STATUS OF ATLANTIC SALMON IN THE MIRAMICHI RIVER DURING 1990

by

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ABSTRACT

Total returns of Atlantic salmon to the Miramichi River in 1990, based on Millbank trap data, were 29,800 MSW salmon and 90,800 1SW salmon. Mark-recapture data (tagging at Millbank and recaptures from anglers) indicated total returns of 29,300 MSW and 89,500 1SW salmon, based on tag reporting rate estimate of 45%. Both methods estimated that returns of 1SW and MSW salmon in 1990 were greater than in 1989, when 17,200 MSW salmon and 75,200 1SW salmon were estimated to have returned to the river. Returns of MSW salmon were 35% greater than average returns during the last five years (1985-89) while 1SW returns were about average. The harvest of bright 1SW salmon (23,782 fish) was 7% below the average harvest over the last five years. Target egg deposition requirements were exceeded in 1990 (148%) and a large proportion of the eggs came from MSW salmon (80%). Target egg deposition levels have apparently been achieved or nearly achieved in the past 6 years in the Miramichi River, and electrofishing surveys indicate that average densities of juvenile salmon have increased accordingly. Repeat spawners made up a larger proportion of large salmon returns than in any other year sampled (1966-90).

RESUME

D'après les données recueillies au piège de Millbank, les remontées totales de saumon de l'Atlantique dans la rivière Miramichi en 1990 s'établissaient à 29 800 redibermarins et 90 800 unibermarins. D'après les données des expériences de marquage-recapture (marquage à Millbank et recapture par les pêcheurs sportifs), elles étaient de 29 300 redibermarins et 89 500 unibermarins, si l'on se fonde sur un taux approximatif de 45 p. 100 d'étiquettes déclarées. Les estimations découlant de ces méthodes révèlent donc que les remontées d'unibermarins et de redibermarins ont été plus élevées en 1990 que l'année précédente, où elles se chiffraient à 17 200 redibermarins et 75 200 unibermarins. Les remontées de redibermarins ont été supérieures de 35 p. 100 à la moyenne des cinq dernières années (1985-1989), tandis que les remontées d'unibermarins correspondaient à peu près à la moyenne. La récolte d'unibermarins de montée (23 782 poissons) était inférieure d'environ 7 p. 100 à la récolte moyenne des cinq dernières années. On a dépassé la ponte cible en 1990 (148 p. 100), une grande partie des oeufs (80 p. 100) provenant de redibermarins. Il apparaît d'ailleurs que la ponte cible a été atteinte ou presque atteinte au cours des six dernières années dans la rivière Miramichi, comme le confirme l'augmentation correspondante des densités moyennes de juvéniles constatée lors d'expériences d'électropêche. Les saumons à pontes antérieures constituaient une plus grande proportion des remontées de gros saumon en 1990 que dans toute autre année de la période considérée (1966-1990).

INTRODUCTION

A five year conservation program for Atlantic salmon was implemented in 1984 to increase spawning levels by minimizing the harvest of multi-sea-winter (MSW) salmon. As returns of large salmon were less than projected in 1987 and 1988 another five year conservation strategy was implemented in 1989 with the objective of ensuring that target spawning requirements are met. Under these conservation strategies, commercial fishing for salmon in Miramichi Bay and estuary has been prohibited as has the possession or sale of salmon caught in non-salmon gear (by-catch). Anglers have been allowed to keep only one-sea -winter (1SW) salmon (<63 cm in fork length), with season, possession and daily bag limits of 10,6 and 2 fish, respectively. Angling seasons for various tributaries of the Miramichi River in 1989 and 1990 are summarized in Appendix 1. Indian food fisheries at Burnt Church (Miramichi Bay), and Eel Ground and Red Bank (tidal waters of the Northwest Miramichi) have not been regulated by quota or season.

The objective of this document is to evaluate the status of Atlan tic salmon in the Miramichi River in 1990. Harvests from the angling and native fisheries are summarized and spawning escapement in 1990 is estimated using Millbank trap data, and mark-and recapture data from anglers.

METHODS

1. Angling catch, effort and harvests

The New Brunswick Department of Natural Resources and Energy (DNRE) estimates angling catches and total effort in the Miramichi River each year. DNRE estimates are based on a license stub reporting system, whereby a random sample of anglers was selected and asked to return records of their angling catch and the number of days spent fishing. Total angling catches are then estimated from the 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).

The numbers of multi-sea-winter (MSW) salmon (≥63 cm in fork length) 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 in the Indian food fishery at Burnt Church, Red Bank, and Eel Ground (Figure 1) in 1990 were recorded by the Band Councils on a daily basis and reported to DFO Resource Allocation Section weekly. Independant estimates of salmon landings at Burnt Church were provided by DFO conservation and protection staff.

3. Other removals of salmon

Other removals of salmon include research samples, broodstock, and Millbank trap mortalities.

4a. Salmon enumeration

Adult Atlantic salmon entering the Miramichi River during 1990 were monitored at the Millbank trap site from 16 May to 16 October. Adult salmon returns to the Miramichi have been monitored at the Millbank trap since 1954.

Adult salmon were enumerated at five counting fences within the Miramichi watershed during 1990: Bartholomew River, Catamaran Brook, and at headwaters of three tributaries, Dungarvon River, South Branch of the Main Southwest Miramichi, and the Northwest Miramichi (Figure 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 have been made only since 1988, and salmon were counted at Catamaran Brook for the first time in 1990.

4b. Biological sampling

Most MSW (391 of 427) and approximately 1 in 5 1SW salmon (252 of 1358) captured at the Millbank trap were scale sampled and measured (FL to the nearest 0.1 cm.). One in ten 1SW salmon was sampled for internal sexing and weight (nearest 0.1 kg). In addition, sexes of 1SW and MSW salmon tagged after 1 September were identified on the basis of external characteristics. External sexing has been verified on sampled grilse during 1989 and 1990 and found to be accurate 97% of the time (n=37) after 1 September. Prior to September external sexing is not reliable. During 1990, a total of 1031 1SW salmon and 391 MSW salmon were tagged (Carlin tags with stainless steel wire).

5. Recruitment

Electrofishing surveys were conducted at 15 headwater sites within the Miramichi watershed during July 1990. Densities of juvenile Atlantic salmon (age 0+, age 1+, and age 2+ parr) were determined by the removal method (Zippin 1956) as per previous

assessments. Densities of salmon have been estimated at the same 15 sites on the Miramichi River since 1970.

6. Spawning escapement in 1990

Two methods were used to estimate the spawning escapement of 1SW and MSW salmon in the Miramichi in 1990:

Method 1. Millbank trap efficiency.
For 1990, a trap catch efficiency of 0.015 (95% confidence limits 0.012-0.020) 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. The trap count for Millbank includes trap mortalities. Spawning escapement was then estimated as returns to Millbank minus known removals of salmon at and 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 1990 from recaptures of fish tagged at Millbank trap. 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 15 January when this assessment was done) was made based on the proportion of late returns that were received during the 1988 and 1989 tagging projects.

Second, a tag reporting rate by anglers was determined. Tagged to untagged ratios in the Miramichi system were determined accurately at four counting fences and at nine angling camps (Fig. 1). In past assessments fence data and index angling camp data were pooled to determine the actual tagged to untagged ratio. In the present assessment we use fence data alone and compare the result with that calculated combining fence and angling camp data. We regard the counting fence data as more reliable because it includes data from tributaries of both the Northwest and Southwest Miramichi Rivers whereas the angling camps are all located on the Southwest Miramichi and angling camp data may suffer from non-reporting of tags. Reporting rate was then estimated as the difference between this tagging ratio and the tagging ratio from the angling fishery.

All tags applied at Millbank were assumed to be available to anglers (eligible) unless they were recaptured in the native fishery. There were no 1SW tag recaptures sent in from the native fishery in 1990.

Tags were not applied to 1SW salmon in direct proportion to their numbers. It has been shown that angler exploitation is greater for early run fish (ie. fish that enter the river prior to August 31) than late run fish (ie. fish that enter the river after August 31) in the Miramichi. A correction factor (CF) was calculated to remove bias in the proportion of early and late run fish tagged (Randall et al. 1991) as:

$$(1) \quad CF = PE/PL$$

where PE and PL were the proportions of early run and late run fish tagged, respectively.

Angling exploitation rate(U) for 1SW salmon was estimated as:

$$(2) \quad U = (RE + RL*CF)/(ME + ML*CF)$$

where RE and RL are the numbers of early and late run tagged fish recaptured, respectively. Note RE and RL are corrected for late returns and reporting rate.
ME and ML are the number of early and late run fish tagged.
CF was the correction factor from (1).

95% confidence limits for of exploitation rates were estimated assuming R (Number of recaptures) followed a poisson frequency distribution (Ricker 1975) as:

$$(3) \quad R + 1.92 \pm 1.96 \, [\, SQRT \, (\, R + 1 \,)]$$

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). MSW salmon returns were estimated by applying the ratio of the MSW to 1SW salmon counts at Millbank in 1990 (427/1358) to the estimate of 1SW returns for 1990. Historically, the proportions of MSW salmon at Millbank were significantly correlated 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.

For both Methods 1 and 2, salmon mortalities from poaching and disease (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).

7. Egg deposition requirements

Total egg deposition requirements for the Miramichi River are 132 million eggs (Randall 1985). Based on the average reproductive potential of Miramichi salmon (= number of eggs/fish), 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 1990, 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 samples collected at Millbank. Total egg deposition in 1990 was calculated as the product of reproductive potential (eggs per spawner) and the estimated numbers of 1SW and MSW spawners.

8. Forecast of salmon returns in 1991

Forecasts of salmon returns in 1991 were reported in a separate document (Claytor et al 1991) and results of that analysis are provided.
Returns of MSW and 1SW salmon were predicted from average returns over the previous five years. Indices of spawning escapement (densities of age 1+ parr) in years that will contribute to 1SW and MSW salmon returns in 1991 were also considered.

RESULTS

1. Angling catch and effort data

The angling season for salmon "kelts" ("black salmon" "slinks" - spent returning to sea) in the Miramichi River occurs from 15 April to 15 May each year. Effort increased from the 1985-89 average of 6,470 rod days to 15,454 rod days in 1990 (Table 1). Total catches of 1SW kelts also increased from an average of 3,437 fish over the last five years (1985-89) to 4,134 fish in 1990, an increase of 20%. Angling catch per unit of effort (CPUE) decreased 47% from the 1985-89 average.

Angling effort during the "bright" (adult salmon that have entered freshwater from the sea but have not yet spawned) season was 75% greater than the 1985-89 average. However, bright 1SW salmon catches and CPUE decreased in 1990 from the 1985-89 averages, by 11% and 51% respectively. Total landings of 1SW salmon in 1990, as estimated by DNRE, was 21,372 fish (Table 1). The angling catch of 15,256 fish for the early bright season (June 1st to August 31st) was 13% below the 1985-89 average. Angling camp managers reported that most fish moved through the lower stretches of angling waters to headwater areas more quickly than in other years, possibly because water levels were higher than average (Fig. 2). Angling catches for the late bright season, from September 1st to October 15th, were equal to the 1985-89 average, but less half those in 1988. Angling camp

managers reported observing large numbers of fish in pools but angling quality was lowered by higher than normal water levels (Fig. 2).

The numbers of MSW salmon caught and released by anglers in 1990 were estimated to be 9,258 fish (Table 2), 20% below the 1985-89 average.

2. Native harvests of salmon in 1990

Harvests of 1SW and MSW salmon in Indian food fisheries totalled 2,410 1SW and 1,809 MSW salmon in 1990 (Table 3). Burnt Church (situated on Miramichi Bay below Millbank) landings, as estimated by DFO conservation and protection (C&P) staff, were considerably higher than catches reported to DFO by the Band Office. DFO C&P reported that the location of nets set in the Burnt Church food fishery changed in 1990. Previously nets had been set in waters adjacent to the reserve while in 1990 nets were moved to Portage Channel, the main channel into the inner bay, and the former location of commercial salmon fishermen's nets. Estimates of the harvest at Burnt Church from DFO staff were judged to be consevative (R. Breault pers. comm.), but a more realistic estimate of the harvest than the reported catch.

Native harvests of 1SW and MSW salmon were 71% and 157% greater respectively than average harvests during the previous five years (Table 4).

Total harvests of salmon in the Miramichi River in 1990 (native and angling fisheries) were estimated to be 2,087 MSW salmon and 23,782 1SW salmon, 13% lower than the average of harvests of the previous five years (Table 4). Landings of Atlantic salmon in the Miramichi over the long term (1951 to 1990) are given in Table 4.

3. Other removals

In addition to the recorded harvests of salmon (Table 3), known salmon mortalities which were subtracted from the total returns were:

	1SW	MSW
Broodstock	0	85
Trap mortalities	37	14
Samples	105	0
Total	142	99

Removals of salmon at and above Millbank were the harvest (Table 3), PAD, and sampling-broodstock removals. Total removals at and above Millbank in 1990 were 27,609 1SW and 1,879 MSW salmon. Total removals below Millbank in 1990 were 315 1SW and 1307 MSW salmon.

4a. Counts of salmon at the Millbank trap and at headwater protection barriers

Counts of 1SW and MSW salmon at the Millbank trap from 1970-1990 are shown in Figure 3. Since the proportion of the total adult salmon returns to the Miramichi caught by the Millbank trap has changed since 1954, comparison of 1990 counts with previous Millbank counts has been limited to 1985-89, a time interval over which the trap calibration has not changed. Counts of early-run 1SW and MSW salmon were down 19% and 24% respectively, from the 1985-89 averages (Table 5). In contrast, counts of late-run 1SW and MSW fish were up 58% and 187% from their respective averages for 1985-89. MSW salmon returns were unusually late, with the highest bimonthly counts occurring during the first two weeks of October (Fig. 4). The Millbank trap was removed on October 16 and counts of late run 1SW and MSW salmon should be taken as a minimum. Over the 33 years when the Millbank trap was fished until the river began to freeze, 2% (range 0 to 23%) of late run 1SW salmon and 4% of late run MSW salmon (range 0 to 54%) were caught after October 16. The proportion of early-run versus late-run salmon in the Miramichi River during 1990 was much lower than the proportions observed since 1975, with the exception of 1988 (Table 5). Total 1SW counts were greater than in 1989 but similar to the 1985-89 average. Counts of MSW salmon were 187% greater than in 1989 and 29% above the 1985-89 average.

Counts of 1SW salmon at the barriers on the Dungarvon and North Branch of the Southwest Miramichi were 12% less and 42% greater than the 1985-89 average repectively (Table 6). The Northwest Miramichi barrier, in place since 1988, had a 1SW count 5% greater than the 1988-89 average. MSW salmon counts were and greater than the 1985-89 averages at the Dungarvon (up 41%) and Southwest (up 6%) barriers while the Northwest barrier count was 37% greater than the 1988-89 average.

4b. Biological sampling

During the 1990 salmon run, a total of 643 salmon (252 1SW salmon and 391 MSW salmon) were sampled for age composition and fork lengths, and subsamples of these were sexed (Table 7). The percent female salmon in the 1990 spawning run was 76.4% for MSW salmon and 18.3% for 1SW salmon. Based on the length-fecundity relationship for Miramichi salmon (Randall 1989) and the average fork lengths and sex ratios of salmon in 1990, reproductive potential (average eggs per spawner) was estimated to be 5,860 eggs for MSW salmon and 635 eggs for 1SW salmon (Table 7).

A larger proportion of the 1SW salmon that returned in 1990 had smoltified at river age 2 (46.8%) than in 1989 (30.4%)(Table 7). Returns of 1SW salmon in 1990 were made up about equal parts of

the 1986 and 1987 year classes (year of fry emergence).

Scale samples indicated that 38% (150/391) of the large salmon sampled at Millbank were repeat spawners. This was the highest percentage of repeat spawners in the large salmon catch at Millbank since adult aging data has been systematically collected at Millbank (1966)(Fig. 5).

5. Recruitment

Mean densities of age 0+ parr increased by 31% from 1989 to 1990 (Fig. 6). Densities of age 1+ parr averaged 0.12 fish per square metre, down 50% from 1989 but high relative to densities prior to 1986 (Fig. 6). Counts of salmon vary substantially between electroseining sites, indicating that the distribution of age 0+ and age 1+ parr is highly contagious. The utility of juvenile salmon densities as an index of spawning escapement in the Miramichi River is presently being investigated.

6. Spawning escapement in 1990.

Method 1. Millbank trap efficiency.
Counts at the Millbank trap of 1,358 1SW and 427 MSW salmon in 1990 resulted in estimates of 90,533 1SW and 28,467 MSW salmon returns to the Miramichi River at Millbank. Spawning escapement was estimated at 62,924 1SW and 26,588 MSW salmon (Table 8).

Method 2. Angling exploitation rate.
During 1990, a total of 1,031 tags were applied to 1SW salmon at Millbank, which was 76% of the 1SW salmon captured (Table 9). For MSW salmon, 391 of 427 (92%) fish were tagged at Millbank. A correction factor (1) of 1.16 (PE/PL= 0.81/0.68) was calculated to correct for differing proportions of early and late run 1SW salmon tagged at Millbank.

To date (15 January 1991) a total of 107 tags have been returned by anglers from 1SW salmon tagged in 1990. During the 1988 and 1989 tagging programs, 3% of the total tag returns from early-run 1SW salmon were returned after January 15th of the following year, and 8% of tag returns from late-run 1SW fish were returned after January 15th (Table 10). Returns of tags in 1990 were therefore adjusted upwards based on these percentages (Table 11). The adjustment for potential late returns of tags increased the number of tags returned in 1990 to 112.

Data used to estimate the reporting rate of tags by anglers in 1990 are summarized in Table 11. Tagged to untagged ratios at the four counting fences in 1989 and 1990 were similar. However, the tagged to untagged ratios from index angling camps in 1990 was 32% lower than in 1989, and 50% lower than the ratio from counting fences. Angling camp and counting fence data were so

different that two ratios of tagged to untagged fish were calculated for 1990, one pooling all the data as in 1989 (0.0088) and the second using only the counting fences (0.0117). The total angling fishery indicated a ratio of tagged to untagged fish of 0.0052. Reporting rates by anglers were calculated to be 0.60 (0.0052/0.0088) using the camp and fence data and 0.45 (0.0052/0.0117) using the fence data alone. We regard counting fence data as a better measure of tagged to untagged fish ratios for several reasons. First, all the angling camps were on the Southwest Miramichi whereas the counting fences were distributed throughout the river system (Fig. 1). Second, the angling camp data may be susceptible to non-reporting of recaptured tags. As well, reporting rates in years when recapture traps were operated ranged from 0.38 to 0.55 (Randall, Moore, and Pickard 1990). Counting fences are expensive to operate and it is uncertain that these data will always be available. Therefore, attempts will be made to obtain data from angling camps on the Northwest Miramichi in 1991.

Angling exploitation rates for 1SW salmon in 1990 were calculated to be 0.24 (95% confidence limits 0.21 to 0.27) based on a tag reporting rate of 0.45 (Table 12).

Returns of 1SW salmon to Millbank were estimated to be 89,204 fish. MSW returns of 28,049 fish were calculated for these exploitation rates by multiplying the appropriate 1SW returns by the ratio of MSW to 1SW counts at Millbank.

Numbers of spawners as estimated by Method 1 and 2 were close (Table 8). Total returns were estimated to be 29,307 to 29,779 MSW salmon and 89,519 to 90,848 1SW salmon. Spawning escapements were estimated as 26,170 to 26,588 MSW salmon and 61,595 to 62,924 1SW salmon. Assuming a reproductive potential of 5,860 eggs per MSW spawner and 635 eggs per 1SW spawner (Table 7), the above spawning escapements indicate total egg depositions of 146% to 148% of the target egg depositions for the Miramichi River.

7. Egg deposition levels, 1970 to 1989

Returns and spawning escapements of 1SW and MSW salmon in the Miramichi River from 1970 to 1990, as estimated from Millbank trap data (Method 1), are summarized in Table 13. Numbers of MSW spawners as estimated from Millbank data (Method 1) had significant positive correlations with other indices of spawning escapement in the Miramichi River, including angling catches of MSW salmon (bright fish) and 1+ parr densities (Table 14). Correlations with other indices of spawning escapement, angled catch of MSW kelts and 0+ parr densities, were positive but not significant. 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). The egg deposition rate in 1990 was estimated to be 3.6 eggs per m^2; MSW salmon contributed 80% of the total egg contribution (Fig. 7).

Correlations between estimated egg deposition levels in the Miramichi River, and resulting 0+ and 1+ parr densities were significant (r^2=0.52 p=0.0005 n=19 for 0+ parr; r^2=0.55 p=0.0004 n=18 for 1+ parr)(Fig. 8).

8. Forecast for 1991

Assuming average returns of salmon in 1991, returns could be 23,887 MSW and 98,073 1SW salmon (based on an average of total returns in 1986-90 from Table 13). For the past 5 years the coefficient of variation in total returns has been 25% for MSW salmon and 21% for 1SW salmon. Long term (1971-90) averages were 26,277 MSW salmon (CV=37%) and 62,619 1SW salmon (CV=47%).

Indices of spawning escapement (age 1+ parr) and adult survival in years that will produce 1SW and MSW salmon returns in 1991 were also considered. As a possible index of sea survival of the smolt group that will return as MSW salmon in 1991, returns of 1SW salmon in 1990 were compared to the average of returns in 1985-89. Also, mean densities of 1+ parr for 1987 were compared to the average of densities in 1982-86 as a possible index of recruitment strength of MSW salmon in 1991. Lastly mean densities of 1+ parr in 1988 are compared to average densities in 1983-87 as an index of recruitment strength of 1SW salmon in 1991.

	Spawning or survival index	
	1SW returns	Age 1+ parr
MSW salmon (1991) (index years)	-2% (1990)	+49% (1987)
1SW salmon (1991) (index year)	-	+47% (1988)

The spawning/survival indices suggest that both MSW and 1SW returns in 1991 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 greater in 1990 than in 1989. Total returns of MSW salmon are a minimum estimate because the Millbank trap was removed on October 16 when salmon were still entering the river. Total returns in 1990 were

estimated as 29,774 MSW salmon and 90,848 1SW salmon (Method 1), compared to 17,211 MSW salmon and 75,231 1SW salmon in 1989. The total harvest of bright 1SW salmon in 1990 (23,782 fish) was 7% less than the average harvest over the previous five years (25,486 fish). Management measures restricting the harvest of MSW salmon succeeded in allowing a high percentage (89%) of total MSW returns to survive and spawn. The large number of repeat spawners returning to spawn in 1990, 38% of the MSW salmon returns and 9% of the total returns to Millbank, was unusual. Previous spawners have made up more than 5% of total counts at Millbank in only one other year (1968 - 8%) since 1966 (unpublished data).

Egg deposition requirements were exceeded in 1990 (148% (Method 1); Fig. 7) and most (80%) of the total egg deposition came from MSW salmon. Target egg deposition rates have apparently been achieved or nearly achieved in the last six years in the Miramichi River (Fig. 7). Average 0+ and 1+ parr densities of juvenile salmon in headwater electrofishing sites seem to reflect the increases in egg deposition (Fig. 6 and Fig. 8).

Estimates of total returns of salmon in 1990 as calculated from Millbank trap data and from mark-recapture data were virtually the same. As in the 1989 assessment, mark-recapture data were useful for providing an estimate of returns which was independent of the Millbank trap counts. Tag reporting rates for anglers in 1990 were estimated to be 0.45 (Table 11).

An angling exploitation rate of 0.24 was estimated for 1SW salmon by mark recapture in 1990. Previous estimates (1966-89) ranged between 0.17 to 0.46, and averaged 0.28 (Randall et al. 1990). Angling effort was 75% greater than average effort over the last five years. A combination of high discharge lewvels and large numbers of fish returning in the late run probably kept angling exploitation low.

More repeat spawning salmon returned to the Miramichi in 1989 and 1990 than in any previous years (1971-90). Previously, large percentages of repeat spawners in the MSW catches resulted from poor returns of virgin MSW salmon (1979 and 1981). Between the years 1971-87 no salmon were found in Millbank samples that were repeat spawners returning to spawn for the fourth time (as indicated from spawning marks on scales). Since 1988 increasing numbers of repeats returning for their fourth spawning have been identified. These increases are probably due to the management plan which has closed the commercial fishery and prohibited anglers from keeping large salmon.

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Table 1. Angling catch and effort data for 1SW salmon in the Miramichi River as estimated by DNRE, 1969 to 1990.

Year	Kelt Catch	Kelt Rod Days	Kelt CPUE	Early Bright Catch	Late Bright Catch	Total Bright Catch	Bright Rod Days	Bright CPUE
1969	2547	21646	0.12	17823	6461	24284	48525	0.50
1970	3719	5746	0.65	13880	5730	19610	56994	0.34
1971	2380	6447	0.37	11276	2451	13727	43074	0.32
1972	1500	3808	0.39	16053	3048	19101	50604	0.38
1973	1538	7997	0.19	12038	1819	13857	59620	0.23
1974	1512	7013	0.22	15542	2690	18232	59843	0.30
1975	1760	7616	0.23	13314	2284	15598	59746	0.26
1976	2316	6197	0.37	23384	3798	27182	66157	0.41
1977	2380	8082	0.29	12546	1044	13590	65266	0.21
1978	1401	7083	0.20	7357	908	8265	68635	0.12
1979	1476	6244	0.24	12654	1854	14508	67599	0.21
1980	2242	7064	0.32	9674	2323	11997	58074	0.21
1981	1732	6373	0.27	19205	3511	22716	72868	0.31
1982	2691	8910	0.30	19233	2169	21402	76041	0.28
1983	2060	6690	0.31	7310	1080	8390	87620	0.10
1984	862	1403	0.61	8472	1925	10397	.	.
1985	2385	4196	0.57	17111	1328	18439	61693	0.30
1986	2473	6394	0.39	20611	5552	26163	67801	0.39
1987	2748	11180	0.25	14824	5941	20765	64453	0.32
1988	4216	4455	0.95	17971	12649	30620	82103	0.37
1989	5361	6124	0.88	17321	7105	24426	72892	0.34
1990	4134	15454	0.27	15256	6116	21372	122470	0.17
Mean(85-89)	3437	6470	0.53	17568	6249	24083	69788	0.35
% chg (90-avg)/avg	+20	+139	-47	-13	-2	-11	+75	-51

Footnote: Early bright catch= Catch from June 1st to August 31st
Late bright catch = Catch from September 1st to October 31st

Table 2. Angling statistics for MSW and 1SW salmon in the Miramichi as reported by N. B. DNRE.

Year	MSW Salmon (brights)	1SW Salmon (brights)
1969	3804	24284
1970	3268	19610
1971	1792	13727
1972	8933	19101
1973	5977	13857
1974	7184	18232
1975	6288	15598
1976	7374	27182
1977	11617	13590
1978	4893	8265
1979	2656	14508
1980	6546	11997
1981	3238	22716
1982	4608	21406
1983	2240	8390
1984	4692	10397
1985	9622	18439
1986	14266	26163
1987	11932	20765
1988	10095	30620
1989	11933	24426
1990	9258	21372
Mean 1985-89	11570	24083
% Change (90-Mean)/Mean	-20	-11

Note: 1984-90 Multi-sea -winter salmon statistics represent numbers of fish hooked and released.
1984 Catches are from DFO

Table 3. Preliminary salmon harvests in the Miramichi River above Millbank (HR) and estuary below Millbank (HE1), 1990. Harvests in 1989 are given for comparison.

	1989		1990	
	1SW	MSW	1SW	MSW
1. Miramichi River above Millbank				
Native				
Red Bank reported	800	400	900	300
estimated by DFO C&P	1980	1020	-	-
Eel Ground	254	62	1195	202
Angling	24426	358	21372	278
Total	26660	1440	23467	780
2. Miramichi estuary below Millbank				
Native				
Burnt Church reported	31	78	15	107
estimated by DFO C&P	-	-	315	1307
Angling	-	-	-	-
Total	31	78	315	1307

Note: MSW angling kills are calculated assuming a catch-and-release mortality rate of 0.03.
Food fishery harvests are estimates from DFO C&P and native bands.

Table 4. Recorded catches of salmon in all fisheries, Miramichi River and Bay, 1951–90 (includes commercial, by-catch, recreational, and native). Kelts angled in year i are added to landings in year i–1. 1990 data are preliminary. All data are numbers X 1000.

Year	Commercial Fishery			Angling Fisheries							Native Fishery			All Fisheries
				Kelts (yr i+1)			Brights (yr i)							
	1SW	MSW	Total	1SW	MSW	Total	1SW	MSW	Total	All	1SW	MSW	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	1.6	0.7	2.3	8.4	2.2	10.6	12.9	0.4	0.2	0.6	32.1
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	5.4	0.0	5.4	30.6	0.0	30.6	36.0	0.9	0.3	1.2	37.2
1989	0.0	0.0	0.0	3.9	0.0	3.9	24.4	0.0	24.4	28.3	2.3	1.2	3.5	31.4
1990	0.0	0.0	0.0	–	0.0	–	21.7	0.0	21.7	21.7	2.4	1.8	4.2	25.9
1985–89 Mean											1.4	0.7	2.1	29.8
% change = (90–mean)/mean											+71	+157	+100	–13

Table 5. Counts of 1SW and MSW salmon at Millbank, 1954 to 1990. Counts are divided into early (May to August 31) and late periods.

	TIME							
	Early		Late		Total		Proportion early 1SW	Proportion early MSW
YEAR	1SW	MSW	1SW	MSW	1SW	MSW		
1954	904	347	925	1783	1829	2130	0.49	0.16
1955	646	99	1161	2747	1807	2846	0.36	0.03
1956	1145	216	2289	3142	3434	3358	0.33	0.06
1957	1322	516	2696	3410	4018	3926	0.33	0.13
1958	2152	549	6250	3823	8402	4372	0.26	0.13
1959	760	209	1400	4094	2160	4303	0.35	0.05
1960	1079	216	3424	4458	4503	4674	0.24	0.05
1961	2213	358	4639	2634	6852	2992	0.32	0.12
1962	1576	254	1387	1661	2963	1915	0.53	0.13
1963	2765	184	11343	1455	14108	1639	0.20	0.11
1964	4674	210	4269	798	8943	1008	0.52	0.21
1965	5023	399	10762	1418	15785	1817	0.32	0.22
1966	4564	310	5426	1323	9989	1632	0.46	0.19
1967	1480	73	6216	924	7723	997	0.19	0.07
1968	2492	292	726	1127	3239	1414	0.77	0.21
1969	3224	333	1116	328	4350	667	0.74	0.50
1970	1826	125	658	120	2484	245	0.74	0.51
1971	1849	370	113	24	1962	394	0.94	0.94
1972	2378	948	164	219	2542	1167	0.94	0.81
1973	1490	478	960	655	2450	1133	0.61	0.42
1974	2948	864	1090	927	4038	1791	0.73	0.48
1975	2954	629	594	580	3548	1209	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	115	58	1265	593	0.91	0.90
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	966	294	44	39	1010	333	0.96	0.88
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
1990	858	189	500	238	1358	427	0.63	0.44
85-89 avg	1063	248	317	83	1381	331	0.77	0.75
% chg (90-avg)/avg	-19	-24	+58	+187	-2	+29	-19	-41

Table 6. Numbers of MSW and 1SW salmon counted at barriers in three tributaries of the Miramichi River, 1981 to 1990.

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	1096	Jul. 1–Oct. 20	112
	1986	1138	2072	3210	Jun. 30–Oct. 19	110
	1987	1266	1175	2441	Jul. 2–Oct. 19	110
	1988	929	1092	2021	Jun. 30–Oct. 24	117
	1989	731	969	1700	Jul. 1–Oct. 24	116
1985–89	Mean	934	1160	2094		
	1990	994	1646	2334	Jun. 29–Oct. 14	108
% chg (90–avg)/avg		+6	+42	+11		
Dungarvon R.	1981	112	550	662	Jun. 24–Oct. 8	107
	1982	122	483	605	Jun. 28–Oct. 15	110
	1983	126	330	456	Jun. 28–Oct. 14	109
	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	1128	Jun. 2–Oct. 25	151
	1989	315	579	894	Jun. 1–Oct. 10	132
1985–89	Mean	226	642	868		
	1990	318	562	880	Jun. 1–Oct. 11	133
% chg (90–avg)/avg		+41	−12	+3		
Northwest Miramichi R.	1988	234	1614	1848	Jun. 27–Oct. 26	122
	1989	234	901	1135	May 30–Oct. 12	136
	Mean	234	1258	1492		129
	1990	331	1318	1649	May 29–Oct. 18	143

Table 7. Biological characteristics of adult salmon sampled at the Millbank trap, 1990.

1. Fork length, sex ratio, and reproductive potential.

Sea age	n	FL	SD	n	% female	eggs/spawner
MSW	391	79.8	8.36	271	76.4	5860
1SW	252	55.1	3.34	175	18.3	635

2. Smolt ages

	n	% at age 2	3	4
1SW (1990)	252	46.8	50.0	3.2
1SW (1989)	283	30.4	66.1	3.5
1SW (1988)	201	54.7	42.8	2.5

Note : Eggs/ spawner are calculated for 1SW and MSW salmon as follows (Randall 1989):

$$\text{Eggs/spawner (1SW)} = \% \text{ Female} \times e^{(3.1718 \times FL - 4.5636)}$$

$$\text{Eggs/spawner (MSW)} = \% \text{ Female} \times e^{(1.4132 \times FL + 2.7560)}$$

Table 8. Spawning escapement as estimated by methods 1 (Millbank trap efficiency) and 2 (angling exploitation rates). 95% confidence limits for estimates of returns to Millbank, spawning escapement, % of required spawners, and % required egg deposition are shown in brackets.

	Method 1	Method 2 exploitation rate 0.24 (0.45 reporting rate)
MSW salmon		
1. Total returns	29774	29307
2. Harvest below Millbank	1307	1307
3. Returns to Millbank	28467 (21350-35583)	28049 (24854-31654)
4. Harvest above Millbank	780	780
5. PAD (poaching and disease)	1000	1000
6. Broodstock/trap mortalities	99	99
7. Spawners	26588 (19471-33704)	26170 (22975-29775)
8. Required spawners	23600	23600
% achieved	113% (83-143%)	111% (97-126%)
1SW salmon		
1. Total returns	90848	89519
2. Harvest below Millbank	315	315
3. Returns to Millbank	90533 (67900-113167)	89204 (79043-100671)
4. Harvest above Millbank	23467	23467
5. PAD	4000	4000
6. Broodstock/trap mortalities	142	142
7. Spawners	62924 (46007-91274)	61595 (51701-74316)
8. Required spawners	22600	22600
% achieved	278% (178-379%)	273% (229-329%)
% egg deposition	148% (106-191%)	146% (127-168%)

Table 9. Number of 1SW salmon tagged and number of 1SW tags returned by anglers during 1990.

	early run	late run	total
Trap count	858	500	1358
Tagged	693	338	1031
Eligible tags (a)	693	338	1031
Proportion tagged	0.81	0.68	0.76
Recaptures	78	29	107
Late recaptures (b)	2	3	5
Total	80	32	112

a. Number tagged minus removals of tagged fish by native fishermen and other mortalities below scheduled salmon angling waters.
b. An estimate of the number of recapture tags from 1990 which will be sent in after January 15,1991.

Table 10. Number and percentage of 1SW tags returned by anglers before and after January 15 (of the tagging year+1) during 1988 and 1989.

Period	Number of recaptures by January 15	Number of recaptures total	% late returns
1988			
early	100	103	3
late	76	82	7
1989			
early	85	87	2
late	1	2	50
total early	185	190	3
total late	77	84	8

Table 11. Estimated tagged to untagged ratios, and tag return rates of 1SW salmon for 1990.

Location	Count or catch	Recaptures	Proportion
A. Counting fences			
1. Bartholomew	443	3	0.0068
2. Catamaran Brook	76	1	0.0132
3. Dungarvon	562	11	0.0196
4. NW Miramichi	1318	13	0.0099
Total	2399	28	0.0117
Total 1989	2260	23	0.0102
B. Index angling camps			
1. Rocky Brook	544	3	0.0055
2. Miramichi Club	222	1	0.0045
3. Wades	243	2	0.0083
4. Halfway Bar	103	1	0.0097
5. Black Brook	240	2	0.0083
6. Clearwater	319	0	
7. Deadman	233	1	0.0043
8. Rocky Bend	157	3	0.0191
9. Burnt Hill	306	1	0.0033
Total	2397	14	0.0058
A. and B. Total 1990	4796	42	0.0088
C. Total Angling 1990	21372	112	0.0052
D. Tag return rates			
1990 C/(A+B)			0.60
1990 C/A			0.45

Table 12. Summary of 1SW mark-recapture data from the angling fisheries in the Miramichi River, 1990. Exploitation rates and total returns are also estimated.

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

Reporting rate	Number tagged		Correction	Angling	Number of recaptures	
	early	late	factor	catch	early	late
0.45	693	338	1.19	21372	177.8	71.1
0.60	693	338	1.19	21372	133.3	53.3
0.80	693	338	1.19	21372	100	40
1.00	693	338	1.19	21372	80	32

2. Angling exploitation

Reporting rate	Exploitation rate
0.45	0.24 (0.21; 0.27)
0.60	0.18 (0.16; 0.21)
0.80	0.13 (0.11; 0.16)
1.00	0.11 (0.09; 0.13)

3. Total returns

Reporting rate	Returns to Millbank
0.45	89,204 (79,043; 100,671)
0.60	118,938 (103,440; 136,760)
0.80	158,584 (134,979; 186,321)
1.00	198,230 (165,551; 237,366)

Note: The correction factor eliminates bias created from tagging differing proportions of fish from the early and late run (see Methods).

Table 13. Estimates of spawning escapement (S) and total returns (R) of MSW and 1SW salmon (from Method 1)in the Miramichi River, 1971 to 1990.

Year	HE1	HE2	HR	MIL	PAD	E1	MILR	S	R	S/R
MSW salmon										
1971	15,128	3,140	1,792	399	1,000	0.043	9,279	3,347	24,407	0.14
1972	2,282	163	8,933	1,151	1,000	0.043	26,767	16,671	29,049	0.57
1973	866	0	5,977	1,132	1,000	0.043	26,326	19,349	27,192	0.71
1974	941	22	7,184	1,791	1,000	0.043	41,651	33,445	42,592	0.79
1975	724	19	6,626	1,208	1,000	0.043	28,093	20,448	28,817	0.71
1976	871	7	7,591	943	1,000	0.043	21,930	13,332	22,801	0.58
1977	6,865	0	12,060	1,934	1,000	0.043	44,977	31,917	51,842	0.62
1978	8,377	0	5,287	693	1,000	0.043	16,116	9,829	24,493	0.40
1979	1,659	0	2,854	318	1,000	0.043	7,395	3,541	9,054	0.39
1980	10,899	0	6,546	1,093	1,000	0.043	25,419	17,873	36,318	0.49
1981	7,137	699	3,738	199	1,000	0.022	9,045	3,608	16,182	0.22
1982	12,213	298	4,989	408	1,000	0.022	18,545	12,258	30,758	0.40
1983	16,788	269	2,409	245	1,000	0.022	11,136	7,458	27,924	0.27
1984	1	0	449	333	1,000	0.022	15,136	13,687	15,137	0.90
1985	5	0	611	311	1,000	0.015	20,733	19,122	20,738	0.92
1986	18	0	1,051	469	1,000	0.015	31,267	29,216	31,285	0.93
1987	21	0	1,344	291	1,000	0.015	19,400	17,056	19,421	0.88
1988	78	0	687	325	1,000	0.015	21,667	19,980	21,745	0.92
1989	78	0	1,593	257	1,000	0.015	17,133	14,540	17,211	0.84
1990	1,307	0	879	427	1,000	0.015	28,467	26,588	29,774	0.89
Mean 1985-89			1057				22,040	19,982	22,080	
% Change=(90-mean)/mean			-17				+29	+33	+35	
1SW salmon										
1971	0	0	13,727	1,962	4,000	0.055	35,673	17,946	35,673	0.50
1972	39	0	19,101	2,543	4,000	0.055	46,236	23,135	46,275	0.50
1973	0	0	13,857	2,540	4,000	0.055	44,545	26,688	44,545	0.60
1974	0	0	18,232	4,038	4,000	0.055	73,418	51,186	73,418	0.70
1975	393	0	16,040	3,548	4,000	0.055	64,509	44,469	64,902	0.69
1976	1,780	39	27,381	4,939	4,000	0.055	89,800	58,380	91,580	0.64
1977	379	28	14,089	1,505	4,000	0.055	27,364	9,247	27,743	0.33
1978	1,232	2	8,700	1,268	4,000	0.055	23,055	10,353	24,287	0.43
1979	5,510	2	14,605	2,500	4,000	0.055	45,455	26,848	50,965	0.53
1980	2,697	0	11,997	2,139	4,000	0.055	38,891	22,894	41,588	0.55
1981	1,332	296	23,716	2,174	4,000	0.034	63,941	35,929	65,273	0.55
1982	1,997	314	22,068	2,665	4,000	0.034	78,382	52,000	80,379	0.65
1983	1,360	229	8,746	810	4,000	0.034	23,824	10,849	25,184	0.43
1984	1	0	10,777	1,010	4,000	0.034	29,706	14,929	29,707	0.50
1985	0	0	18,985	912	4,000	0.015	60,800	37,815	60,800	0.62
1986	16	0	28,135	1,763	4,000	0.015	117,533	85,398	117,549	0.73
1987	16	0	22,023	1,272	4,000	0.015	84,800	58,777	84,816	0.69
1988	52	0	31,589	1,828	4,000	0.015	121,867	86,278	121,919	0.71
1989	31	0	26,815	1,128	4,000	0.015	75,200	44,385	75,231	0.59
1990	315	0	23,609	1,358	4,000	0.015	90,533	66,924	90,848	0.74
1985-89 Mean			25,509				92,040	62,531	92,063	
% Change=(90-Mean)/Mean			-7				-2	-7	-1	

HE1= harvest in estuary below Millbank
HE2= harvest in estuary above Millbank
HR = harvest in river (includes broodstock, Millbank trap mortalities, and samples)
MIL= Millbank trap count
PAD= poaching and disease
E1 = Millbank catch efficiencies
MILR= returns to Millbank
S = spawners
R = total returns

Table 14. Indices of spawning escapement in the Miramichi River, 1970 to 1990.

Year (i) 1	Angled Kelt MSW (i) 2	Angled Bright MSW (i-1) 3	0+ fry (i) 4	1+ parr (i+1) 5	Spawners (i-1) 6
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	7,382	10,095	72.2	12.4	19,980
1990	5,720	11,933	94.6	-	14,540

Correlations:

	n	r	p
2 with 3	21	0.78	0.0001
2 with 4	21	0.83	0.0001
2 with 5	20	0.83	0.0001
2 with 6	19	0.41	0.0825
3 with 4	21	0.77	0.0001
3 with 5	20	0.75	0.0001
3 with 6	19	0.72	0.0005
4 with 5	20	0.81	0.0001
4 with 6	19	0.36	0.1298
5 with 6	18	0.54	0.0219

Note: Spawners are estimated from Method 1

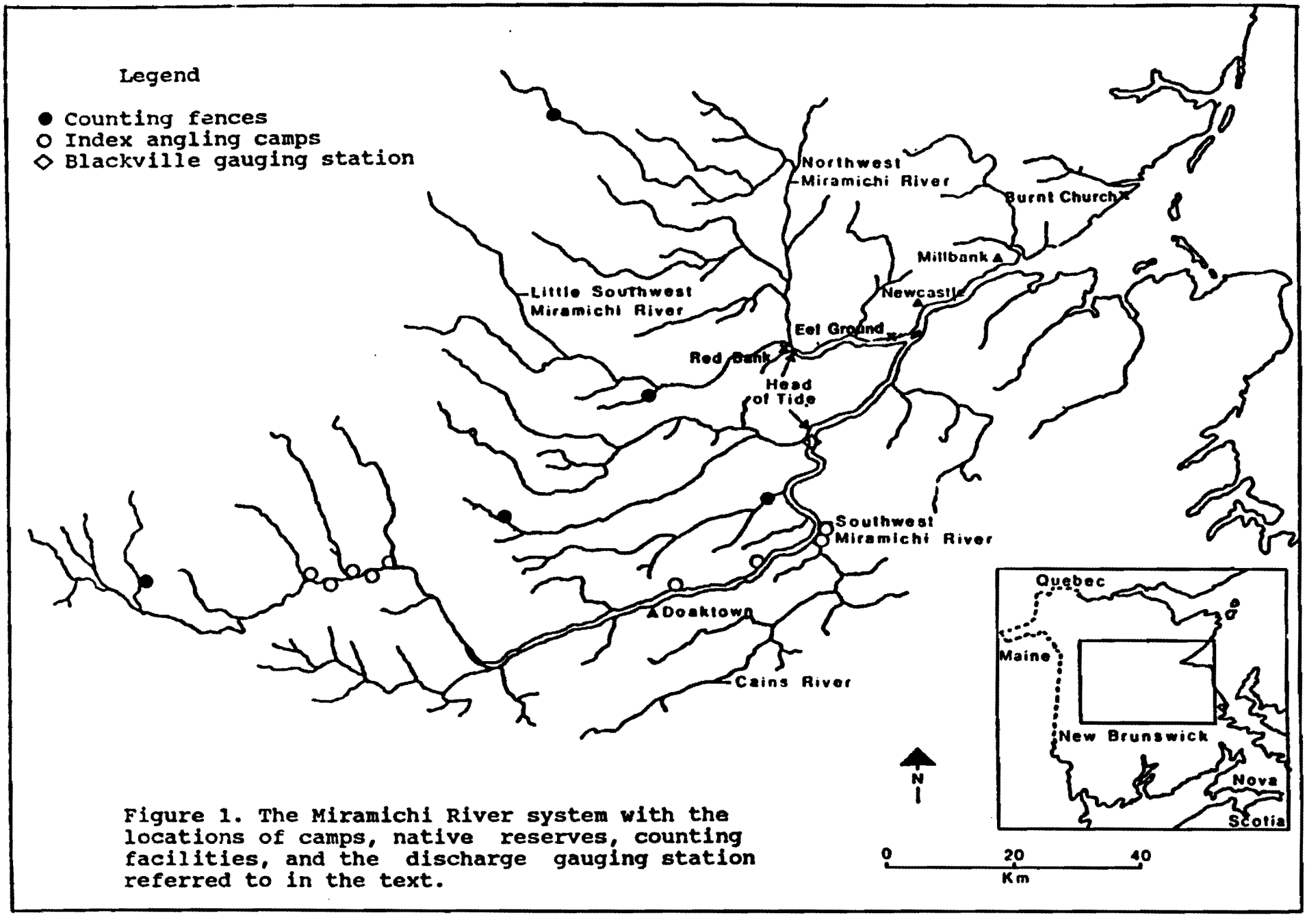


Figure 1. The Miramichi River system with the locations of camps, native reserves, counting facilities, and the discharge gauging station referred to in the text.

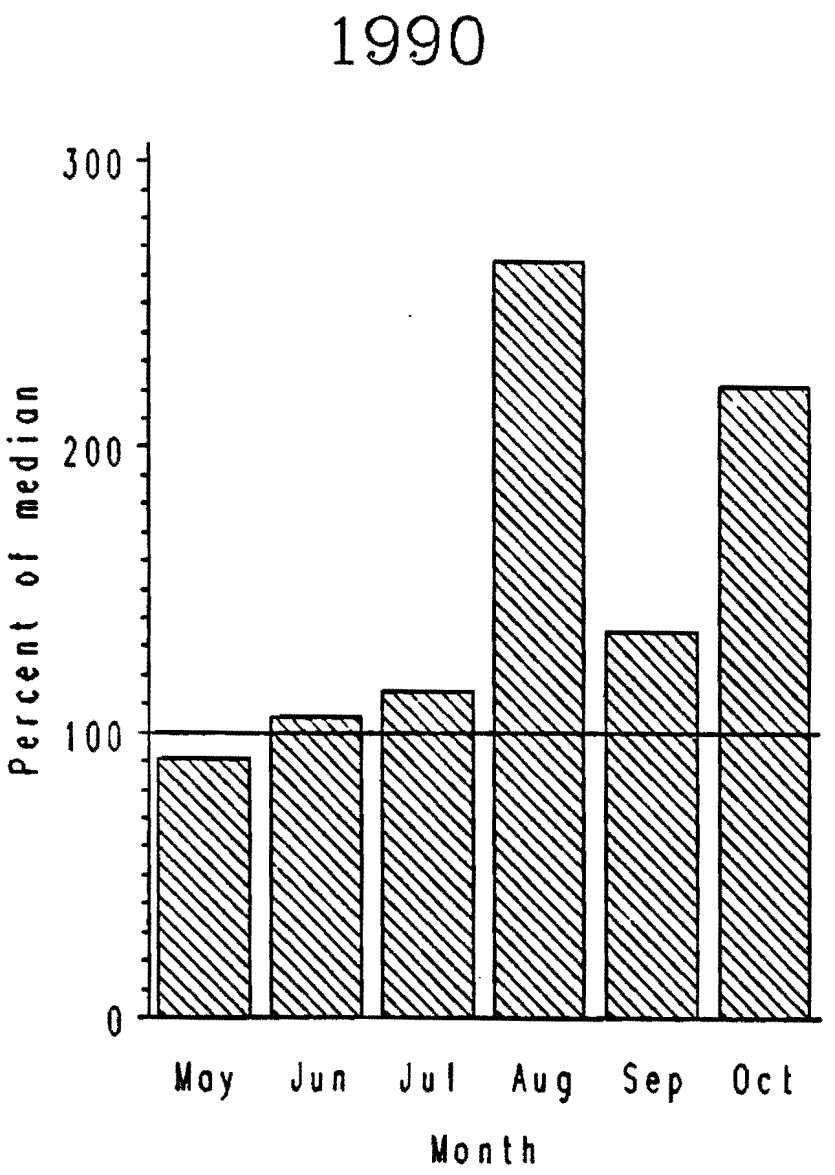


Figure 2. Mean monthly water discharge rates, expressed as a percent of the long term median, at the Blackville gauging station, in 1990.

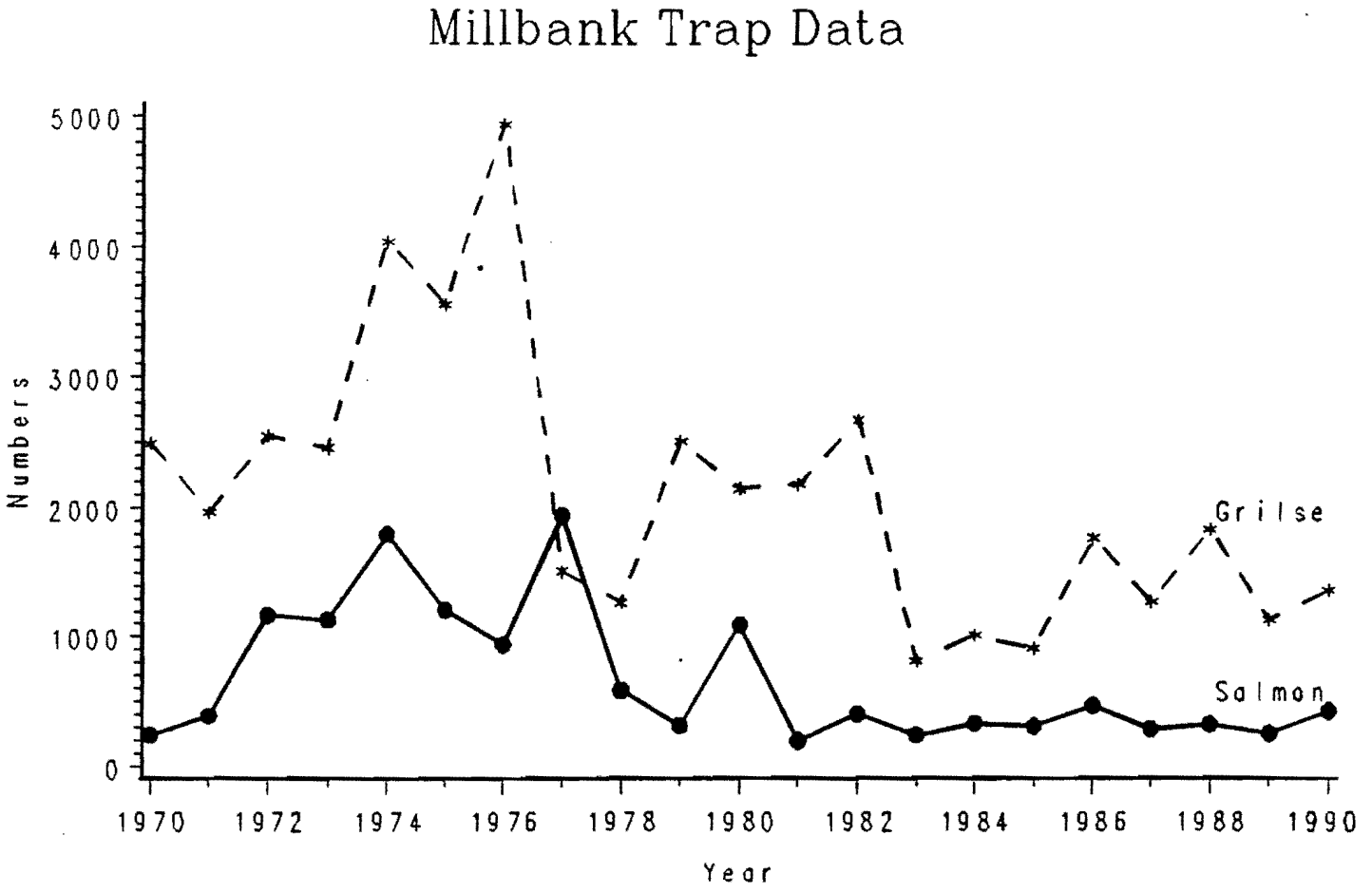


Figure 3. Numbers of MSW salmon (solid line) and 1SW salmon (dashed line) counted at Millbank trap from 1970 to 1990.

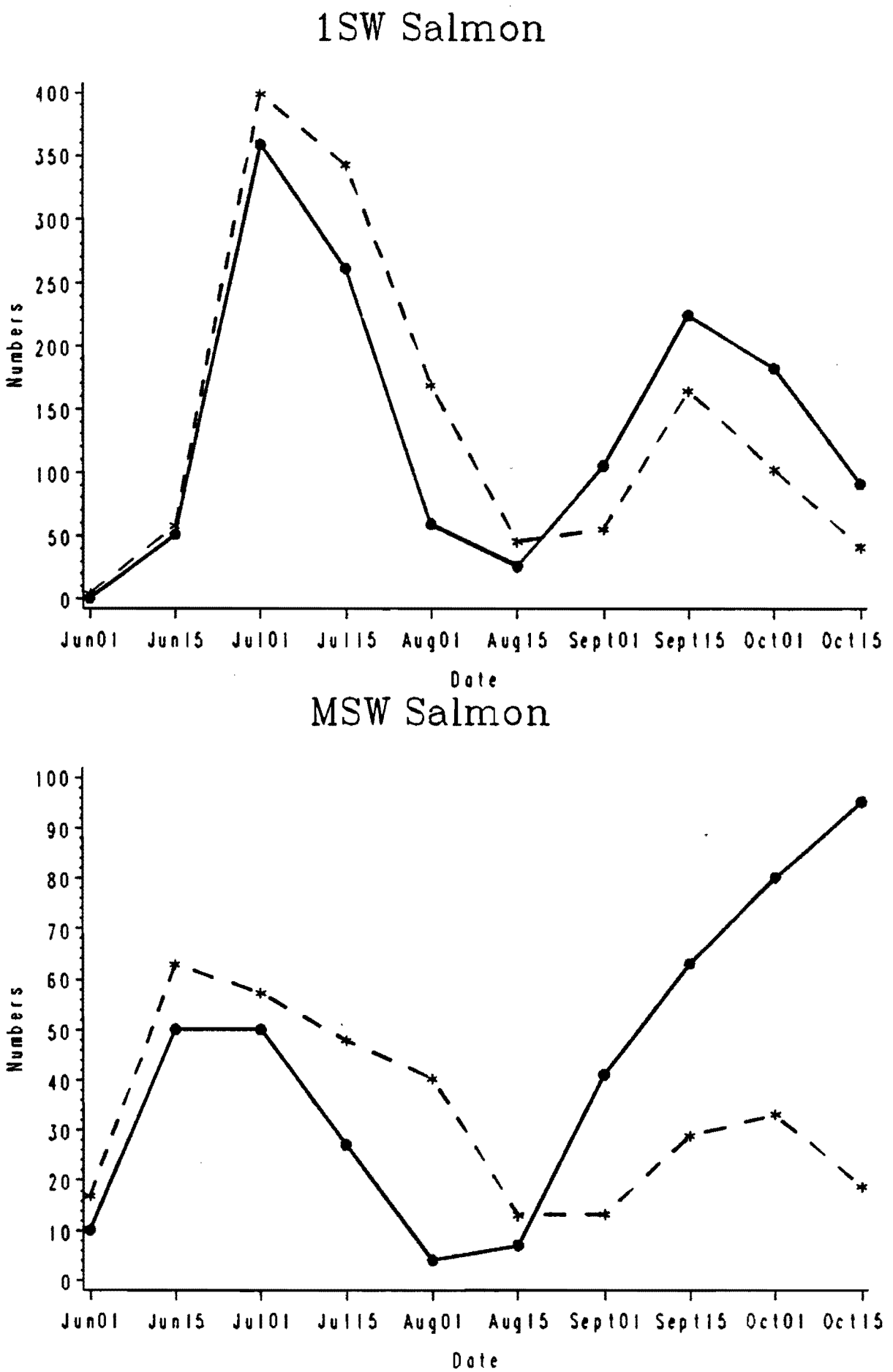


Figure 4. Bimonthly counts of 1SW (upper) and MSW (lower) salmon at the Millbank trap in 1990 (solid line) and 1985-89 (dashed line).

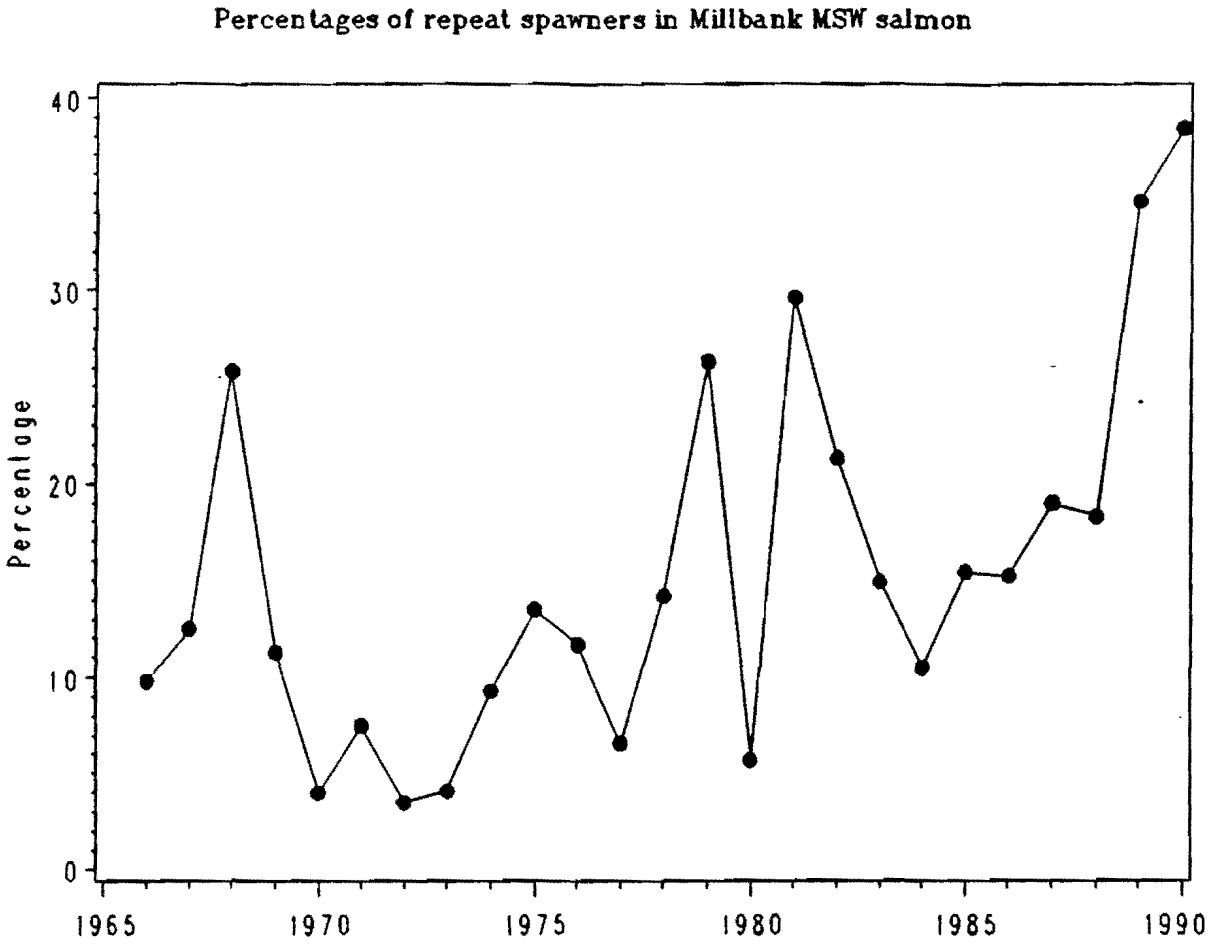
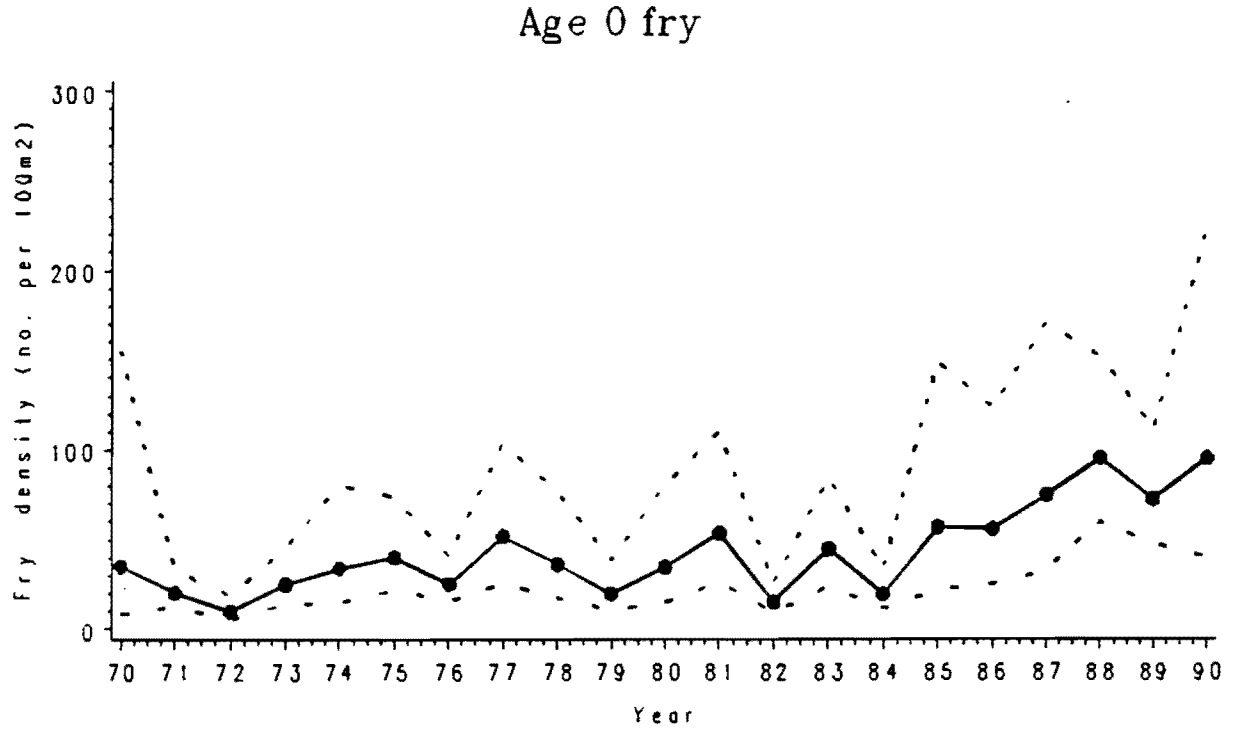


Figure 5. Percentages of repeat spawners in MSW salmon sampled at Millbank, 1966 to 1990.



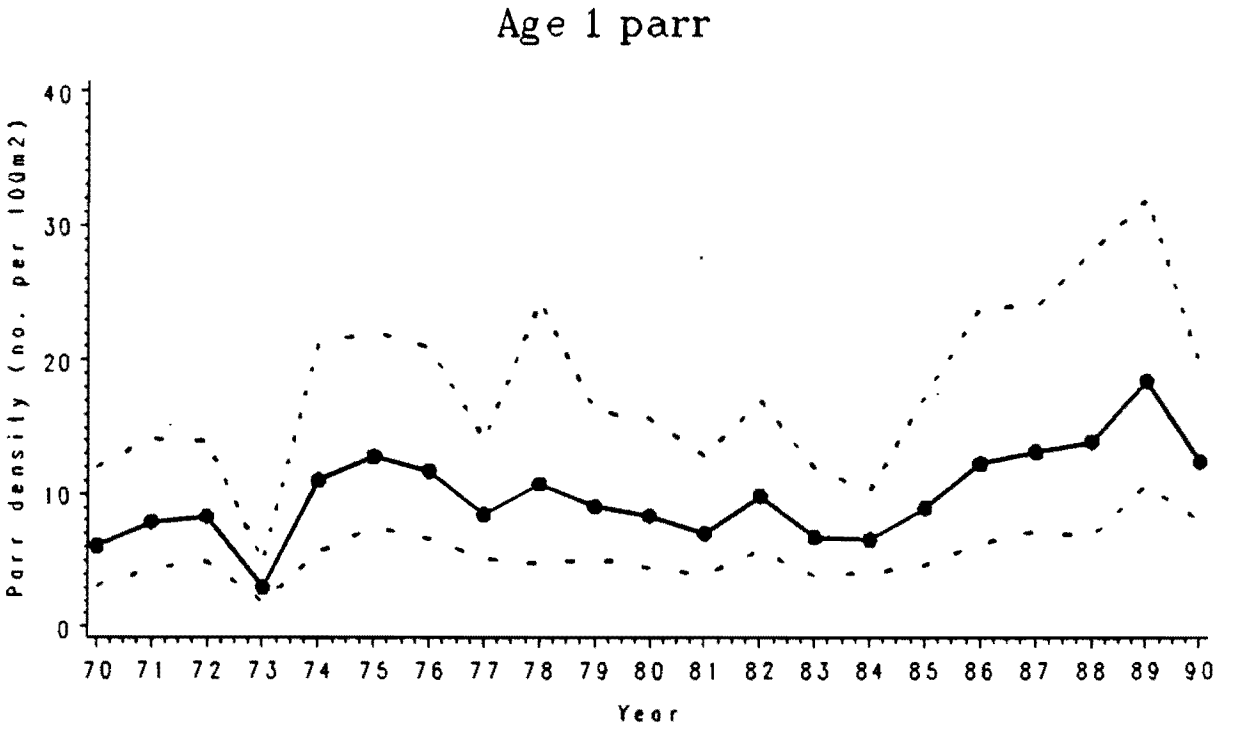


Figure 6. Mean densities of age 0+ (upper) and age 1+ (lower) parr at 15 electrofishing sites in the Miramichi River, 1970 to 1990. Densities are numbers per 100 square meters of stream area. The upper and lower 95% confidence limits of the means are shown as dashed lines.

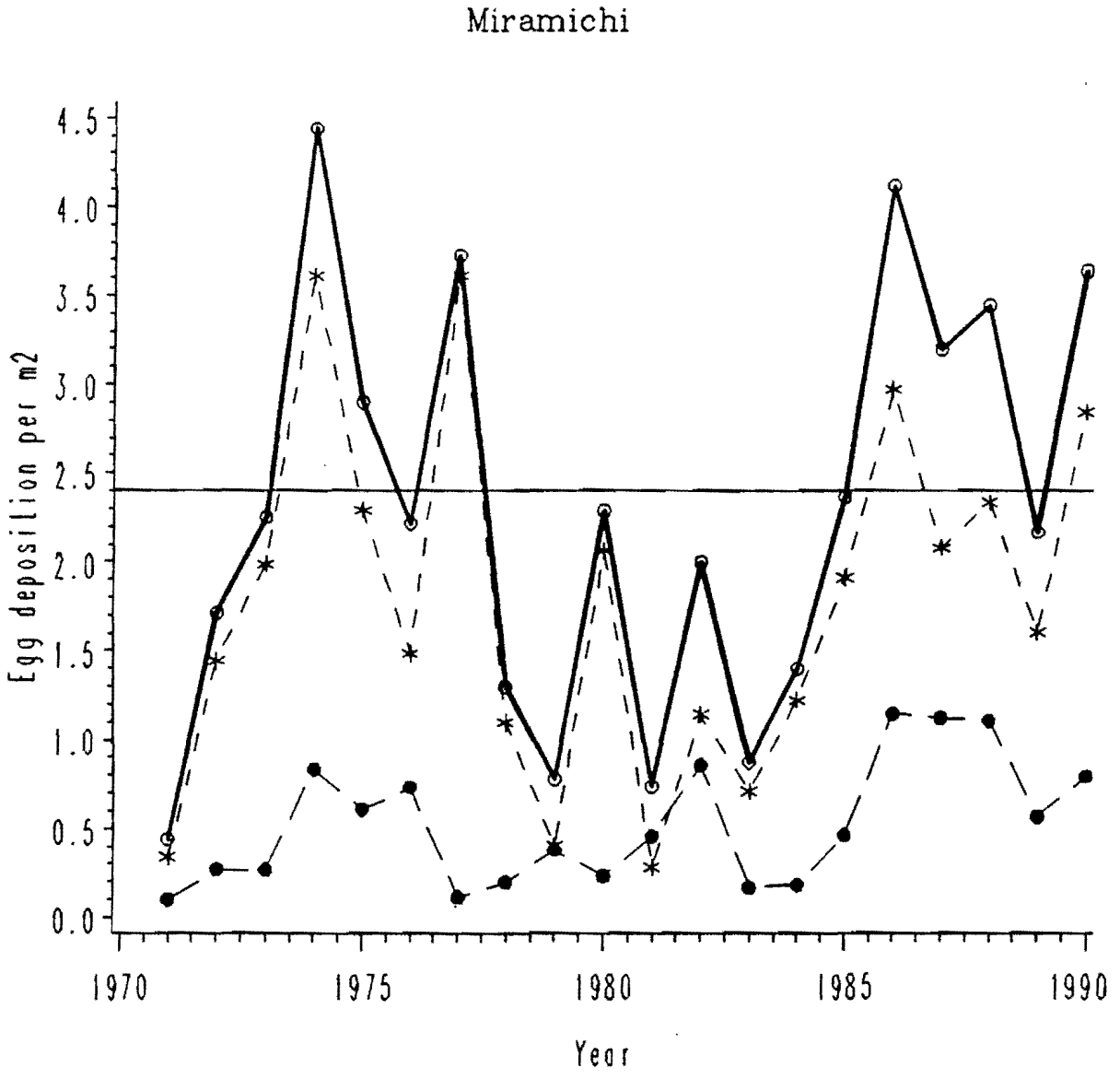
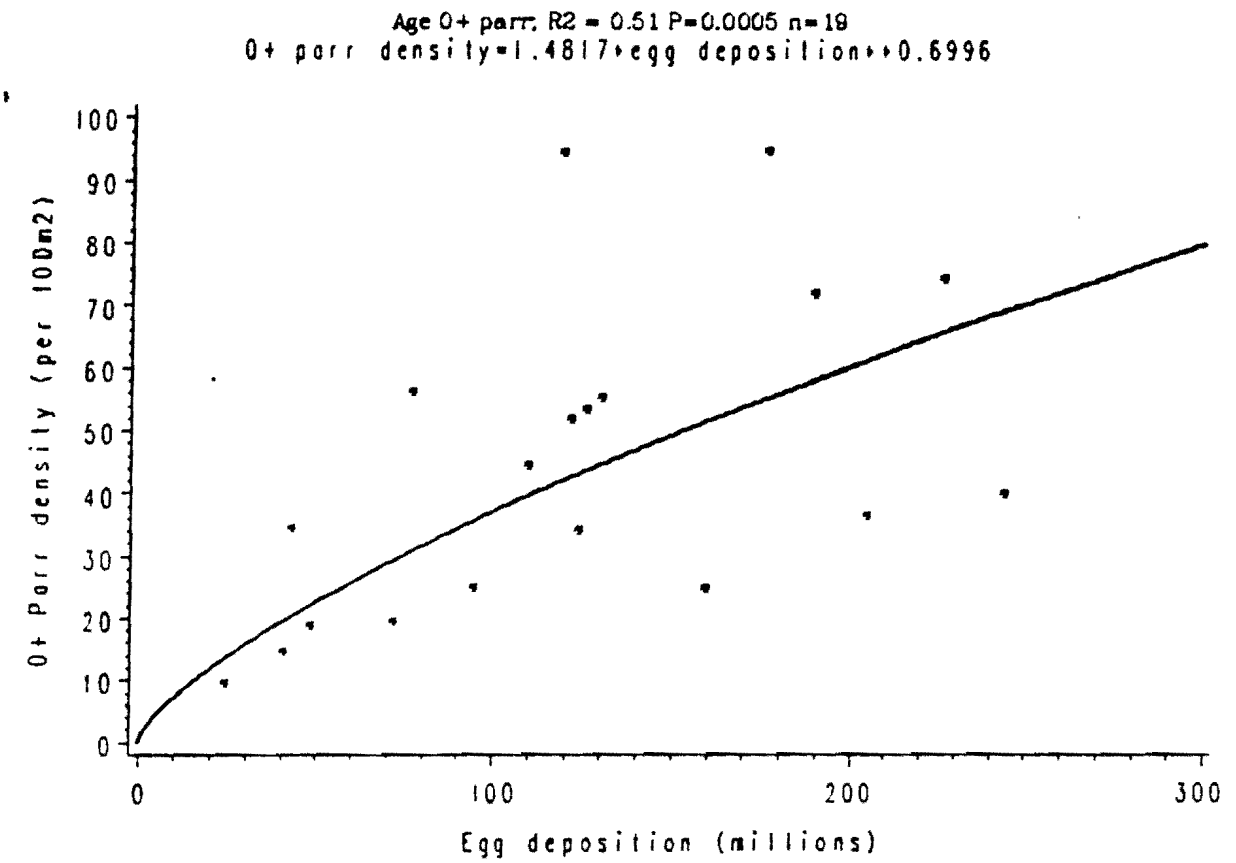


Figure 7. Estimated egg deposition rates (number of eggs per square metre) in the Miramichi River, 1971 to 1990. Egg depositions from 1SW salmon (dots), MSW salmon (stars), and total egg deposition (circles) are shown separately. The horizontal line represents the target egg deposition rate of 2.4 eggs per square metre.



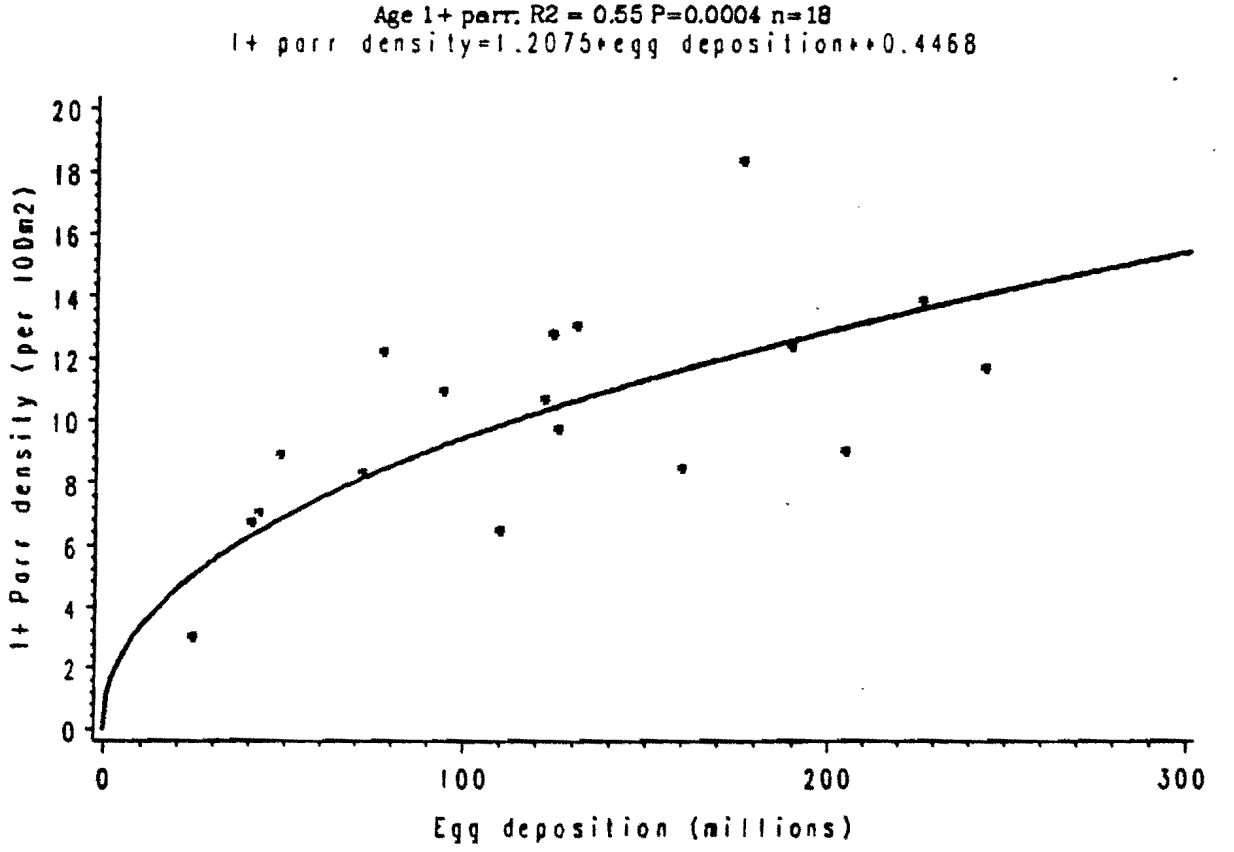


Figure 8. Relationships between egg deposition rates (millions) and resulting age 0 (upper) and age 1 parr densities in the Miramichi River, 1971 to 1990.

APPENDIX I. Angling seasons on Miramichi tributaries, 1989 and 1990.

Tributary	Season 1989	Season 1990
General (bright salmon)	June 8- September 30	June 8-October 15
Exceptions		
Bartholowmew		
(above Ledbetters Brook)	Closed	Closed
(below Ledbetters Brook)	Closed	June 8-Sept 25 Saturdays only Sept 28-Oct 14 All week
Bartibog	June 1-October 29	June 1-October 15
Cains	June 8-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
(MacKeil Brook to Burntland Brook)	n.a.	June 8-October 7
Northwest		
(above Little River)	June 8-August 31	June 8-August 31
Renous (above Forks)	June 8-September 15	June 8-September 15
Rocky Brook	June 1-August 31	June 1-August31
Sevogle (above Square Forks)	June 8-September 15	June 8-September 15
Other tributaries of the Main Southwest Miramichi (above Cains River - except Rocky Brook)	June 8-September 15	June 8-September 15