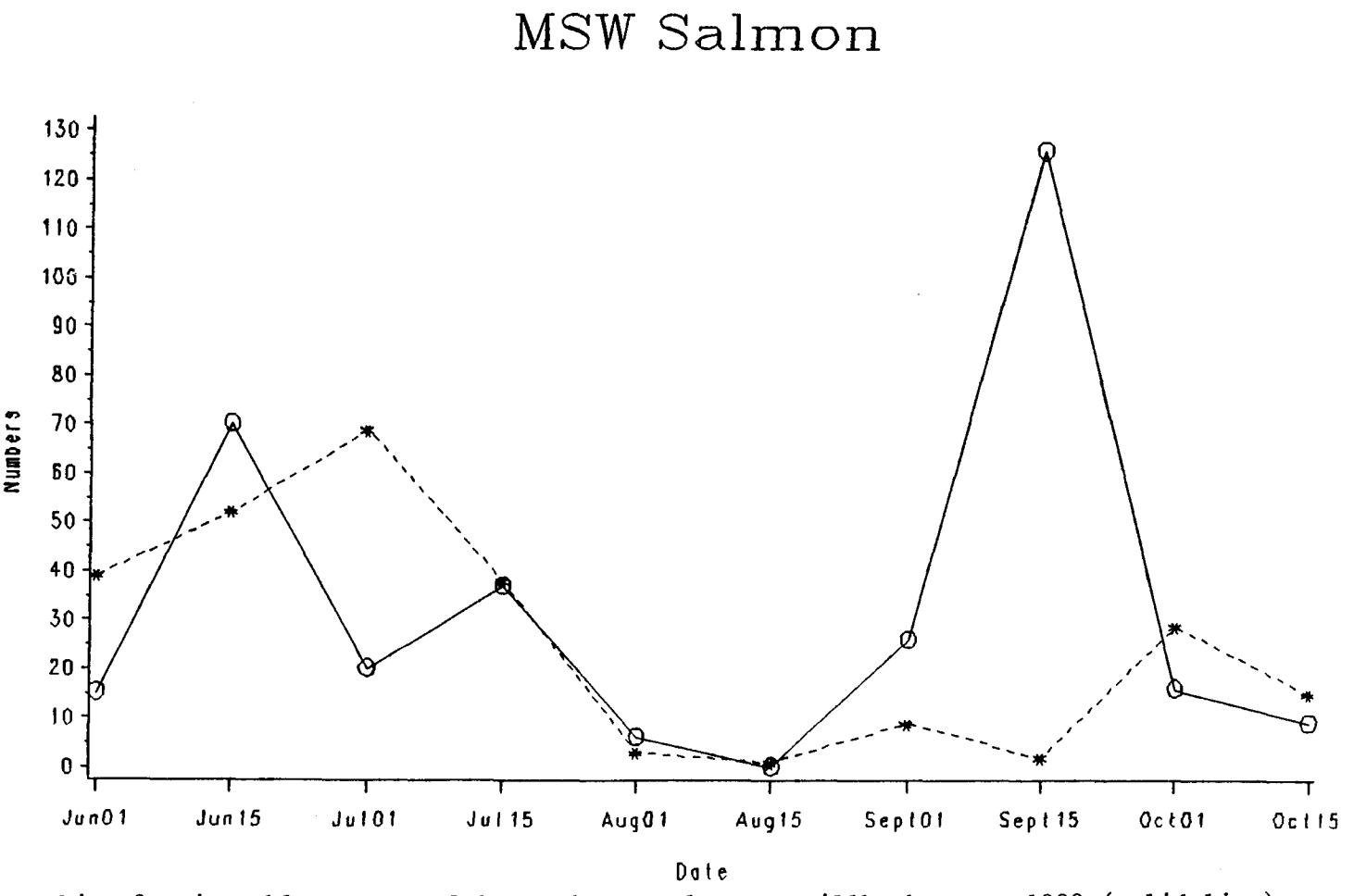


Fig. 3. Bimonthly counts of 1SW and MSW salmon at Millbank trap, 1988 (solid line) and 1989 (dashed line)

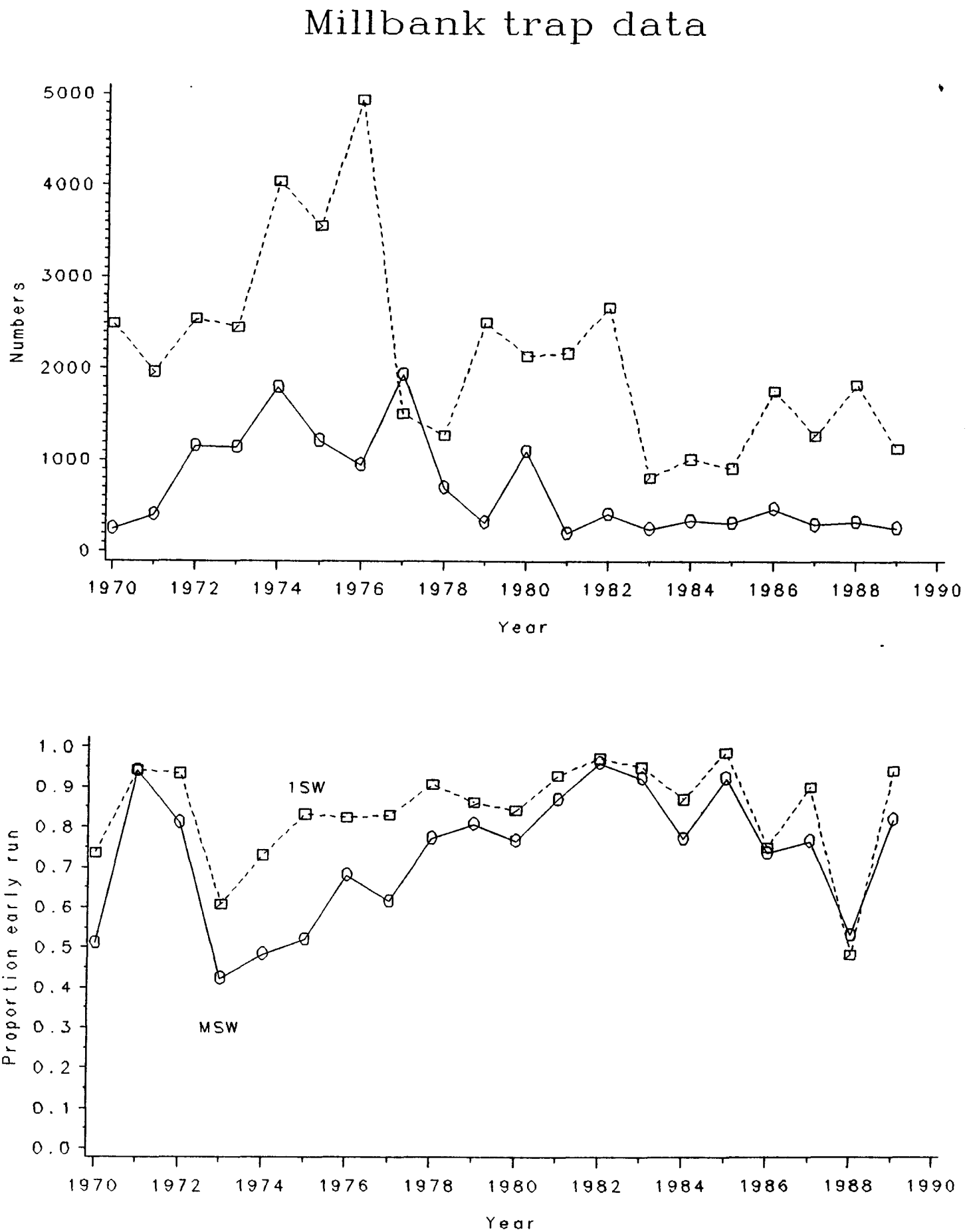
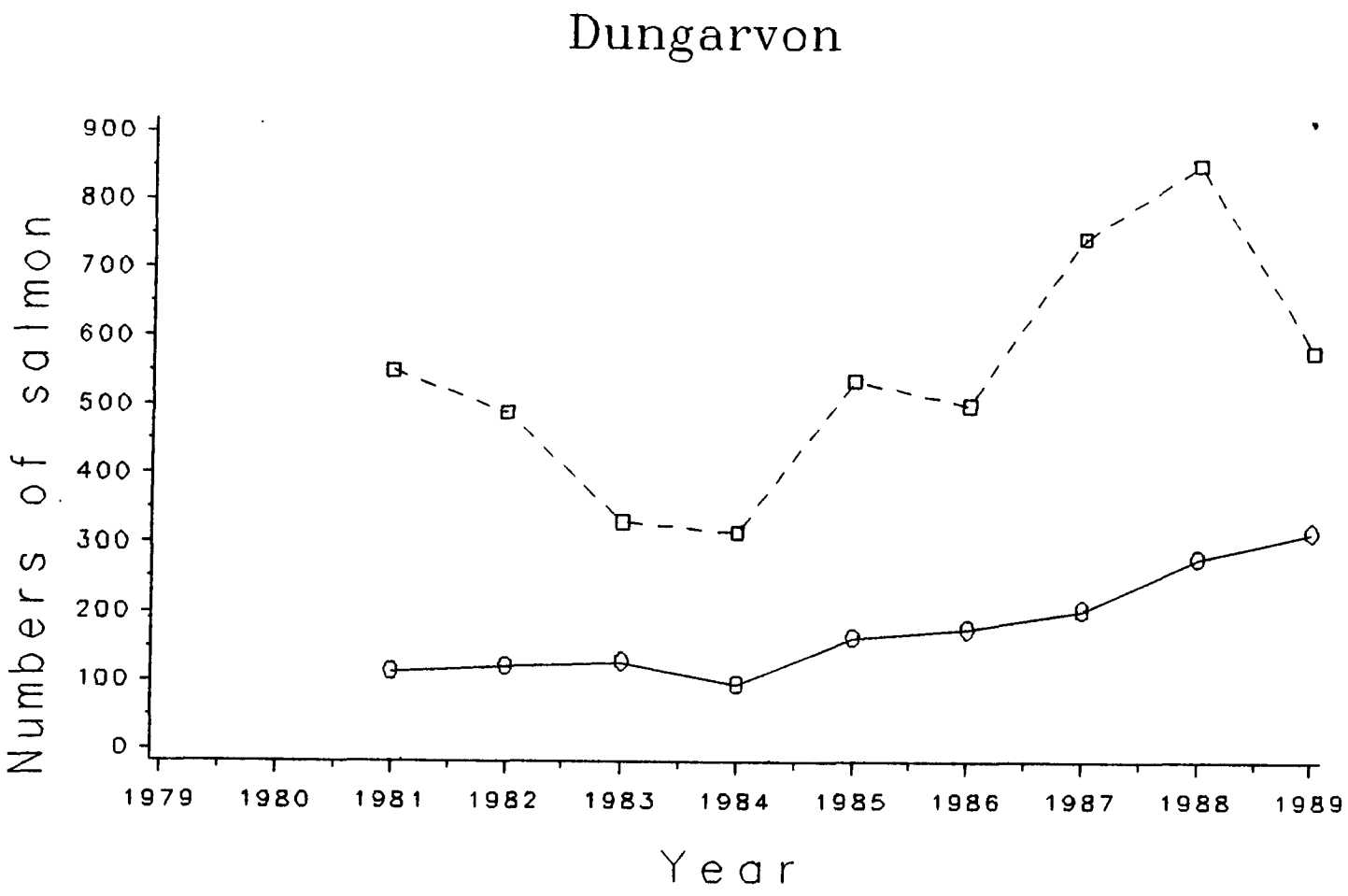


Fig. 4. Upper: Numbers of MSW salmon (solid line) and 1SW salmon (dashed line) counted at Millbank from 1970 to 1989. Lower: Proportion of total returns of salmon which were early-run (before August 31) at Millbank, 1970 to 1989.



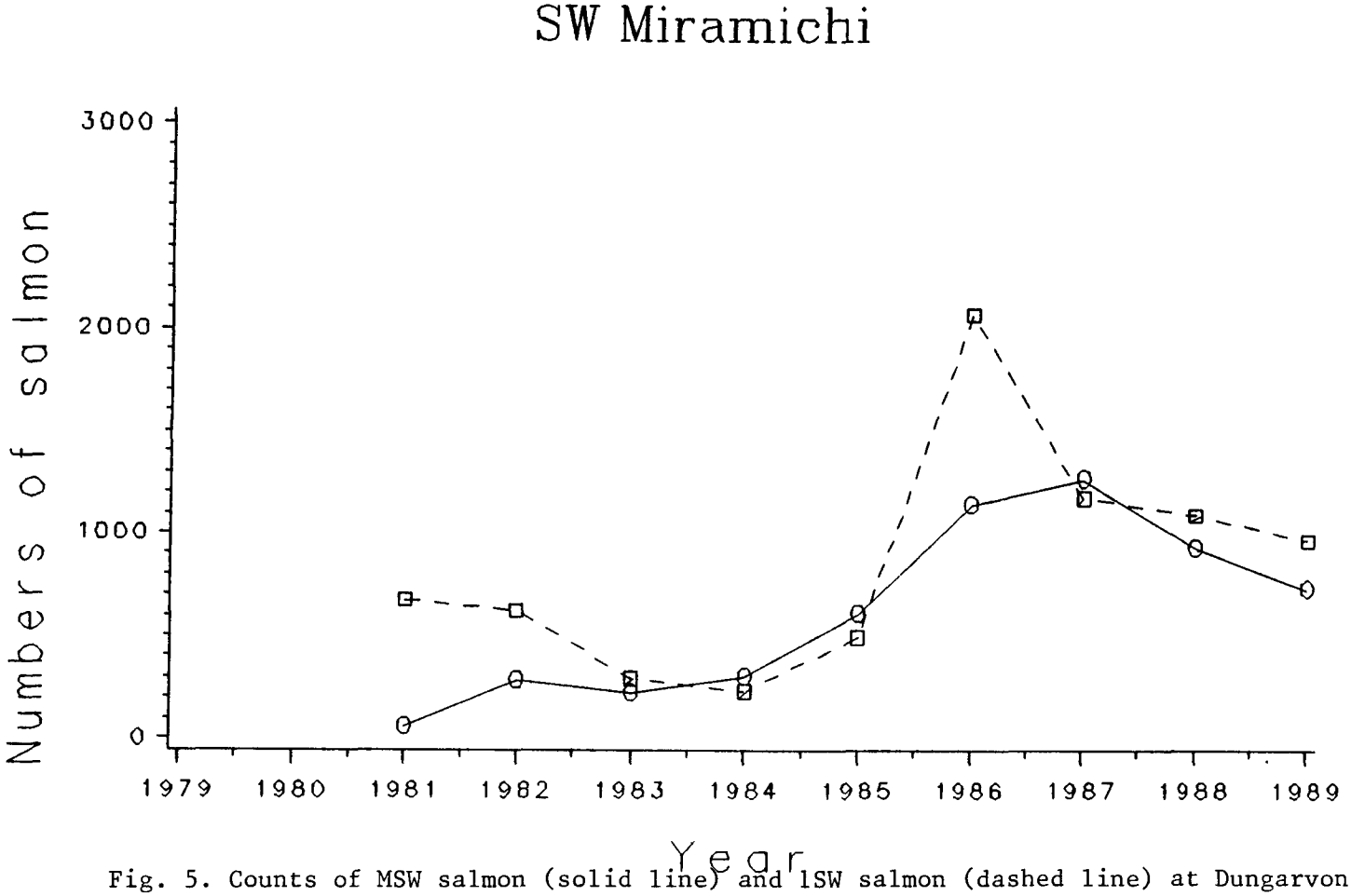
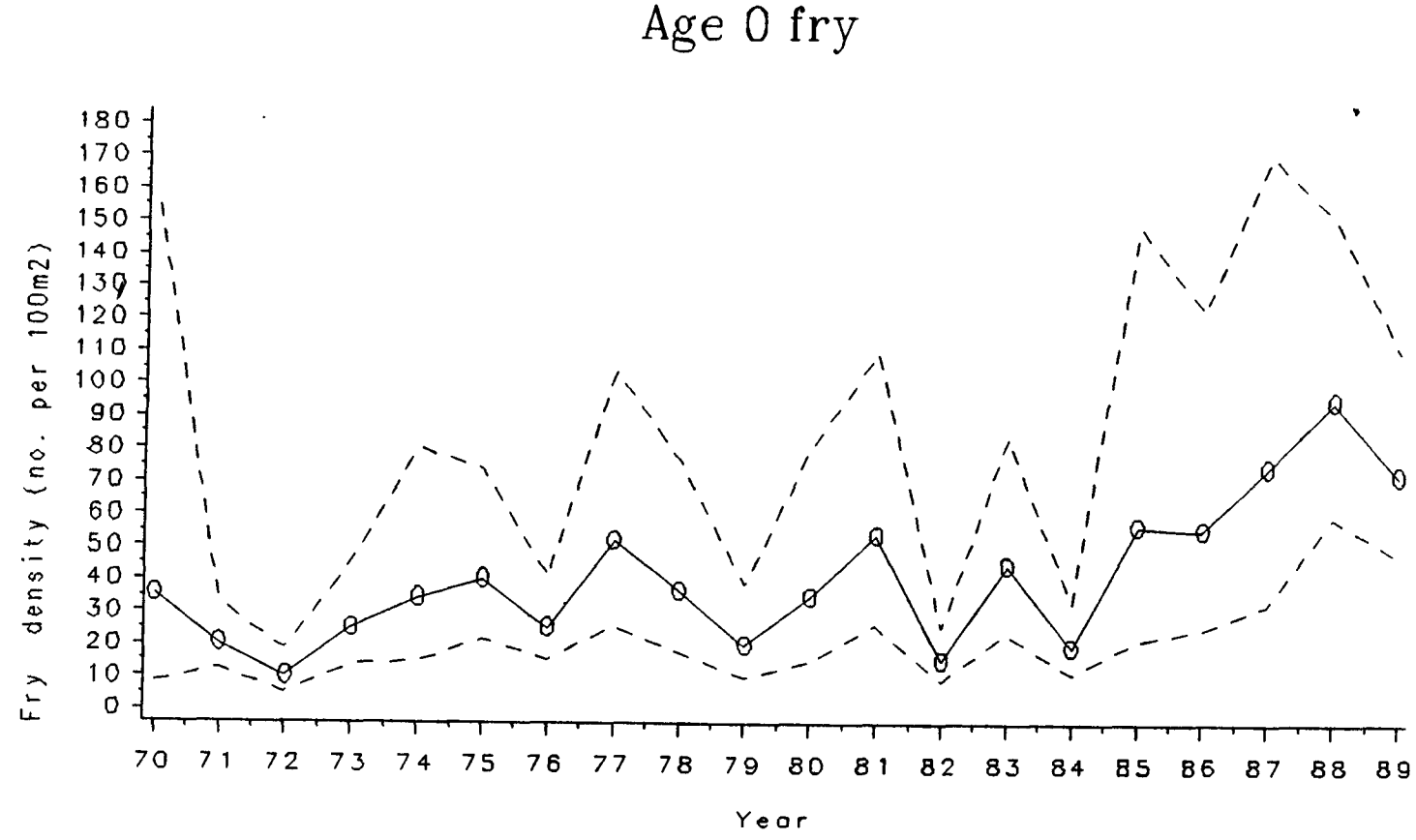


Fig. 5. Counts of MSW salmon (solid line) and 1SW salmon (dashed line) at Dungarvon and SW Miramichi protection barriers, 1981 to 1989.



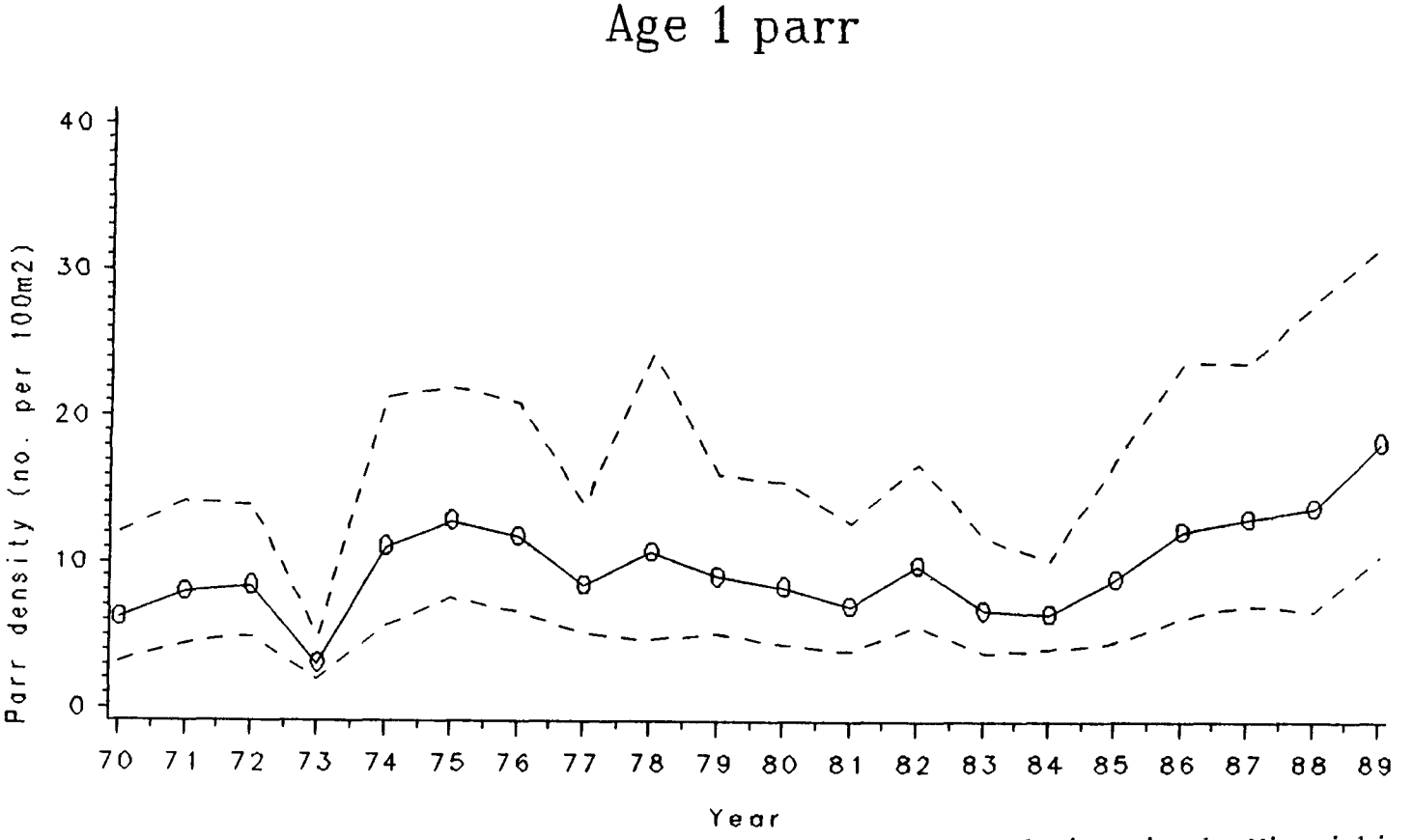


Fig. 6. Mean densities of age 0 (upper) and age 1 parr at 15 sites in the Miramichi River, 1970 to 1989. Densities are numbers of salmon per 100 m^2 of stream area.

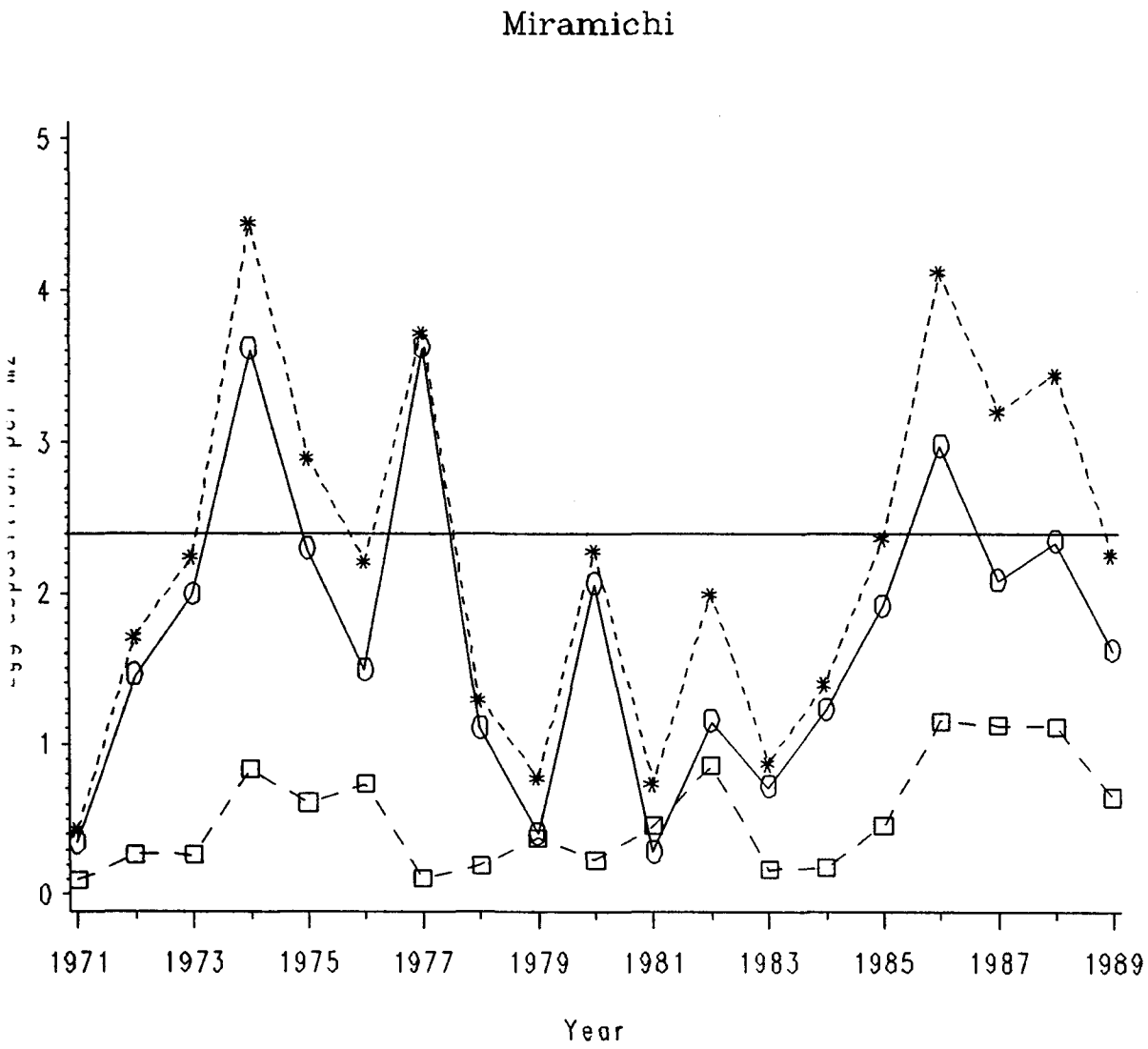
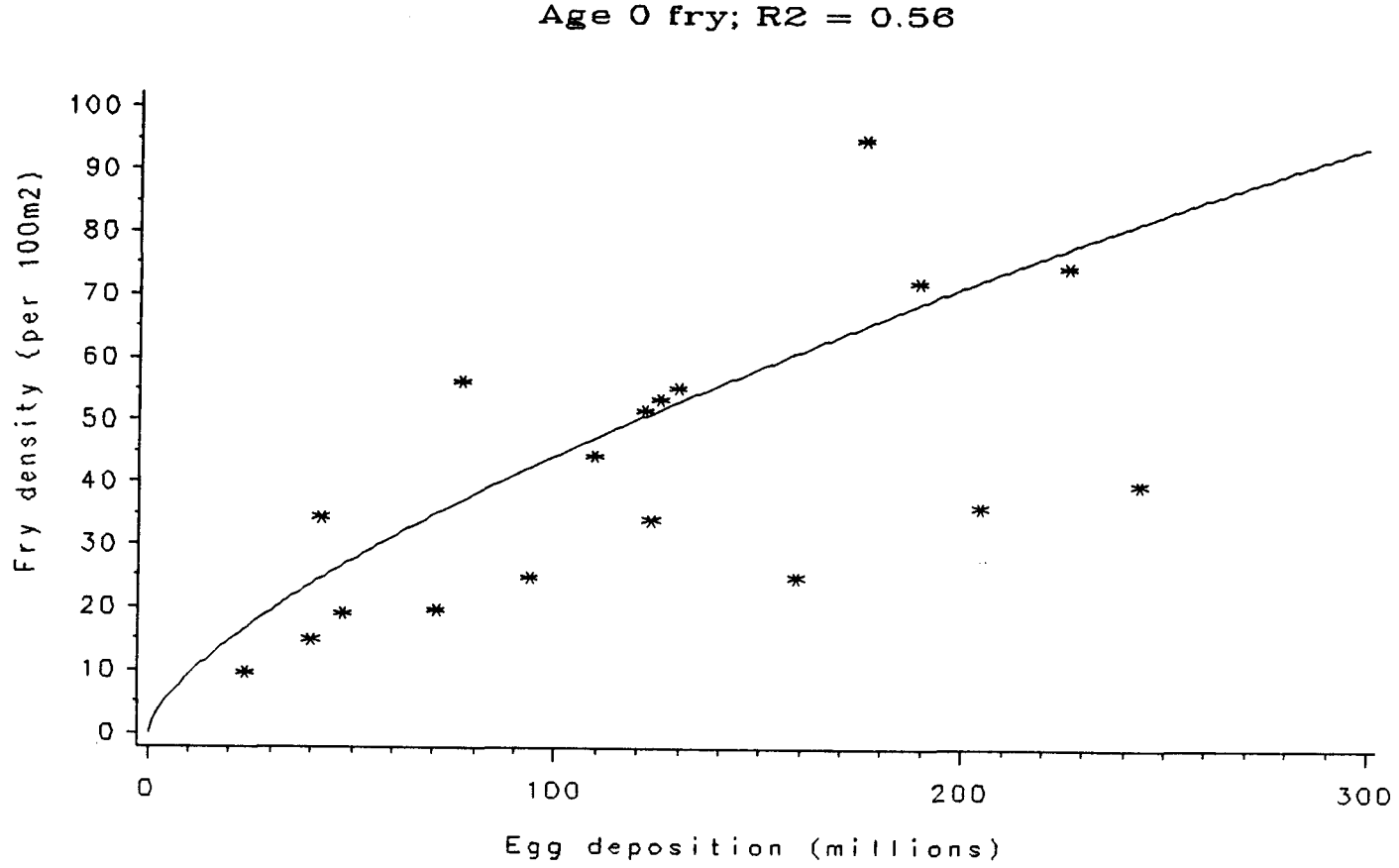


Fig. 7. Estimated egg deposition rates (number of eggs per square metre) in the Miramichi River, 1971 to 1989. Egg depositions are for 1SW salmon (squares), MSW salmon (circles) and total eggs (asteriks). Horizontal line is the target egg deposition rate.



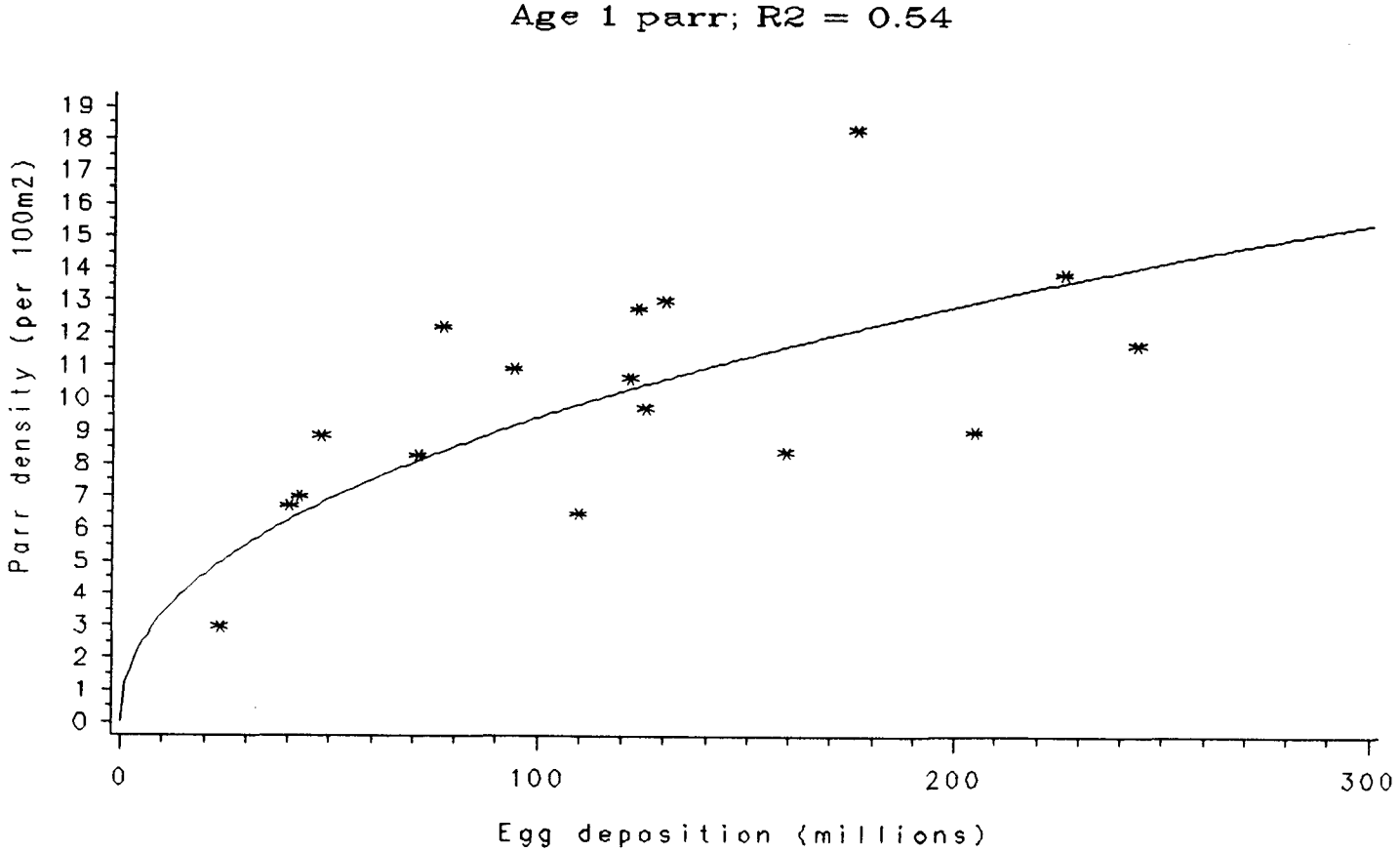


Fig. 8. Relationships between estimated egg deposition rates and resulting age 0 and age 1 parr densities in the Miramichi River, 1971 to 1989.

APPENDIX I. Angling seasons on Miramichi tributaries, 1988 and 1989.

Tributary	Season 1988	Season 1989
General (bright salmon)	June 8 - September 30	June 8 - September 30
Exceptions		
Bartholomew	Closed	Closed
Bartibog	July 1 - October 29	June 1 - October 15
Cains	July 1 - October 15	June 8 - October 15
Dungarvon (above Underwood Brook)	June 8 - September 15	June 8 - September 15
Little Southwest (above Catamaran Brook)	June 8 - September 15	June 8 - September 15
Southwest (above MacKeil Brook)	June 8 - September 15	June 8 - September 15
Northwest (above Little River)	June 8 - August 31	June 8 - August 31
Renous (above North Renous, 88; above Forks, 89)	June 8 - September 15	June 8 - September 15
Rocky Brook	June 1 - August 31	June 1 - August 31
Sevogle (above Square Forks)	June 8 - September 15	June 8 - September 15
Other tributaries of Main Southwest Miramichi (above Cains River - except Rocky Brook)	June 8 - September 15	June 8 - September 15