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Stock status of Atlantic salmon (*Salmo salar*) in the Miramichi River, 1993

by

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ABSTRACT

Atlantic salmon (*Salmo salar*) were harvested by First Nations and recreational fishers. First Nations harvest in 1993 of large salmon was 60% below the previous five-year average harvest, while small salmon harvest was 57% below. Recreational fishery catches of small and large salmon in 1993 were 30% below and 24% below, respectively, the previous five-year average catch. About two-thirds of the angling catch was reported from the Southwest Branch of the Miramichi. The exploitation rate on early-run salmon remained higher than on late-run fish. Returns of small and large salmon are estimated using mark/recapture methods. Returns of small salmon in 1993 were estimated at about 92,400 fish whereas large salmon returns were about 35,200 fish. The estimated returns of small salmon to each branch are not well defined in 1993. Large salmon returns were about 21,900 in the Southwest Branch and 10,500 in the Northwest Branch. Indicators of returns (mark/recapture estimates, angling catches, CPUE in angling fisheries) suggest that 1993 returns were greater than 1991 but less than 1992. Total egg depositions in 1993 were estimated to have equalled 4.1 eggs/m^2 for the Miramichi River with 92% of the eggs contributed by large salmon. Egg depositions in the Northwest Branch were about 4.2 eggs/m^2 and in the Southwest Branch were 3.6 eggs/m^2. Conservation spawning requirements for the Miramichi River have been met or exceeded in nine of the last 10 years. Densities of juveniles in 1993 were similar to those noted since 1985 and correspond to the higher egg depositions noted in recent years. Spawning/hatching success in 1992/1993 was equally good if not better in the Northwest relative to the Southwest Miramichi branches. Expected returns of large salmon in 1994 are 28,200 fish with a 69% probability of the returns being at least equal to the conservation requirement of 23,600 large salmon.

RÉSUMÉ

Le saumon de l'Atlantique (*Salmo salar*) a été exploité dans les pêches autochtones et dans les pêches récréatives. Les captures de grands saumons (>= 63 cm longueur à la fourche) dans les pêches autochtones en 1993 étaient 60% plus faibles que celles des cinq dernières années tandis que les captures de petits saumons (<63 cm longueur à la fourche) étaient inférieures de 57%. De plus, les captures de la pêche récréative étaient inférieures à la moyenne des cinq dernières années; 30% inférieures pour les petits saumons et 24% inférieures pour les grands. Deux tiers des captures sportives provenaient de la sud-ouest Miramichi. Le taux d'exploitation sur les saumons de retour d'été (juin à août) était supérieur à celui des saumons d'automne (septembre et octobre). Nous avons uitlisé des méthodes de marquage et recapture pour estimer la remontée des saumons. En 1993, la remontée était 92400 petits saumons et de 35200 grands saumons. La remontée de petits saumons dans chacune des deux branches de la rivière n'a pu être bien évaluée. Pour le grand saumon, environ 21900 poissons ont remonté la sud-ouest Miramichi et 10500 poissons ont remonté la nord-ouest. Selon les estimations de marquage et recapture, captures brutes et captures par unité d'effort de la pêche sportive, la remontée en 1993 était supérieure à celle de 1991, mais inférieure à celle de 1992. Le dépôt d'oeufs dans la Miramichi en 1993 a atteint 4,1 oeufs/m^2, dont 92% par les grands saumons. Le dépôt dans la nord-ouest Miramichi était de 4,2 oeufs/m^2, tandis que dans la sud-ouest le dépôt était de 3,6 oeufs/m^2. Les dépôts d'oeufs ont atteint ou dépassé le niveau cible (2,4 oeufs/m^2) dans 9 des 10 dernières années. Les densités de juvéniles en 1993 étaient similaires à celles observées depuis 1985, ceci dû aux dépôts élevés d'oeufs depuis quelques années. Le frai et le taux de survie des oeufs et des alevins en 1992-93 étaient aussi bons voire meilleurs dans la nord-ouest Miramichi. Nous prévoyons que la remontée du grand saumon en 1994 sera de 28200 poissons. Il est toutefois probable, à 69%, que la remontée soit égale ou supérieure au niveau cible de géniteurs, 23600 grands saumons.

INTRODUCTION

Annual assessments of the Atlantic salmon (*Salmo salar*) stock of the Miramichi River have been prepared since 1982. All the assessments prior to 1992 are published in the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC) research document series (Randall and Chadwick MS1983a, b; Randall and Schofield MS1987, MS1988; Randall et al. MS1985, MS1986, MS1989b, MS1990; Moore et al. MS1991, MS1992). The assessment of the 1992 returns was published in the Dept. of Fisheries and Oceans Atlantic Fisheries research document series (Courtenay et al. MS1993).

The Miramichi River watershed covers about 14,000 km^2. There are two major branches: the Northwest Branch covers about 3,900 km^2 and the Southwest Branch about 7,700 km^2 of drainage area (Randall et al. 1989a). The two branches join at Newcastle New Brunswick and drain into the Gulf of St. Lawrence at latitude 47° (Fig. 1). The total fluvial habitat area of the system above head of tide has been estimated at 54.6 million m^2 with the Northwest Branch containing 16.8 million m^2 and the Southwest Branch 36.7 million m^2 (Amiro MS1983). The main Miramichi, below the confluence of the branches, contains about 1.2 million m^2 of fluvial habitat. The Miramichi River is considered to have two runs of Atlantic salmon, an early or summer run and a late or fall run component.

The following terms are used in the document:

Kelts: (black salmon) salmon which have spawned and are still in freshwater or returning to the sea.

Bright Salmon: mature adult salmon moving into freshwater from the ocean.

Small Salmon: adult salmon of fork length less than 63 cm. Generally referred to as grilse. Usually salmon which have spent only one winter at sea. May contain some previously spawned salmon.

Large Salmon: adult salmon of fork length greater than or equal to 63 cm. Generally referred to as multi-sea-winter salmon. Contains varying proportions of one-sea-winter, two-sea-winter and three-sea-winter maiden (first time) spawners as well as previous spawners.

Early versus Late

Early: refers to the time period from the spring up to and including Aug. 31
Late: after Aug. 31.

This stock status report consists of the following sections:

1 - an accounting of the harvests and total removals by size group, by user group and by the time of year,
2 - a description of the environmental conditions in 1993 which would have affected the run-timing and the intensity of the migrations into the river,
3 - an estimate of the total returns of small and large salmon to the river and to each of the Northwest and Southwest branches of the Miramichi,

4 - an estimate of the escapement and egg depositions in 1993,
5 - escapement and egg depositions relative to the target, and
6 - a forecast of potential returns of large salmon for 1994.

Indices of abundance based on harvest rates are compared to the estimates of returns. Trends over time in the estimated spawning escapement are compared to indices of escapement at barrier and counting fences and to relative abundance indices of juvenile salmon. The assessment of absolute returns, the composition of the returns, and the relative exploitation rates in the recreational fisheries are based on the capture and marking of salmon in estuarine trapnets.

Input from industry, user groups and other government agencies was obtained during a stock assessment workshop, of which the minutes are provided in Appendix A. Minutes from the peer review held on Feb. 11 are provided in Appendix B. Summary sheets of the status of Atlantic salmon in the Miramichi River and for each branch are also provided (Appendix C).

1 - Harvests, Total Removals

Atlantic salmon were harvested by two user groups in 1993; First Nations and recreational fishers. Other removals of Atlantic salmon included broodstock collections and kelt reconditioning projects, as well as scientific sampling and incidental mortalities at the tagging trapnets.

Management in 1993

The management of the Atlantic salmon Aboriginal food fishery in the Miramichi River differed in 1993 from previous years. Harvesting agreements were signed between DFO and two Native Bands and these included reductions in the gillnet effort to a maximum of 18 stands at Eel Ground and the complete elimination of gillnetting on reserve waters at Redbank. The reduced gillnetting effort was compensated by food fishery trapnets operated by the bands, one at Eel Ground and two at Redbank. Maximum harvests were also negotiated:

	Small Salmon	Large Salmon
Eel Ground	1400	100
Redbank	5000	10

In late summer, Burnt Church Band negotiated a harvest allowance of 2000 small salmon and 25 large salmon from the Miramichi Bay and estuary to be taken with up to a maximum of 25 gillnets.

There were no significant changes in recreational fishery regulations in 1993 relative to 1992. Daily limits of 2 small salmon kept (<63cm fork length) and a maximum of 8 kept for the year remained in place. Angling seasons were generally as in previous years (Appendix D).

Aboriginal Food Fisheries

With exception to the Burnt Church catches, which occurred in estuary waters at Millbank, salmon were harvested exclusively in the Northwest Miramichi River. The breakdown of the catches by size and week are summarized in Table 1. Reported catches from food fisheries in the Northwest Miramichi in 1993 were 54 large salmon and 477 small salmon (Table 1). These catches are exclusive of harvest off-reserve prior to July 9 (standardized week 28). Of these catches, 96% of the large salmon were caught in gillnets whereas 37% of the small salmon catch was taken from trapnets. More than 99% of the large salmon catch in trapnets was released. The catches represent a decrease of 57% for small and 60% for large salmon relative to harvest reported in previous years (Table 2). Food fishery harvests from the estuary by Burnt Church Band were 124 small and 154 large salmon of which most were taken by gillnets (Table 1).

Food fishery harvests at Eel Ground were exclusively from the early-run while 77% of the harvests at Redbank were from the late-run (Table 1).

Kelt Reconditioning and Harvests

A total of 1,104 kelts (821 small salmon and 283 large salmon) were caught in May and June by the Eel Ground Band in the lower section of the Northwest Miramichi and reconditioned in cages in the Northwest Miramichi River. A total of 250 reconditioned small salmon were subsequently harvested in late August. None of the large salmon were harvested, all the survivors were released in August.

Recreational Fisheries

Angling catch data are available from two sources: from the New Brunswick Department of Natural Resources and Energy (DNRE), and from the Government of Canada Department of Fisheries and Oceans (DFO). For the Miramichi River system, the DNRE estimates are considered to be more accurate than the DFO estimates (Randall and Chadwick MS1983a). DFO estimates of catch have generally been lower than the DNRE estimates (Table 3).

The DNRE estimates are based on a license stub reporting system. A random sample of anglers is selected and they are solicited by mail to submit a record of their angling catch and angling effort by river. Total angling catches and effort are estimated from the returns submitted.

DFO Conservation and Protection officers provide monthly estimates of angling catch and effort. The estimates are based on angling camp log records, Crown Reserve water angling records, and personal observations and interviews of anglers in public waters. The estimates from public waters are considered to be less accurate than those from private camps and Crown Reserve waters.

Black Salmon Fishery

The black salmon catch in 1993 was estimated at 1,760 kept small salmon, 3,307 released small salmon and 3,066 released large salmon. These catches represent a decrease of 52% for kept small and 44% for released large salmon relative to the previous 5-year mean (Table 4a, 4b). Effort during the black salmon fishery, estimated to have been 6,828 rod days, was down by 29% relative to the previous 5-year mean (each rod day represents one person fishing on a given day regardless of the total hours actually fished). Catches of black salmon in the spring fishery and catches of bright salmon in the previous year are highly correlated; large salmon catch correlation is 0.71 ($P<0.01$), small salmon catch correlation is 0.70 ($P<0.01$) (Fig. 2).

Bright Salmon Fishery

The estimated catch of bright salmon in 1993 was 15,271 small salmon and 7,082 large salmon hooked and released (at 3% H&R mortality, this represents losses of 212 large salmon). The effort in 1993 was 103,100 rod days (Table 4a, 4b). The 1993 catches of small salmon and of large salmon were down 30% from the previous 5-year mean catches while the effort was unchanged from the average. With the exception of 1991 and 1993, small salmon recreational catches in the Miramichi have consistently been above 20,000 fish since 1986, a level which was exceeded on occasion prior to 1986 but never in such a consistent manner. Although large salmon catches are now exclusively hook and release, and the comparison of these data to the years when large salmon could be killed may not be direct, clearly large salmon fishing activity has been consistently over 9,000 fish since 1985, again except for 1991 and 1993 (Table 4b).

Since 1969, the catches of small salmon and large salmon have varied annually by almost three times and the catch per unit of effort (CPUE) has varied by over four times (Fig. 3). The catches and the CPUE have tended to fluctuate in synchrony, especially since 1990 when they are almost perfectly matched. The effort doubled in 1990 from previous years and has remained relatively constant. There is a strong negative correlation between effort and CPUE of small salmon (r = -0.599) but a weak one between effort and large salmon CPUE (r = -0.189).

Geographic distribution of the catches

The distribution of the recreational catches of salmon between the Northwest and the Southwest branches in 1993 was about two thirds Southwest, one third Northwest (Table 5, 6):

	Small Salmon	Large Salmon	Effort (Rod days)
Southwest	9,702 (64% of total)	5,044 (71% of total)	74,560 (68% of total)
Northwest	5,569 (36% of total).	2,038 (29% of total)	35,368 (32% of total)

The effort estimate for 1993 includes the black salmon effort because the kelt effort estimates by branch of the river were not yet available.

The distributions of the catches and effort between the two branches in previous years (median with minimum and maximum for the period 1969 to 1992) have been similar to those of 1993:

	Small Salmon	Large Salmon	Effort (Rod days)
Southwest	68% (49%-83%)	77% (63%-87%)	71% (55%-82%)
Northwest	32% (17%-51%)	23% (13%-37%)	29% (18%-45%).

There has been a doubling of the effort in both the Northwest and Southwest branches of the Miramichi since 1990 relative to the effort in the 1970's. This doubling of effort has resulted in a corresponding decrease in the catch per unit effort of both small and large salmon in both branches (Fig. 4, 5). The catches of both small and large salmon have also doubled in the Northwest branch (Fig. 4) but the catches of small salmon in the Southwest in the last four years are of similar magnitude to the catches from the early 1970's but higher than those of the early 1980's (Fig. 5). There was a decrease in the CPUE for small salmon in 1993 in both branches but the large salmon CPUE increased (Fig. 4, 5). As with the total Miramichi River fishery, there is a strong negative correlation between effort and CPUE of small salmon in both branches (r = -0.47 for the Northwest and r = -0.54 for the Southwest). The correlations were weaker but also negative for the large salmon CPUE in both branches (r = -0.36 for Northwest, r = -0.43 for Southwest).

The Crown Reserve waters of the Northwest Miramichi are regulated in terms of effort, and the estimated fishing effort in those waters has not changed since 1972 (Fig. 6, Table 7). The small salmon CPUE has fluctuated by almost two times while the large salmon CPUE has fluctuated by almost four times since 1972 (Fig. 6). The CPUE for small salmon in 1993 was basically unchanged from that of 1992 and the previous seven years, the only exception being 1991. The CPUE for large salmon has fluctuated much more in the last seven years and was 50% higher in 1993 relative to 1992 and was as high as it has been in the last seven years.

Timing of Harvests

Recreational fisheries harvested from both the early and late portions of the run. The small salmon catch from the Miramichi River was distributed as 66% early and 34% late (after Aug. 31) run (Table 4a). Large salmon were also mostly angled in the summer with the late period catch representing 42% of the total catch (Table 4b). The distribution in each branch of the river was different. The Southwest small salmon catch was distributed as 57% early catch while the Northwest small salmon catch was 83% early (Table 5a, 6a). Large salmon catches were mostly early in the Northwest (80%) while the Southwest catches were about 50% in each season (Table 5b, 6b).

In most years, the largest share of the catches in both the Northwest and Southwest occurred in the early portion of the season:

	Proportion in the early part of the season (1969 to 1992)		
	Median	Minimum	Maximum
Small salmon			
Northwest	93%	81%	98%
Southwest	79%	48%	91%
Large Salmon			
Northwest	90%	73%	97%
Southwest	71%	44%	89%

The dominance of the early portion of the run in the recreational catches of the Southwest Miramichi does not correspond to the pattern of catches noted at Quarryville pool in 1993 (Fig. 7, 8). The creel survey sampling indicated that the catches were greatest in the second half of September and early October, with 47% of the estimated small salmon catch at Quarryville Pool for the year occurring between Sept. 13 and 26. Some of this large catch is due to increased effort at that time relative to earlier in the year but the greater catch-per-unit effort would suggest that the higher catches in the fall were the result of greater abundance and/or increased catchability (Fig. 8).

Relative exploitation levels

The return rate of tags by anglers is used as an index of the relative exploitation rate in the recreational fishery. The return rates in this case refer to the proportion of the tags available for angling which are recaptured and returned to DFO by mail. The relative exploitation rate on grilse is higher in the Southwest than in the Northwest; the estimated return rate of tags from the Southwest was 14% in 1993 as compared to 5% in the Northwest (in 1992, the same pattern was apparent with Southwest return rates of 15% as compared to 7% in the Northwest). The return rate on large salmon tags is lower than on grilse tags and about equal in both branches. In 1993, less than 1% of the total large salmon tags released were returned whereas in 1992, 3% of the tags from the Northwest and 2% of those in the Southwest were returned.

The exploitation on early-run small salmon remained higher than on the late run fish. In both 1992 and 1993, the return rate of tags from the angling fishery was higher on July and August tagged fish than on September and October salmon, and in both years, the return rate was almost double the value for July salmon as it was for Sept. and October tagged fish. Lower escapements of summer fish relative to fall fish are in part attributable to the heavier exploitation on the early group of fish.

Return Rates by Tagging Group	1992			1993		
	Total	NW	SW	Total	NW	SW
June	16%	12%	24%	11%	0%	33%
July	16%	15%	17%	14%	13%	15%
August	10%	8%	11%	13%	12%	14%
September	9%	5%	10%	8%	5%	9%
October	6%	5%	9%	5%	2%	6%

Other Removals

Broodstock Collections and Kelt Reconditioning

Broodstock collections from the Miramichi River in 1993 included the following:

		Large Salmon	Small Salmon
from	Northwest Miramichi	99	71
	Southwest Miramichi	53	32

In October and November, 1992, a total of 339 large salmon and 353 small salmon post-spawners were captured from the Northwest Miramichi and retained for kelt reconditioning at the Miramichi Salmonid Enhancement Centre. None of the fish were reconditioned and released to the Northwest Miramichi in late summer 1993 as was originally planned because of bacterial kidney disease infection. These removals are reported here but do not impact on the removals of spawners for 1993.

Scientific Sampling and Incidental Mortalities

Samples of small salmon are collected at random (1 out of 10) at the tagging trapnets for detailed analysis of length, weight and more importantly sex ratio. In 1993, a total of 132 small salmon were sacrificed from the trapnets, 97 from the Southwest and 35 from the Northwest. Incidental mortalities, mostly from meshing in leaders included 14 large salmon and 2 small salmon.

Illegal Removals

Seizures by enforcement personnel were minimal in 1993 (Table 8).

Summary of Total Removals

The total harvests and removals of salmon from the Miramichi River in 1993 were 16,132 small salmon and 611 large salmon (Table 8). Total removals in the Northwest Branch were 6,161 small salmon and 218 large salmon while Southwest Branch removals were 9,841 small salmon and 222 large salmon. Seizures are not considered as removals for the purposes of calculating the escapement relative to the conservation target.

2 - Environmental conditions in 1993

The monthly discharge levels in the Miramichi in 1993 were variable relative to the long-term average values (1918-1991) with water levels greatly above normal in June and July and below normal in August and in the fall: about 45% lower in May, 120% higher in June, 35% higher in July, 35% lower in August and September, and comparable in October (Figure 9). During the 1992 season, the monthly water discharges were about 45% lower in May, 25% lower in June, 50% higher in July and August, 50% lower in September, and similar to the long-term average in October (Figure 9).

The largest daily catches of salmon at the Enclosure trapnets occurred after September 1 in both branches and for both small and large salmon (Fig. 10). The proportions of the total run of small and large salmon were greater after Sept. 1, 61% for small, 78% for large salmon in both branches of the Miramichi (Fig. 11). This distribution of small and large catches is similar to what was noted in 1992.

The analysis of the catches of salmon at the trapnets relative to season, discharge levels, water temperature and other environmental factors is in the preliminary stage but the relationship between discharge levels and catches at the trapnets at the Enclosure is stronger in the early portion of the run, less so in late summer and fall. Other studies of the effects of discharge levels on movements of salmon into rivers suggest that salmon do not seem to distinguish river flow by volume but rather in terms of changes in depth and water velocity. River flows are likely to be correlated with other factors which are prime stimuli for movement such as air and water temperatures, season, daylight, tidal flow. In late spring and summer, the upstream migration of salmon seems to occur when river flows are somewhat higher than the long term average for any given river, and not at their extreme values. Fish ascend both while the water is rising and falling, although highest catch rates coincide with falling water levels. Therefore, large freshets could stimulate important runs into a river, provided other prime factors are favourable. During late summer and fall, fish seem to be move into the river regardless of water flow conditions.

3 - Estimation of Returns

Total returns of small and large salmon are estimated using mark/recapture methods. The tagging trapnets were situated near the Enclosure Provincial Park in each branch of the river and were fished cooperatively with the Eel Ground First Nation (Fig. 1). Recaptures were obtained at several counting facilities in both branches of the Miramichi and through creel surveys at selected pools of the Southwest Branch. The tagging and recapture locations are indicated in Figure 1.

The small salmon returns are estimated directly from tagging and recapture data. Large salmon returns have in the past been estimated directly from the small salmon return estimate using the ratio of large to small salmon at the tagging trapnet. Large salmon returns can also be estimated from the tag and recapture data after adjustment for removals of tags by anglers. No adjustment is required for the small salmon estimate because it is assumed that tagged and untagged small salmon are removed in the same proportion by the recreational fisheries. Estimates of large salmon returns since 1985 using the ratio method versus the tagging method indicate that both estimates were generally within 10% of each other, without consistent bias. In some years, the ratio method provided estimates of higher returns while in other years, it indicated lower returns.

Tagging Trapnets

The trapnet fishing dates in 1993 were as follows:
Southwest Branch: May 12 to October 17 (washout between May 30 to June 3 and June 23 to 29)
Northwest Branch: May 19 to October 21 (no washouts).

Small and large salmon were sampled, marked and released in both branches:

	Small Salmon		Large Salmon	
	Catch	Tagged	Catch	Tagged
Southwest:	1193	1057	375	359
Northwest:	428	385	175	174

Recoveries of Tagged Salmon

Tagged fish were recovered in recreational fisheries in both branches (total returns to date 142 small salmon tags, 10 large salmon tags), from Native food fisheries at Redbank (3 tags), and from barrier pools, counting fences and creel surveys. The recaptures from the sources with known and reliable tagged to untagged ratios were used to calibrate the trapnets in each branch. The sources of data available and used included:

	Total Sampled Catch			
	Small Salmon		Large Salmon	
	Catch	Recaptures	Catch	Recaptures
Northwest Branch				
Redbank trapnet (Redbank First Nation)	83	3	-	
Northwest Barrier (DNRE)	1034	4	216	0

	Total Sampled Catch			
	Small Salmon		Large Salmon	
	Catch	Recaptures	Catch	Recaptures
Catamaran Brook counting fence (DFO and others)	108	4	45	4
Southwest Branch				
Quarryville, Renous and Doaktown creels (DFO, DNRE, etc.)	179	8	-	
Bartholomew River counting fence (DNRE)	222	8	328	7
Dungarvon Barrier (DNRE)	659	0	223	0
Juniper Barrier (DNRE)	1349	1	1145	0

The catches at the Southwest Barrier (Juniper) have never been used in the recapture component for two main reasons:

1 - The marked to unmarked ratio at the Juniper fence has consistently been different from that at the other recapture facilities. In several years, no tagged fish were reported at the Juniper barrier.

2 - The ratio of large to small salmon is also consistently much higher at the Juniper barrier than at the other facilities; the ratio at Juniper averaged 0.85 since 1985, at Dungarvon the ratio averaged 0.40, and at NW Barrier averaged 0.22.

Estimation of Returns

The estimation of returns using mark/recapture methods is based on calculating the efficiency of the recapture gear (Ricker 1975):

$$u = R / M$$

where u = rate of exploitation or efficiency of the gear
R = number of marks recaptured
M = number of marks available for recapture.

A consistent estimator of the population size (N) is:

$$N = C/u$$

where N = population size
C = sampled catch
u = exploitation rate (from above).

When R & M are substituted for u, we obtain the following relationship:

$$N = C * M / R$$

This is known as the Petersen population estimate (Ricker 1975).

Estimates of the confidence intervals of N are calculated by resampling from the observed data and assuming that the variability in the number of recaptures follows a binomial distribution. A combined tag loss/tagged fish mortality factor of 10% is assumed (varying between 0% and 20%) (Randall et al. MS1989b) which reduces the number of tags available for recapture.

Estimation of returns to each branch and total returns

The estimate of the returns to each branch is obtained after adjusting for the emigration of tagged fish out of the branch where they were marked. Failure to adjust for "losses" of these fish from the available marked population will result in an overestimate of the population size, in each branch and for the total returns. The emigration rate was calculated using the angling recaptures in the following way:

1 - assume that the reporting rate of tags from the angling fisheries in the Northwest and Southwest branches are identical (but unknown).

2 - calculate the return rate of tags from each branch based on the number of tags returned by anglers and the original branch in which the fish were tagged.

As an example, (from Table 9 for 1993 small salmon)

	Recovered by anglers in branch		Total
Origin of Tagged Fish	Northwest	Southwest	Tagged
Northwest	16	16	386
Southwest	8	101	1057

We have the following relationships:

Tagged fish in the Northwest = reported recaptures of tags by anglers in Northwest / return rate of tags from the Northwest.

Tagged fish in the Southwest = reported recaptures of tags by anglers in Southwest / return rate of tags from the Southwest.

Since we know how many tags were originally placed in each branch, we can solve for the two unknowns (return rate of tags in the Northwest "RR_{NW}", return rate of tags in the Southwest "RR_{SW}") as follows:

$$16/RR_{NW} + 16/RR_{SW} = 386 \quad \text{(Northwest tags)}$$
$$8/RR_{NW} + 101/RR_{SW} = 1057 \quad \text{(Southwest tags).}$$

The point estimate for RR_{NW} is 0.05 while the point estimate for RR_{SW} is 0.14. This suggests that the number of tags originally placed in the Northwest which stayed in the Northwest was 16/0.05 or 328 tags. Since 386 tags were originally placed in the Northwest, the proportion of the tagged fish which stayed in the Northwest was 328/386 = 84%. The proportion of the fish which emigrated out of the Northwest was 16%. Separate branch estimates are most sensitive to the estimate of emigration rate.

Total returns to the Miramichi are estimated as the sum of the separate branch estimates (stratified estimate) or by combining all the tags and all the recapture data from the two branches (unstratified estimate).

Returns of Small Salmon to the Miramichi in 1993

The raw data inputs are summarized in Table 9. The straying rate for small salmon from the Southwest Miramichi (32%) was estimated to be twice the rate for small salmon from the Northwest (14%) (Table 9). Estimates of the returns to each branch were obtained using only the non-straying tag component (resident model) and both resident tags and strayed tags (resident+migrant model). Estimates of returns to the river as a whole were obtained by summing the separate branch estimates (resident model, resident+migrant model) and by grouping all tags together regardless of tagging origin (unstratified model).

Estimated returns to the Enclosure area of the Miramichi using the resident tag model were about 92,400 small salmon (Table 9). The estimate based on the recaptures of resident and migrant tagged fish was about 107,500 small salmon, the unstratified estimate was midway between the two previous values, at 96,500 fish. The confidence intervals for the small salmon returns are wide, (Fig. 12) but we can be 95% certain that the small salmon returns in 1993 were greater than 61,500 while we would only be 50% certain that they were greater than 92,400 salmon (Table 9, Figure 12).

Returns to each branch

The returns of small salmon to the Northwest Miramichi were estimated to be about equal to the returns to the Southwest Branch, about 45,000 fish each (Table 9). In 1992, the returns of small salmon to the Northwest were estimated at about 31,000 fish while the returns to the Southwest were over 100,000 fish (Courtenay et al. MS1993). The separate branch estimates for small salmon are less reliable this year than in 1992 because of the smaller number of tags placed and recaptured. The estimates are also very sensitive to the estimated emigration rate of tagged fish. The confidence limits on the branch estimates are wide but we can be 95% certain that the returns of small salmon to the Northwest were at least 28,000 fish while returns to the Southwest were at least 23,000 fish (Table 9, Figure 13).

Returns of Large Salmon to the Miramichi in 1993

Large salmon return are estimated using the ratio of large to small salmon at the tagging trapnets (ratio model) as well as with the large salmon tag and recapture data (tags model). For the Northwest Branch estimate, the ratio of large to small from the Northwest trapnet was used while for the Southwest Branch, the ratio at the Southwest trapnet was used. For the unstratified estimate, the large to small salmon ratio was the average of the ratios at the trapnets, weighted by the total catch of salmon at each trap. The raw data inputs for the large salmon estimates are summarized in Table 10. The straying rate for large salmon from the Southwest Miramichi was estimated to be greater than the rate for salmon from the Northwest but not significantly different; the confidence intervals for both estimates were wide and overlapping.

The estimate based on the large/small salmon ratio indicated that the total returns of large salmon to the Miramichi were in the order of 33,000 to 40,300 large salmon. The estimate based on tags and recaptures indicated that the returns were in the order of 35,200 to 38,000 large salmon (Table 10). The confidence intervals for the large salmon returns are also wide, (Fig. 14) but we can be 95% certain that the large salmon returns in 1993 were greater than 19,700 fish (resident tag model) (Table 10, Figure 14). The unstratified estimate of the total returns was 35,600 salmon, with 95% probability that the returns were greater than 22,800..

Returns to each branch

The returns of large salmon to the Northwest Miramichi, based on tag recaptures of large salmon, were estimated to be between 10,500 and 13,500 depending upon whether only resident tags are used or both resident and migrant tags (Table 10). The estimate for the Southwest was just under 22,000 salmon for both models. The returns to the Northwest were at least 3,700 salmon (95% certainty) while those to the Southwest were at least 11,000 (95% certainty) (Fig. 15, 16).

A reanalysis of the 1992 data indicated that the returns of large salmon to the Northwest were in the order of 10,000 large salmon (at least 3,400; lower 5% limit) while returns to the Southwest were not well defined but greater than 22,000 fish (lower 5% limit of the estimate). Total returns to the Miramichi in 1992 were at least 37,000 large salmon (lower 5% limit of the estimate).

Alternate estimates of returns to each branch

Equal returns of small salmon to both branches, or even higher returns to the Northwest is contradictory to the conventional perception of the relative sizes of the runs in each branch; the habitat area of the Southwest is about twice that of the Northwest.

Angling catches and estimated exploitation rates provide estimates of the total returns to each branch. The estimated return rate of tags from the Southwest in 1993 was 14% while in the Northwest, the return rate was 5%. Not all tagged fish which are caught are reported. During the creel survey in the Southwest in 1993, 8 tagged small salmon were sampled by the creel clerk and the tag numbers were recorded. As of the end of December 1993, only 3 of the 8 recorded tags had been mailed in. Previous studies on the Miramichi had estimated the reporting rate of tags to be in the order of only 50% (Randall et al. 1991). If we assume a tag reporting rate of 50% in 1993, then the angling exploitation rates and estimated returns to each branch would be as follows:

	Exploitation Rate	Angling Catch	Estimated Returns (Catch / Exploitation Rate)
Northwest	0.10	5,600	56,000
Southwest	0.28	9,700	35,000

Similar calculations for 1992 provided the following results:

	Exploitation Rate	Angling Catch	Estimated Returns (Catch / Exploitation Rate)
Northwest	0.14	7,000	50,000
Southwest	0.30	14,500	48,300

The 1992 estimates based on angling catches do not correspond to the estimates based on the mark/recapture model; the estimate is too high for the Northwest and too low for the Southwest. If we assume the same bias in 1993, then the returns of small salmon would be overestimated for the Northwest and underestimated for the Southwest.

If the run sizes to each branch are roughly 2/3 Southwest and 1/3 Northwest then the exploitation rate in the Northwest is severely underestimated. An angling catch of 7,000 small salmon in 1992 and a total return of 31,000 as estimated by mark-recapture would have required an exploitation rate of 23%, not 14% (after 50% reporting rate) as estimated above.The exploitation rate would be underestimated if less than 50% of tags are reported. In 1992, the reporting rate by anglers in the Northwest would have been 30% if the true exploitation rate in the angling fishery was 23% (7% return rate divided by 30% = 23% exploitation rate), a level of reporting rate which is consistent with the lower levels in the Miramichi in previous years (Randall et al. 1991) and in 1993 from the Southwest Miramichi creel survey (3 of 8 tags returned to DFO = 38% reporting rate).

The exploitation rate would also be underestimated if tags in the Northwest are removed and unaccounted for before the angling fishery. One point of removal would be Native food fisheries. In 1993, three tags (less than 1% of Northwest tags) were removed at the Redbank food fishery trapnet. There was a greater number of removals in 1992, 5.7% of the small salmon tags from the Northwest (56 of 980) were returned from Native food fishery gear while only 1.3% of the Southwest small salmon tags were returned from Native gear. The 1992 removals by themselves, if not accounted for, would not have resulted in the magnitude of the underestimation of the exploitation rate by the recreational fishery in the Northwest.

On the other hand, the overall exploitation rate in the Northwest should be lower than in the Southwest for the following reasons:

1 - the angling season is shorter in the Northwest than in the Southwest (Appendix D),
2 - Crown Reserve waters in the Northwest limit the total effort on those sections of water.

When considering the angling catches of small salmon in the Northwest relative to the Southwest in 1993, and the differences in exploitation rates in the two branches, we probably should not expect the relative run sizes to be 2/3 Southwest, 1/3 Northwest but given the uncertainty in the emigration rates of tagged salmon, the separate branch estimates in 1993 are probably not reliable.

Trend over Time

Returns of small salmon to the Miramichi have been increasing since 1986. The return in 1993 of 92,400 small salmon is 6% below the previous 5-year average return to the river. The large salmon returns have also been increasing,; the 1993 return was 31% above the previous 5-year average (Table 11).

Angling catches and CPUE in the angling fishery provide an index of the relative returns to the Miramichi for those years when the angling effort has been relatively similar, 1990 to 1993. These are compared to the estimated returns from the mark/recapture experiments.

Bright Small Salmon

Catches	91 < 93 < 90 = 92
CPUE	91 < 93 < 90 = 92
Returns	91 < 90 = 93 < 92

All three indicators suggest that 1993 returns of small salmon were greater than 1991 but less than 1992. The 1990 returns are either as high or much higher than 1993.

4 - Estimation of Egg Depositions in 1993

The estimated egg depositions in 1993 are obtained from the estimates of the escapement of small and large salmon and the biological characteristics of the salmon in 1993. The escapement of salmon refers to fish which were not harvested in fisheries or otherwise removed from the river. No adjustments are made for illegal removals or disease.

Estimation of Escapement

The escapements of small and large salmon in each branch and for the river as a whole in 1993 are summarized below, based on the estimate of returns from the resident tag model. Escapements of small and large salmon to the Miramichi River since 1971 are summarized in Table 11.

Small Salmon		Percentiles	
	Median	5%	95%
Miramichi			
Returns	92,400	61,500	153,800
Removals	15,984		
Escapement	76,416	45,516	137,816
Northwest Miramichi			
Returns	46,200	27,700	97,500
Removals	6,152		
Escapement	40,048	21,548	91,348
Southwest Miramichi			
Returns	42,600	22,700	73,800
Removals	9,832		
Escapement	32,768	12,868	63,968

Large Salmon		Percentiles	
	Median	5%	95%
Miramichi			
Returns	35,200	19,700	76,700
Removals	498		
Escapement	34,702	19,202	76,202
Northwest Miramichi			
Returns	10,541	3,700	37,500
Removals	281		
Escapement	10,260	3,419	37,219
Southwest Miramichi			
Returns	21,900	10,800	58,900
Removals	217		
Escapement	21,683	10,583	58,683

Biological Characteristics of Salmon in 1993

The average fork length, sex ratio and eggs per small and large Atlantic salmon spawners in 1993 are summarized in Table 12. Sex determinations for small salmon were based on both external and internal (sacrificed) examinations. The percentage of males in the small salmon component was consistently higher in the sacrificed samples as compared to the external determinations. Males comprised more than 90% of the small salmon samples in both the Northwest and the Southwest branches. External sex determinations resulted in 10% fewer males than the internal sampling. Based on the average fork length, the length fecundity relationship and the percent female composition (internal determination), the number of eggs per small salmon spawner was estimated at 294 for Southwest Miramichi and 221 eggs per spawner in the Northwest (Table 12).

The sex ratio of large salmon was based on external examination of fall (Sept. and Oct.) fish from the trapnets which indicated that the percent female in each branch was 82 to 84% (Table 12). If the percent male component is underestimated in the large salmon as was found in the small salmon (10% underestimate of the male component: (external - internal) / internal), then the male component in the large salmon would be closer to 19% (17% + 10%*17%), or the female composition would be 80 to 82%. The eggs per large salmon spawner in the Southwest in 1993 were estimated at about 5,700 whereas in the Northwest, the eggs per spawner were about 6,100.

Sampling of salmon at Northwest Headwater barrier and the Dungarvon Headwater barrier in the Southwest in September 1993 indicated that the sex ratio of small salmon at both barriers was about 47% female (Table 12). This is very different from the sex ratios of small salmon from the trapnet samples for the whole year. The proportion female was also higher for the large salmon. The data from the barrier fences are presented only for information, the samples from the trapnets are considered to be more representative of the run in the entire river.

Previous spawners constituted 30% of the 1993 large salmon returns while maiden multi-sea-winter salmon (mostly 2SW) made up 70% (Table 13). This continues the trend of the high proportions of previous spawners in the returns. The proportions of previous spawning multi-sea-winter salmon in the two branches were similar at 22% and 25% of large salmon returns. Previous spawning 1SW salmon were less abundant in 1993 than in recent years. This is the result of the low 1991 return of maiden 1SW salmon; previous spawning 1SW fish tend to be alternate spawners (spend an additional year at sea before returning).

Egg depositions in 1993

Total egg depositions in 1993 were estimated at 223.3 million eggs, equivalent to 4.1 eggs per m^2. Large salmon contributed 92% of the total egg depositions. The lower estimate (5th percentile) of egg deposition for the river was equal to 2.3 eggs per m^2. In the Northwest Miramichi, egg depositions were at least 25.4 million eggs (lower limit of the estimate) which is equivalent to 1.5 eggs per m^2 of habitat area. Large salmon contributed 82% of the egg depositions. In the Southwest Miramichi, large salmon contributed at least 96% of the 62.2 million eggs (lower limit), which is equal to 1.7 eggs per m^2. Total egg depositions in 1993 in each branch and for all Miramichi are summarized in the following table.

	Egg Depositions in 1993 (millions)		
	by All Salmon	% by Large Salmon	Eggs per m^2
Miramichi (habitat area = 54.6 million m^2)			
Estimate	223.3	92	4.1
Lower	123.6	92	2.3
Upper	484.7	93	8.9
Northwest Miramichi (habitat area = 16.8 million m^2)			
Estimate	71.3	88	4.2
Lower	25.4	82	1.5
Upper	240.2	92	14.3
Southwest Miramichi (habitat area = 36.7 million m^2)			
Estimate	131.6	94	3.6
Lower	62.2	96	1.7
Upper	352.7	95	9.6

Target Egg Depositions for the Miramichi River

The conservation spawning requirement for the Miramichi River and each branch separately is based on an egg requirement of 2.4 eggs/m^2 of spawning and rearing habitat area. Habitat area estimates are from Amiro (MS1983).

	Habitat Area (m^2)	Egg Requirement (million eggs)
Miramichi River	54.6 million	131.05
Northwest Branch	16.8 million	40.32
Southwest Branch	36.7 million	88.08

The egg depositions in the Miramichi River by both small and large salmon are summarized in Figure 17. Using the median estimate of escapement, egg depositions in the Miramichi have attained or exceeded the target egg deposition (2.4 eggs per m^2) in 9 of the last 10 years, egg depositions by large salmon alone have met or exceeded the target in 6 of the last 10 years.

Other indices of escapement of Atlantic salmon to the Miramichi River

Juvenile Surveys in the Miramichi River

Electrofishing surveys in 1993 were conducted at the 15 standard sites which have been fished every year since 1971 (Fig. 1). The densities of juvenile salmon at each site were estimated by the successive removal method within a closed site using upstream and downstream barrier nets. Population estimates were obtained by the Zippin method (Zippin 1956). Densities of fry and parr in 1993 were compared to densities in previous years and between branches of the Miramichi using analysis of variance without interaction term (SAS 1990).

The densities of fry at the 15 standard sites in the Miramichi River in 1993 were not significantly different from the densities noted since 1985 (Fig. 18, Table 14). The densities since 1985 have been significantly higher than those observed prior to 1985 which corresponds to the increased egg depositions which the river has received. Densities between sites remained quite variable. Parr densities were not significantly different between years (Fig. 19, Table 15).

The densities of fry in the Southwest are significantly higher than the densities observed in the Northwest (Table 14). Over the 23 year data series, the densities of fry at the sites in the Southwest have averaged 94 per 100m^2 as compared to 52 per 100 m^2 in the Northwest, a difference of 42 fry per 100m^2 (Fig. 18). Parr densities were also significantly higher in the Southwest, averaging 22 per 100m^2 as compared to 16.5 per 100 m^2 in the Northwest (Fig. 19, Table 15).

Extended survey in 1993

An extended juvenile survey was conducted in 1993. At the additional sites, juvenile salmon were sampled using a fixed effort method without barrier nets. The sites were surveyed by systematically fishing from bank to bank in an upstream direction, passing only once through the site. The catches per second of effective electroshocking time were adjusted to correspond to the catches per unit time in sites of known density, i.e. the catch per unit effort was calibrated at the standard sites where barrier nets were used. The analysis of the relationships between catch per unit effort and density are presented in Appendix E.

A total of 67 sites (Fig. 20) were surveyed in the following sections of the Miramichi (standard sites are in boldtype):

Tributary	Sites
Northwest Miramichi	
Little Southwest	**43**, **44**, 45, **46**
Little Sevogle	**40**, 41, 42
Big Sevogle	37, 38, 39
Northwest Miramichi (upper)	20, 22, 29, 31, 32, 34
Northwest Miramichi (main)	18, 23, 24, 26, 27, 28
Southwest Miramichi	
Renous/Dungarvon	47, 48, 51, 52, 53, 55, 56, 57
Barnaby's	97, 98
Cains	**74**, **75**, 76, 77, 78
Southwest Miramichi (lower)	61, 64, 67, 71, 72, 73
Southwest Miramichi (middle)	**62**, 63, 68, 70, **79**, 80, 81, **82**, 83, **84**, 85
Southwest Miramichi (upper)	58, 59, **60**, 65, 69, 86, 87, 88, 89, 90, **92**, 95, 96
Estuary	
Bartibog	**7**, **9**

The average, minimum, and maximum densities, in terms of the number of fish per 100 m^2 of stream area are summarized in Table 16 and Figures 21 to 22. The average densities of fry in 1993 were generally higher in the Northwest Miramichi sites than in the Southwest Miramichi; for example, the maximum densities observed in the Northwest exceeded 100 fry per 100 m^2 in 3 of the 5 sections, but only in 2 of 6 sections of the Southwest. In the lower and middle sections of the Southwest (main river sites), no fry were present at some sites. Parr densities were also equally high in the Northwest as compared to the Southwest. In 4 of the 6 sections of the Southwest, no parr were sampled at some sites whereas parr were seen at all sites in 4 of the 5 sections from the Northwest Branch.

On the basis of the extended survey, it appears that spawning/hatching success in 1992/1993 was equally good if not better in the Northwest relative to the Southwest Miramichi. The densities in the main stems of the rivers were generally lower than in the upper sections of the rivers and smaller tributaries.

<u>Headwater Barrier Fences</u>

Large and small salmon have been enumerated at headwater barrier fences on the Southwest branch (North Branch of SW Miramichi, Dungarvon River) since 1981 and on the Northwest branch (Northwest Miramichi River) since 1988 (Table 17). The fences are operated for varying periods each year but generally cover the entire migration period. The counts of large salmon in 1993 at the barrier fences of the Southwest Miramichi were contradictory, at one fence returns were up by 37% from the previous 5-year mean while at the other, the returns were down by 17% (Table 17). Returns of large salmon were down by 13% at the Northwest Barrier. The returns of large salmon in 1993 were almost identical to those of 1992, similar to the relationship in the returns estimated for each branch by mark/recapture.

The 1993 small salmon returns were up in the Southwest relative to the 5-year average, but down in the Northwest (Table 17). Small salmon returns were down at all three fences relative to the 1992 returns, the greatest reduction was noted at the Dungarvon Barrier (-20%). Lower returns of small salmon at the barrier fences corresponds to the lower returns of small salmon in 1993 as estimated by mark/recapture.

Summary of trends in escapement

The trends in escapement from the mark/recapture experiments, juvenile surveys and barrier fences are summarized below:

Small	
Mark/recapture	89 = 91 < 90 <93 < 88 < 92
Barrier fences	91 < 89 < 92 = 93 = 90 = 88
Large	
Mark/recapture	89 < 88 < 90 < 91 < 93 < 92
Barrier fences	91 < 89 < 88 = 92 < 93 = 90
Total Escapement	
Mark/Recapture (eggs)	89 < 88 < 90 < 91 < 93 < 92
Juvenile Abundance (fry)	90 < 92 = 88 = 91 < 89

For small salmon, the barrier fences and the mark/recapture estimates are similar in that 1989 and 1991 were both estimated to be years of low escapement relative to the other years in the comparison. Large salmon indices are not so comparable except for 1989 which was a low escapement year in both estimates. Total escapement, in terms of eggs, as compared to fry densities the following year, suggest that our perception of 1989 relative to the other years is inconsistent, 1989 being the lowest egg deposition estimate which resulted in the highest densities of fry in the series. Densities have increased as estimated egg depositions have increased since 1970 (Locke et al. MS1993).

5 - Forecast of Large Salmon Returns in 1994

The forecast model for large salmon returns is based on a relationship with small salmon returns in the preceding year (Claytor et al. MS1991, Claytor et al. 1992) (Fig. 23). The 1994 forecast of large salmon was obtained using the median return of small salmon in 1993 of 92,400 fish. The most probable return of large salmon in 1994 is 28,200 fish within a 90% confidence interval of 16,160 to 54,090 fish (Fig. 23). There is a probability of 68.6% that the returns of large salmon will at least be equal to the conservation target of 23,600 large salmon (average number of large salmon required to produce 132 million eggs).

6 - Hatchery Returns to the Miramichi River

Proportion of Trapnet Catches at the Enclosure

Adipose-fin clipped fish were recorded at both enclosure trapnets in 1993 and made up less than 2% of the total catch of small salmon in the Northwest and less than 1% of the small salmon catch in the Southwest trapnet. Large salmon adipose-clipped fish were not recorded from the Southwest and made up about 1% of the Northwest trapnet catch in 1993. These proportions are similar to those noted in 1992 at the enclosure trapnets.

Proportion in the Southwest Miramichi creel samples

Out of 179 small salmon sampled during the 1993 creel surveys, 3 adipose-clipped salmon were recorded, two from the Quarryville catch (Aug. 11 and 20) and one from Doaktown creel (Sept. 17). This represents 1.7% of the sampled catch.

CONCLUSIONS

The angling catches of small salmon and of large salmon in 1993 were down relative to 1992 and the previous 5-year average catch. The total effort was similar to the 5-year average effort at about 102,000 rod days. Catches in each branch were also down but the Crown Reserve catches in the Northwest were unchanged from the previous five years. Total returns to the river of small salmon were up relative to the 5-year average while large salmon returns were slightly down. Egg depositions by both small and large salmon were estimated to have been equal to 4.1 eggs/m^2, about 71% above the target requirement. Large salmon contributed 92% of the total egg depositions. Increased precision of the returns estimates is the next challenge and this could be obtained by tagging more fish, running two tagging trapnets in each branch, or by increasing the recapture rate, such as more fences or with special recovery programs including creel surveys, logbooks and private camp surveys.

The separate branch estimates of the small salmon returns in 1993 do not correspond to conventional perceptions of relative run sizes. These branch estimates are sensitive to the emigration rate of tagged salmon between the branches and the method used in 1993 to quantify the emigration rate may not be appropriate. Estimates of emigration rate derived from the barrier fence tag recaptures should also be considered as an alternative measure of emigration rate. As more years of data are collected, differences in emigration rates between years can be tested and if similar, the data from several years could be pooled to provide for a more robust value. The estimates of the total returns are assumed to be unbiased because the branch estimation method simply reallocates tags between branches without changing the total tags available or tags recovered data. The estimation of emigration rate will continue to be an important consideration as long as the tagging trapnets are situated at their present locations. Consideration of the recaptures in the angling fishery and at recapture facilities relative to the tags available in each branch should provide a reasonable picture of the movements of tagged salmon between the branches.

Better estimates of the movement of salmon in tidal waters between the branches could be obtained from radio-tagging experiments. Radio-tagging of salmon would also provide information on the distribution of salmon within each branch, especially relative to early and late-run salmon. Such information would be especially useful in providing estimates of the spawning requirements of early and late-run components, particularly if these two groups are geographically separated at spawning. Additionally, radio-tagging projects would provide information on the movement of kelts in the winter, under the ice and how these may be affected by hydrological conditions.

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Table 1. Catch and effort for native food fisheries on the Miramichi in 1993 for early and late runs by week, as reported by band councils. Red Bank Indian Band harvests are from the two salmon index traps that they operated. The harvest reported by Burnt Church Indian Band are for the Millbank trap that they operated as a food fishery trap. Gillnet effort is number of net-days per week.

	Burnt Church		Eel Ground				Red Bank	
	Trapnet		Gillnets			Trapnet	Trapnet	
Week	Small	Large	Effort	Small	Large	Small	Small	Large
Early run								
May 21-27	-	-	-	-	-	-	-	-
May 28 - June 3	-	-	-	-	-	-	-	-
June 4-10	-	-	14	4	0	-	-	-
June 11-17	-	-	35	15	11	-	-	-
June 18-24	-	-	63	29	11	-	-	-
June 25 - July 1	-	-	63	86	7	-	-	-
July 2-8	-	-	77	69	6	-	-	-
July 9-15	-	-	63	42	5	-	1	0
July 16-22	-	-	77	41	5	-	1	0
July 23-29	-	-	21	2	2	-	8	0
July 30 - Aug. 5	-	-	35	6	4	13	6	0
Aug. 6-12	-	-	7	9	0	18	1	0
Aug. 13-19	-	-	7	0	0	8	0	0
Aug. 20-26	-	-	7	0	0	11	1	0
Aug. 27 - Sept. 2	-	-	7	0	0	31	1	0
Subtotal	-	-	476	303	51	81	19	0
Late run								
Sept. 3-9	-	-	-	-	-	10	14	1
Sept. 10-16	0	0	-	-	-	-	29	0
Sept. 17-23	0	0	-	-	-	-	4	0
Sept. 24-30	0	0	-	-	-	-	16	2
Oct. 1-7	0	0	-	-	-	-	0	0
Oct. 8-14	1	2	-	-	-	-	1	0
Subtotal	1	2	-	-	-	10	64	3
Gill Nets (date unknown)	123	152	-	-	-	-	-	-
Total Season	124	154	476	303	51	91	83	3
% early run	0%	0%	100%	100%	100%	89%	23%	0%

Note: These figures do not include catch and effort data for fishing off reserve prior to July 9.

Table 2. Recorded catches of salmon in all fisheries, Miramichi River and Bay, 1951-93 (includes commercial, by-catch, recreational, and native). Kelts angled in year i are added to landings in year i-1. 1993 data are preliminary. All data are numbers X 1000.

				Angling Fisheries										
	Commercial Fishery			Kelts (yr i+1)			Brights (yr i)				Native Fishery			
Year	Small	Large	Total	Small	Large	Total	Small	Large	Total	All	Small	Large	Total	All Fisheries
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	32.5
1984	0.0	0.0	0.0	2.4	0.0	2.4	18.8	0.0	18.8	21.2	0.4	0.3	0.7	21.9
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	1.1	0.5	1.6	29.9
1990	0.0	0.0	0.0	2.4	0.0	2.4	21.7	0.0	21.7	24.1	2.1	0.6	2.7	26.8
1991	0.0	0.0	0.0	2.3	0.0	2.3	11.3	0.0	11.3	13.6	1.1	0.5	1.6	15.2
1992	0.0	0.0	0.0	1.8	0.0	1.8	21.5	0.0	21.5	23.3	1.7	0.6	2.3	25.6
1993	0.0	0.0	0.0	-	0.0	-	15.3	0.0	15.3	15.3	0.6	0.2	0.8	16.1
1988-92 Mean											1.4	0.5	1.9	
change = (93-mean)/mean											-57%	-60%	-58%	

Note: Angling catches from 1951-68 are from DFO while catches from 1969-93 are from DNRE FISHSYS

Table 3. Angling statistics for bright large and small salmon in the Miramichi as reported by N.B. DNRE and DFO, 1969 to 1993. The 1993 data are preliminary.

Year	Large Salmon		Small Salmon	
	DNRE	DFO	DNRE	DFO
1969	3,804	2,827	24,284	26,715
1970	3,268	2,057	19,610	19,662
1971	1,792	1,247	13,727	8,464
1972	8,933	5,456	19,101	15,472
1973	5,977	4,881	13,857	9,033
1974	7,184	5,895	18,232	17,957
1975	6,285	3,756	15,598	9,730
1976	7,374	5,319	27,182	14,749
1977	11,617	14,344	13,590	8,244
1978	4,893	4,196	8,265	5,353
1979	2,656	2,422	14,508	7,625
1980	6,540	5,422	11,997	7,533
1981	3,235	1,602	22,716	7,031
1982	4,608	2,642	21,402	9,217
1983	2,240	1,646	8,390	3,897
1984	7,685	-	18,790	9,892
1985	9,619	-	18,439	11,926
1986	14,223	-	26,163	28,299
1987	11,932	-	20,765	11,363
1988	10,090	-	30,620	13,732
1989	11,928	-	24,426	12,665
1990	9,258	-	21,372	11,584
1991	6,147	-	11,300	9,456
1992	9,476	-	21,509	23,936
1993	7,082	-	15,271	18,772
Mean 1988-92	9,380	-	21,846	14,275
Change (93-Mean)/Mean	-24%	-	-30%	+32%

Note: 1984-93 Large salmon statistics represent numbers of fish hooked and released.

Table 4a. Angling catch and effort data for kelt and bright small salmon in the Miramichi River as estimated by DNRE, 1969 to 1993. Note that 1993 data are preliminary.

	Kelts			Bright Salmon				
Year	Catch	Rod Days	CPUE	Early Catch	Late Catch	Total Catch	Total Rod Days	CPUE
1969	2547	20873	0.12	17823	6461	24284	49298	0.49
1970	3719	8883	0.42	13880	5730	19610	53857	0.36
1971	2380	5969	0.40	11276	2451	13727	43552	0.32
1972	1500	3808	0.39	16053	3048	19101	61604	0.31
1973	1538	7382	0.21	12038	1819	13857	60235	0.23
1974	1512	7013	0.22	16727	1505	18232	70843	0.26
1975	1760	7616	0.23	13314	2284	15598	59746	0.26
1976	2316	5264	0.44	23384	3798	27182	66157	0.41
1977	2380	7828	0.30	12546	1044	13590	65266	0.21
1978	1401	5623	0.25	7357	908	8265	70830	0.12
1979	1476	5625	0.26	12654	1854	14508	68218	0.21
1980	2242	6411	0.35	9674	2323	11997	58727	0.20
1981	1732	5479	0.32	19205	3511	22716	73762	0.31
1982	2691	7587	0.35	19233	2169	21402	77364	0.28
1983	2060	4800	0.43	7310	1080	8390	89510	0.09
1984	1559	1959	0.80	15315	3475	18790	57028	0.33
1985	2385	4079	0.58	17111	1328	18439	61810	0.30
1986	2473	7496	0.33	20611	5552	26163	66699	0.39
1987	2748	10547	0.26	14824	5941	20765	65086	0.32
1988	4216	5305	0.79	17971	12649	30620	81253	0.38
1989	5361	5861	0.91	17321	7105	24426	73155	0.33
1990	4134	15563	0.27	15256	6116	21372	122361	0.17
1991	2356	11028	0.21	7769	3531	11300	109597	0.10
1992	2263	10973	0.21	16569	4940	21509	122122	0.18
1993	1760	6828	0.26	10147	5124	15271	103100	0.15
Mean (88-92)	3666	9607	0.50	14977	6868	21845	101698	0.21
Change (93-mean)/mean	-52%	-29%	-48%	-32%	-25%	-30%	+1%	-29%

Table 4b. Angling catch and effort data for kelt and bright large salmon in the Miramichi River as estimated by DNRE, 1969 to 1993. Note that 1993 data are preliminary.

	Kelts			Bright Salmon				
Year	Catch	Rod Days	CPUE	Early Catch	Late Catch	Total Catch	Total Rod Days	CPUE
1969	1828	20873	0.09	2434	1370	3804	49298	0.08
1970	1647	8883	0.19	1806	1442	3248	53857	0.06
1971	1352	5969	0.23	1493	299	1792	43552	0.04
1972	547	3808	0.14	6973	1960	8933	61604	0.15
1973	2970	7382	0.40	4527	1450	5977	60235	0.10
1974	3037	7013	0.43	6278	906	7184	70843	0.10
1975	3111	7616	0.41	4945	1342	6285	59746	0.11
1976	1446	5264	0.27	5949	1425	7374	66157	0.11
1977	2156	7828	0.28	10364	1253	11617	65266	0.18
1978	2126	5623	0.38	4121	772	4893	70830	0.07
1979	1668	5625	0.30	2184	472	2656	68218	0.04
1980	1504	6411	0.23	4623	1917	6540	58727	0.11
1981	2118	5479	0.39	2384	851	3235	73762	0.04
1982	1368	7587	0.18	3456	1152	4608	77364	0.06
1983	960	4800	0.20	1850	390	2240	89510	0.03
1984	731	1959	0.37	6253	1432	7685	57028	0.13
1985	3771	4079	0.92	8409	1210	9619	61810	0.16
1986	6856	7496	0.91	10087	4136	14223	66699	0.21
1987	5108	10547	0.48	6618	5314	11932	65086	0.18
1988	6700	5305	1.26	5298	4792	10090	81253	0.12
1989	7382	5861	1.26	6559	5369	11928	73155	0.16
1990	5641	15563	0.36	6055	3203	9258	122361	0.08
1991	2997	11028	0.27	3946	2201	6147	109597	0.06
1992	4564	10973	0.42	6758	2718	9476	122122	0.11
1993	3066	6828	0.45	4132	2950	7082	103100	0.07
Mean (88-92)	5457	9607	0.57	5723	3657	9380	101698	0.10
Change(93-mean)/mean	-44%	-29%	-21%	-28%	-19%	-24%	+1%	-30%

Table 5a. Angling catch and effort data for kelt and bright large salmon in the Northwest Miramichi River as estimated by DNRE, 1969 to 1993. The 1993 data are preliminary.

	Kelts			Bright Salmon				
Year	Catch	Rod Days	CPUE	Early Catch	Late Catch	Total Catch	Total Rod Days	CPUE
1969	116	-	-	370	114	484	15230(T)	0.04(T)
1970	414	-	-	394	90	484	12730(T)	0.07(T)
1971	207	-	-	364	55	419	10443(T)	0.06(T)
1972	137	278	0.49	1129	146	1275	12664	0.10
1973	402	536	0.75	862	46	908	14294	0.06
1974	438	711	0.62	1327	68	1395	12401	0.11
1975	540	653	0.83	1195	106	1301	15369	0.08
1976	249	911	0.27	1332	43	1375	13483	0.10
1977	397	1017	0.39	2349	73	2422	15982	0.15
1978	327	1070	0.31	719	36	755	15527	0.05
1979	197	1265	0.16	623	53	676	31031	0.02
1980	130	724	0.18	1243	229	1472	16594	0.09
1981	349	669	0.52	942	95	1037	25175	0.04
1982	207	891	0.23	999	99	1098	27909	0.04
1983	190	620	0.31	660	40	700	30770	0.02
1984	248	220	1.13	2636	192	2828	16505	0.17
1985	653	442	1.48	2925	172	3097	23041	0.13
1986	931	933	1.00	3259	577	3836	22706	0.17
1987	661	771	0.86	1705	383	2088	22858	0.09
1988	1186	406	2.92	2248	834	3082	25186	0.12
1989	856	914	0.94	2098	707	2805	21905	0.13
1990	1076	3254	0.33	1679	463	2142	35511	0.06
1991	523	1683	0.31	1175	344	1519	34715	0.04
1992	630	1635	0.39	1587	207	1794	37146	0.05
1993	502	-	-	1622	416	2038	35368(T)	0.07(T)
Mean (88-92)	854	1578	0.98	1757	511	2268	30893	0.07
Change (93-mean)/mean	-41%	-	-	-8%	-19%	-10%	n.a.	n.a.

Table 5b. Angling catch and effort data for kelt and bright small salmon in the Northwest Miramichi River as estimated by DNRE, 1969 to 1993. The 1993 data are preliminary.

	Kelts			Bright Salmon				
Year	Catch	Rod Days	CPUE	Early Catch	Late Catch	Total Catch	Total Rod Days	CPUE
1969	727	-	-	3736	499	4235	15230(T)	0.33(T)
1970	810	-	-	4258	490	4748	12730(T)	0.44(T)
1971	472	-	-	2749	151	2900	10443(T)	0.32(T)
1972	291	278	1.05	3357	285	3642	12664	0.28
1973	221	536	0.41	3117	194	3311	14294	0.23
1974	213	711	0.30	3780	165	3945	12401	0.32
1975	393	653	0.60	3153	163	3316	15369	0.22
1976	328	911	0.36	4795	249	5044	13483	0.37
1977	355	1017	0.35	3653	62	3715	15982	0.23
1978	362	1070	0.34	2190	42	2232	15527	0.14
1979	365	1265	0.29	4765	199	4964	31031	0.16
1980	229	724	0.32	3942	339	4281	16594	0.26
1981	200	669	0.30	8149	509	8658	25175	0.34
1982	423	891	0.47	9081	349	9430	27909	0.34
1983	350	620	0.56	3630	190	3820	30770	0.12
1984	524	220	2.38	5717	247	5964	16505	0.36
1985	288	442	0.65	9258	172	9431	23041	0.41
1986	223	933	0.24	8418	1119	9537	22706	0.42
1987	266	771	0.35	6184	911	7095	22858	0.31
1988	693	406	0.37	8053	1772	9825	25186	0.39
1989	655	914	0.72	6491	1076	7567	21905	0.35
1990	781	3254	0.25	5879	948	6827	35511	0.19
1991	382	1683	0.23	2472	584	3056	34715	0.09
1992	264	1635	0.16	6333	627	6960	37146	0.19
1993	433	n.a.	n.a.	4647	922	5569	35368(T)	0.17(T)
Mean (88-92)	555	1578	0.35	5846	1001	6847	30893	0.22
Change (93-mean)/mean	-22%	n.a.	n.a.	-21%	-8%	-19%	n.a.	n.a.

Table 6a. Angling catch and effort data for kelt and bright large salmon in the Southwest Miramichi River as estimated by DNRE, 1969 to 1993. The 1993 data are preliminary.

	Kelts			Bright Salmon				
Year	Catch	Rod Days	CPUE	Early Catch	Late Catch	Total Catch	Total Rod Days	CPUE
1969	1712	-	-	2064	1256	3320	54941(T)	0.09(T)
1970	1233	-	-	1412	1372	2784	50010(T)	0.08(T)
1971	1145	-	-	1129	244	1373	39078(T)	0.06(T)
1972	410	3530	0.12	5844	1814	7658	37940	0.20
1973	2568	7461	0.34	3665	1404	5069	45326	0.11
1974	2599	6302	0.41	4951	838	5789	47442	0.12
1975	2571	6963	0.37	3750	1236	4986	44377	0.11
1976	1197	5514	0.22	4617	1382	5999	52346	0.11
1977	1759	7426	0.24	8015	1180	9195	48923	0.19
1978	1799	4553	0.40	3402	736	4138	54568	0.08
1979	1471	4360	0.34	1561	419	1980	37187	0.05
1980	1374	5687	0.24	3380	1688	5068	42134	0.12
1981	1769	4810	0.37	1442	756	2198	48587	0.05
1982	1161	6696	0.17	2457	1053	3510	49455	0.07
1983	770	4180	0.18	1190	350	1540	58748	0.03
1984	483	1739	0.28	3617	1240	4857	40523	0.12
1985	3118	3637	0.86	8114	1038	9152	34573	0.26
1986	5925	6563	0.90	6828	3559	10387	37599	0.28
1987	4447	10409	0.43	4913	4931	9844	41595	0.24
1988	5514	4899	1.13	3050	3958	7008	56550	0.12
1989	6526	5210	1.25	4461	4662	9123	50987	0.18
1990	4565	12200	0.37	4376	2740	7116	86959	0.08
1991	2474	9345	0.26	2771	1856	4628	74882	0.06
1992	3934	9338	0.42	5171	2511	7682	84976	0.09
1993	2564	n.a.	n.a.	2510	2534	5044	74560(T)	0.10(T)
Mean (88-92)	4603	7734	0.60	3966	3145	7111	70871	0.10
Change (93-mean)/mean	-44%	-	-	-37%	-19%	-29%	5%	0%

Table 6b. Angling catch and effort data for kelt and bright small salmon in the Southwest Miramichi River as estimated by DNRE, 1969 to 1993. The 1993 data are preliminary.

	Kelts			Bright Salmon				
Year	Catch	Rod Days	CPUE	Early Catch	Late Catch	Total Catch	Total Rod Days	CPUE
1969	1820	-	-	14087	5962	20049	54941(T)	0.36(T)
1970	2909	-	-	9622	5240	14862	50010(T)	0.30(T)
1971	1908	-	-	8527	2300	10827	39078(T)	0.28(T)
1972	1209	3530	0.34	12696	2763	15459	37940	0.41
1973	1317	7461	0.18	8921	1625	10546	45326	0.23
1974	1299	6302	0.21	12947	1340	14287	47442	0.30
1975	1367	6963	0.20	10161	2121	12282	44377	0.28
1976	1988	5514	0.36	18589	3548	22137	52346	0.42
1977	2025	7426	0.27	8793	981	9774	48923	0.20
1978	1039	4553	0.23	5167	867	6034	54568	0.11
1979	1111	4360	0.25	7889	1650	9539	37187	0.26
1980	2013	5687	0.35	5732	1978	7710	42134	0.18
1981	1532	4810	0.32	11056	2997	14053	48587	0.29
1982	2268	6696	0.34	10152	1820	11972	49455	0.24
1983	1710	4180	0.41	3680	890	4570	58740	0.08
1984	1035	1739	0.60	9598	3228	12876	40523	0.32
1985	2097	3637	0.58	7853	1154	9007	34573	0.26
1986	2250	6563	0.34	12193	4433	16624	37599	0.44
1987	2482	10409	0.24	8640	5030	13670	41595	0.33
1988	3523	4899	0.72	9918	10872	20790	56067	0.38
1989	4706	5210	0.90	10830	6028	16858	50987	0.33
1990	3353	12200	0.27	9377	5168	14545	86959	0.17
1991	1974	9345	0.21	5297	2947	8244	74882	0.11
1992	1999	9338	0.21	10236	4313	14549	84976	0.17
1993	1327	n.a.	n.a.	5500	4202	9702	74560(T)	0.13(T)
Mean (88-92)	3111	8198	0.38	9132	5866	14997	70774	0.21
Change (93-mean)/mean	-57%	n.a.	n.a.	-40%	-28%	-35%	n.a.	n.a.

Table 7. Angling statistics for bright large and small salmon in the Northwest Miramichi Crown Reserves as reported by N.B. DNRE.

	Salmon Catch				CPUE	
	Small Harvest	Small Released	Large	Effort Rod Days	Small	Large
1972	1268	-	267	2705	0.47	0.10
1973	1210	-	138	2648	0.46	0.05
1974	1259	-	121	2940	0.43	0.04
1975	1391	-	125	2694	0.52	0.05
1976	1280	-	157	2791	0.46	0.06
1977	1120	-	266	2719	0.41	0.10
1978	522	-	117	2043	0.26	0.06
1979	1147	-	78	2378	0.48	0.03
1980	1306	-	159	2835	0.46	0.06
1981	1953	-	89	2887	0.68	0.03
1982	1816	-	134	2200	0.83	0.06
1983	823	-	167	2269	0.36	0.07
1984	1240	-	229	2179	0.57	0.11
1985	1563	144	206	2269	0.75	0.09
1986	1676	111	156	2456	0.73	0.06
1987	1072	91	88	1839	0.63	0.05
1988	1860	138	102	2423	0.82	0.04
1989	1595	192	127	2535	0.70	0.05
1990	1587	144	144	2502	0.69	0.06
1991	612	45	77	2395	0.27	0.03
1992	1423	209	94	2364	0.69	0.04
1993	1426	175	135	2432	0.66	0.06
Mean 1988-92	1415	146	109	2444	0.63	0.04
Change (93-Mean)/Mean	+1%	+20%	+24%	0%	+5%	+50%

For 1972-81 two stretches on North Pole Stream are included.
For 1982-93 North Pole Stream is excluded.
Released small salmon catches are unavailable for 1972-84 because anglers in Crown Reserve Waters provided statistics on numbers caught but were not asked if the fish were subsequently released or harvested.

Table 8. Salmon harvest in the Miramichi River for 1991-93. Harvests for 1993 are preliminary. Illegal fishing seizures are reported but are not included in the total removals for estimation of escapement relative to the conservation target.

	1991		1992		1993	
	Small	Large	Small	Large	Small	Large
1. Miramichi River above Enclosure						
Native (NW Miramichi)						
Red Bank	899	350	1123	401	83	3
Eel Ground	210	112	493	179	394	51
Angling Total	11300	184	21509	284	15271	212
NW Miramichi	3056	46	6960	54	5569	61
SW Miramichi	8244	139	14549	230	9702	151
Total above Enclosure	12409	646	23125	864	15766	266
NW Miramichi	4165	508	8576	634	6055	118
SW Miramichi	8244	139	14549	230	9711	156
2. Miramichi estuary below Enclosure						
Native						
Burnt Church reported	2	82	36	28	124	154
estimated by DFO	70	130	-	-	-	-
Total below Enclosure	2	82	36	28	125	159
3. Other Removals						
Broodstock (Total)	97	99	87	123	103	152
NW Miramichi	-	-	61	55	71	99
SW Miramichi	-	-	26	68	32	53
Trap mortalities (Total)	29	32	32	19	2	14
NW Miramichi	-	-	0	1	1	1
SW Miramichi	-	-	0	7	1	13
Millbank	29	32	32	11	-	-
Samples (Total)	63	0	79	0	131	0
NW Miramichi	-	-	-	-	34	0
SW Miramichi	-	-	-	-	97	0
Millbank	63	0	79	0	-	-
Total other removals	189	131	198	142	236	166
NW Miramichi	-	-	61	56	106	100
SW Miramichi	-	-	26	75	130	66
Millbank	92	32	111	11	-	-
4. Total Removals	12600	859	23359	1034	16132	611
5. Illegal Fishing Seizures						
Miramichi River above Enclosure						
NW Miramichi	n.a.	n.a.	n.a.	n.a.	9	3
SW Miramichi	n.a.	n.a.	n.a.	n.a.	9	5
Miramichi estuary below Enclosure	n.a.	n.a.	n.a.	n.a.	1	5
Other Removals						
Illegal Fishing Seizures (area unknown)	n.a.	n.a.	n.a.	n.a.	5	12

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

Table 9. Estimated returns of small salmon to the Enclosure area, Miramichi River, 1993.

Raw data used in the population estimation procedures

Branch	At trapnets Total Catch	At trapnets Tags Placed	Recoveries of Tags From angling in Northwest	Recoveries of Tags From angling in Southwest	Barrier pools, fences, creel Tags recovered in Northwest	Barrier pools, fences, creel Tags recovered in Southwest	Total Fish Examined
Northwest	428	386	16	16	8	3	1225
Southwest	1193	1057	8	101	3	14	2409
Total	1621	1443	24	117	11	17	3634

Estimation of **residency and emigration rate** for small salmon of each branch

	Median	Percentiles 5th	Percentiles 95th
From Northwest to Northwest (resident)	86.0%	73.1%	94.8%
From Northwest to Southwest (migrant)	14.0%	5.2%	26.9%
From Southwest to Southwest (resident)	68.2%	37.6%	83.8%
From Southwest to Northwest (migrant)	31.8%	16.2%	62.4%

Estimates of **returns of small salmon** to the Miramichi River in 1993

Tags Used	Branch	Median	Percentiles 5th	Percentiles 95th
Resident	Northwest	46,230	27,742	97,492
	Southwest	42,581	22,689	73,835
	Miramichi (sum of branches)	92,373	61,548	153,751
Resident+	Northwest	68,293	39,020	141,073
Migrant	Southwest	36,694	19,802	60,922
	Miramichi (sum of branches)	107,508	76,962	175,510
Unstratified				
	Miramichi (total)	96,530	72,717	135,849

Table 10. Estimated returns of large salmon to the Enclosure area, Miramichi River, 1993.

Raw data used in the population estimation procedures

Branch	At trapnets Total Catch	At trapnets Tags Placed	Recoveries of Tags From angling in Northwest	Recoveries of Tags From angling in Southwest	Barrier pools, fences, creel Tags recovered in Northwest	Barrier pools, fences, creel Tags recovered in Southwest	Total Fish Examined
Northwest	175	173	3	2	3	1	261
Southwest	375	359	1	7	1	6	1696
Total	550	532	4	9	4	7	1957

Estimation of **residency and emigration rate** for large salmon of each branch

	Median	Percentiles 5th	Percentiles 95th
From Northwest to Northwest (resident)	82.1%	30.6%	100.0%
From Northwest to Southwest (migrant)	17.9%	0.0%	69.4%
From Southwest to Southwest (resident)	60.4%	51.8%	100.0%
From Southwest to Northwest (migrant)	39.6%	0.0%	48.2%

Trapnet **large salmon to small salmon ratio**

	Observed Catch Small	Observed Catch Large	Large/ Small	Median	Percentiles 5th	Percentiles 95th
Northwest	428	175	0.409	0.41	0.35	0.47
Southwest	1193	375	0.314	0.31	0.28	0.35

Estimates of **returns of large salmon** to the Miramichi River in 1993

Tags Used	Branch	Model	Median	Percentiles 5th	Percentiles 95th
Resident	Northwest	Ratio	18,911	10,921	40,975
		Tags	10,541	3,696	37,500
	Southwest	Ratio	13,313	7,052	23,535
		Tags	21,906	10,809	58,947
	Miramichi (sum of branches)	Ratio	33,300	22,211	57,024
		Tags	35,245	19,732	76,695
Resident+ Migrant	Northwest	Ratio	27,964	15,548	57,616
		Tags	13,476	3,693	41,541
	Southwest	Ratio	11,536	6,173	19,353
		Tags	21,659	9,681	57,870
	Miramichi (sum of branches)	Ratio	40,280	27,742	68,774
		Tags	38,056	23,271	82,455
Unstratified	Miramichi (total)	Ratio	24,422	18,398	34,370
		Tags	35,629	22,760	66,454

Table 11. Estimated returns and escapement to the Miramichi River (to Millbank 1971 to 1991; to enclosure area 1992 to 1993) of small and large salmon.

Year	Returns to the Estuary		Escapement	
	Small Salmon	Large Salmon	Small Salmon	Large Salmon
1971	35,673	24,407	21,946	4,347
1972	46,275	29,049	27,135	17,671
1973	44,545	27,192	30,688	20,349
1974	73,418	42,592	55,186	34,445
1975	64,902	28,817	48,469	21,448
1976	91,580	22,801	62,380	14,332
1977	27,743	51,842	13,247	32,917
1978	24,287	24,493	14,353	10,829
1979	50,9656	9,054	30,848	4,541
1980	41,588	36,318	26,894	18,873
1981	65,273	16,182	39,929	4,608
1982	80,379	30,758	56,000	13,258
1983	25,184	27,924	14,849	8,458
1984	29,707	15,137	18,929	14,687
1985	60,800	20,738	41,815	20,122
1986	117,549	31,285	89,398	30,216
1987	84,816	19,421	62,777	18,056
1988	121,919	21,745	90,278	20,980
1989	73,231	17,211	48,385	15,540
1990	83,148	28,574	59,524	27,588
1991	60,869	29,949	48,269	29,089
1992	152,647	37,000	129,288	35,927
1993	92,400	35,200	76,416	34,702
1993-(5 Year Avg.) /(5 Year Avg.)	-6%	31%	0%	33%

Table 12. Biological characteristics (fork length, sex ratio and fecundity) of adult salmon sampled at the Southwest Enclosure and Northwest Eel Ground trap nets and at the headwater barrier pools in 1993.

Small Salmon

	Southwest Miramichi River			Northwest Miramichi River		
Mean Fork Length	53.3 cm		(n=1155)	54.2 cm		(n=419)
% Female	Internal sex determination			Internal sex determination		
	Early	18.5	(n=30)	Early	20.0	(n=5)
	Late	6.0	(n=55)	Late	4.0	(n=25)
	Total	9.4	(n=85)	Total	6.7	(n=30)
	External sex determination			External sex determination		
	Early	29.2	(n=168)	Early	25.0	(n=28)
	Late	13.0	(n=579)	Late	12.7	(n=268)
	Total	16.9	(n=747)	Total	13.9	(n=296)
	Dungarvon Headwater Barrier			NW Headwater Barrier Pool		
	Total	47.4	(n=287)	Total	46.5	(n=217)

Eggs/Spawner	Southwest Miramichi River	Northwest Miramichi River
Internal sex determination	294	221
External sex determination	528	458
Headwater Barrier	1483	1534

Large Salmon

	Southwest Miramichi River			Northwest Miramichi River		
Mean Fork Length	74.8 cm		(n=356)	77.2 cm		(n=172)
% Female	from trapnet (Sept. & Oct.)			from trapnet (Sept. & Oct.)		
	Total	81.8	(n=324)	Total	83.5	(n=164)
	Dungarvon Headwater Barrier			NW Headwater Barrier Pool		
	Total	92.6	(n=54)	Total	87.2	(n=39)

Eggs/Spawner	Southwest Miramichi River	Northwest Miramichi River
Trapnet sampling	5726	6112
Headwater Barrier	6482	6383

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

Eggs/spawner (small) = % Female X $e^{[3.1718 \times \mathrm{Ln(FL)} - 4.5636]}$

Eggs/spawner (large) = % Female X $e^{[1.4132 \times \mathrm{Ln(FL)} + 2.7560]}$

Table 13. Age composition of small and large salmon sampled at the trapnets in the Miramichi River for 1971 to 1993. Values shown are percentages. For 1993, SW = Southwest Miramichi samples and NW = Northwest Miramichi samples.

	Small Salmon		Large Salmon			
Year	1SW Maiden	1SW Previous	1SW Maiden	1SW Previous	MSW Maiden	MSW Previous
1971	100	0	0	5	94	0
1972	100	0	0	3	97	0
1973	100	0	0	2	98	0
1974	100	0	0	5	93	2
1975	100	0	0	7	88	4
1976	100	0	1	7	88	4
1977	99	1	1	3	94	3
1978	100	0	0	11	87	2
1979	100	0	0	6	78	15
1980	99	1	0	3	95	2
1981	100	0	0	19	73	8
1982	99	1	1	14	80	5
1983	100	0	0	12	85	3
1984	100	0	1	8	89	2
1985	100	0	1	6	88	6
1986	100	0	5	9	80	6
1987	100	0	0	5	81	14
1988	100	0	2	6	80	12
1989	99	1	0	23	66	11
1990	100	0	3	18	61	19
1991	100	0	1	14	61	25
1992	100	0	4	14	57	26
1993 (SW)	99	1	2	5	68	25
1993 (NW)	100	0	2	6	70	22

Table 14. Analysis of variance of the density of fry at 15 standard sites in the Miramichi River, 1970 to 1993.

General Linear Models Procedure
Class Level Information

Class	Levels	Values
YEAR	24	1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993
RIVER	2	NW = Northwest sites, SW = Southwest sites

Number of observations in data set = 292

Dependent Variable: DENSFRY

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	24	333597.30205619	13899.88758567	6.45	0.0001
Error	267	575078.43398513	2153.85181268		
Corrected Total	291	908675.73604132			

R-Square	C.V.	Root MSE	DENSFRY Mean
0.367125	90.25491	46.40960906	51.42059225

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YEAR	23	223117.63204585	9700.76661069	4.50	0.0001
RIVER	1	111462.95005642	111462.95005642	51.75	0.0001

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		94.71928699 B	7.29	0.0001	12.99860570
YEAR	1970	-40.93212889 B	-1.79	0.0753	22.92042398
	1971	-60.70322078 B	-3.27	0.0012	18.57932607
	1972	-70.47099510 B	-3.87	0.0001	18.20334632
	1973	-54.29937972 B	-2.98	0.0031	18.20334632
	1974	-43.08561049 B	-2.37	0.0187	18.20334632
	1975	-40.31414895 B	-2.21	0.0276	18.20334632
	1976	-54.89899510 B	-3.02	0.0028	18.20334632
	1977	-21.21814895 B	-1.17	0.2448	18.20334632
	1978	-39.78791818 B	-2.19	0.0297	18.20334632
	1979	-60.25922587 B	-3.31	0.0011	18.20334632
	1980	-42.08022587 B	-2.31	0.0216	18.20334632
	1981	-21.64045664 B	-1.19	0.2356	18.20334632
	1982	-64.89545664 B	-3.57	0.0004	18.20334632
	1983	-33.84630280 B	-1.86	0.0641	18.20334632
	1984	-61.04468741 B	-3.35	0.0009	18.20334632
	1985	-16.78872078 B	-0.90	0.3670	18.57932607
	1986	-21.15607203 B	-1.16	0.2462	18.20334632
	1987	0.16238951 B	0.01	0.9929	18.20334632
	1988	23.38315874 B	1.28	0.2001	18.20334632
	1989	-1.43153356 B	-0.08	0.9374	18.20334632
	1990	23.75254336 B	1.30	0.1931	18.20334632
	1991	-21.86932123 B	-0.73	0.4637	29.80100376
	1992	2.78627922 B	0.15	0.8809	18.57932607
	1993	0.00000000 B	.	.	.
RIVER	NW	-42.36094864 B	-7.19	0.0001	5.88854937
	SW	0.00000000 B	.	.	.

NOTE: The X'X matrix has been found to be singular and a generalized inverse was used to solve the normal equations. Estimates followed by the letter 'B' are biased, and are not unique estimators of the parameters.

Table 15. Analysis of variance of the density of parr at 15 standard sites in the Miramichi River, 1970 to 1993.

General Linear Models Procedure
Class Level Information

Class	Levels	Values
YEAR	24	1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993
RIVER	2	NW = Northwest sites, SW = Southwest sites

Number of observations in data set = 292

Dependent Variable: DENSPARR

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	24	8430.86947083	351.28622795	1.57	0.0481
Error	267	59893.85300031	224.32154682		
Corrected Total	291	68324.72247113			

R-Square	C.V.	Root MSE	DENSPARR Mean
0.123394	105.1362	14.97736782	14.24568122

Source	DF	Type III SS	Mean Square	F Value	Pr > F
RIVER	1	1928.81481201	1928.81481201	8.60	0.0037
YEAR	23	6679.70362992	290.42189695	1.29	0.1698

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		22.04174536 B	5.25	0.0001	4.19492650
RIVER	NW	-5.57244354 B	-2.93	0.0037	1.90036011
	SW	0.00000000 B	.	.	.
YEAR	1970	-9.60167143 B	-1.30	0.1954	7.39690826
	1971	-9.75793084 B	-1.63	0.1048	5.99594364
	1972	-7.29868581 B	-1.24	0.2152	5.87460698
	1973	-15.79460888 B	-2.69	0.0076	5.87460698
	1974	-5.91299350 B	-1.01	0.3151	5.87460698
	1975	-4.17668581 B	-0.71	0.4777	5.87460698
	1976	-3.84345504 B	-0.65	0.5135	5.87460698
	1977	-7.22360888 B	-1.23	0.2199	5.87460698
	1978	-4.62122427 B	-0.79	0.4322	5.87460698
	1979	-7.96676273 B	-1.36	0.1762	5.87460698
	1980	-8.87099350 B	-1.51	0.1322	5.87460698
	1981	-9.47237811 B	-1.61	0.1081	5.87460698
	1982	-6.52445504 B	-1.11	0.2677	5.87460698
	1983	-10.02960888 B	-1.71	0.0889	5.87460698
	1984	-12.16745504 B	-2.07	0.0393	5.87460698
	1985	-10.89709751 B	-1.82	0.0703	5.99594364
	1986	-4.23345504 B	-0.72	0.4718	5.87460698
	1987	-3.80214734 B	-0.65	0.5180	5.87460698
	1988	-4.18660888 B	-0.71	0.4767	5.87460698
	1989	-0.09937811 B	-0.02	0.9865	5.87460698
	1990	-4.70537811 B	-0.80	0.4239	5.87460698
	1991	6.32455034 B	0.66	0.5114	9.61741768
	1992	7.43556916 B	1.24	0.2160	5.99594364
	1993	0.00000000 B	.	.	.

NOTE: The X'X matrix has been found to be singular and a generalized inverse was used to solve the normal equations. Estimates followed by the letter 'B' are biased, and are not unique estimators of the parameters.

Table 16. Densities of fry and parr from the Northwest and Southwest Miramichi in 1993.

Section	Mean	Min	Max	Std. Dev.	N
Fry Densities					
Northwest Miramichi					
Little Southwest	67.1	48.2	83.5	14.8	4
Main Northwest	81.8	24.2	175.5	54.5	6
Little Sevogle	75.7	36.5	113.0	38.3	3
Big Sevogle	80.2	55.0	119.4	34.4	3
Upper Northwest	66.5	29.5	95.4	26.8	6
Southwest Miramichi					
Barnaby's	66.6	51.5	81.8	21.4	2
Renous/Dungarvon	57.5	17.9	84.7	25.1	8
Cains	60.2	39.1	85.6	21.9	5
Lower Southwest	46.6	0.07	7.3	28.1	6
Middle Southwest	78.0	0.0	181.1	68.5	11
Upper Southwest	93.6	44.3	200.8	45.1	13
Estuary					
Bartibog	28.7	22.8	34.7	8.5	2
Parr Densities					
Northwest Miramichi					
Little Southwest	16.6	0.0	39.7	16.8	4
Main Northwest	19.3	9.4	31.2	8.0	6
Little Sevogle	26.7	23.5	28.8	2.9	3
Big Sevogle	17.4	12.5	23.4	5.6	3
Upper Northwest	24.3	8.9	51.8	17.2	6
Southwest Miramichi					
Barnaby's	29.9	17.6	42.2	17.4	2
Renous/Dungarvon	16.6	4.9	36.8	10.8	8
Cains	12.7	0.0	24.7	10.0	5
Lower Southwest	5.6	0.0	12.8	5.1	6
Middle Southwest	18.1	0.0	47.0	15.5	11
Upper Southwest	23.8	0.0	56.6	17.6	13
Estuary					
Bartibog	14.8	7.1	22.4	10.8	2

Table 17. Numbers of large and small salmon counted at barriers in three tributaries of the Miramichi River, 1981 to 1993.

Tributary	Year	Large	Small	Total	Dates Operated	No. of Days
North Branch of SW Miramichi River						
	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
	1990	994	1646	2640	Jun. 29-Oct. 14	108
	1991	476	495	971	Jun. 30-Oct. 21	107
	1992	1047	1383	2430	Jun. 30-Oct. 20	113
	1993	1145	1349	2494	Jun. 30-Oct. 22	115
1988-92 Mean		835	1117	1952		
Change (93-mean)/mean		+37%	+21%	+28%		
Dungarvon River						
	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
	1990	318	562	880	Jun. 1-Oct. 11	133
	1991	204	296	500	Jun. 4-Oct. 14	133
	1992	232	825	1057	Jun. 4-Oct. 16	135
	1993	223	659	882	Jun. 14-Oct. 27	131
1988-92 Mean		269	623	892		
Change (93-mean)/mean		-17%	+6%	-1%		
Northwest Miramichi River						
	1988	234	1614	1848	Jun. 27-Oct. 26	122
	1989	287	966	1253	May 30-Oct. 12	136
	1990	331	1318	1649	May 29-Oct. 18	143
	1991	224	765	989	Jun. 4-Oct. 18	137
	1992	219	1165	1384	Jun. 3-Oct. 16	136
	1993	216	1034	1250	Jun. 14-Oct. 27	136
1988-92 Mean		259	1166	1425		
Change (93-mean)/mean		-17%	-11%	-12%		

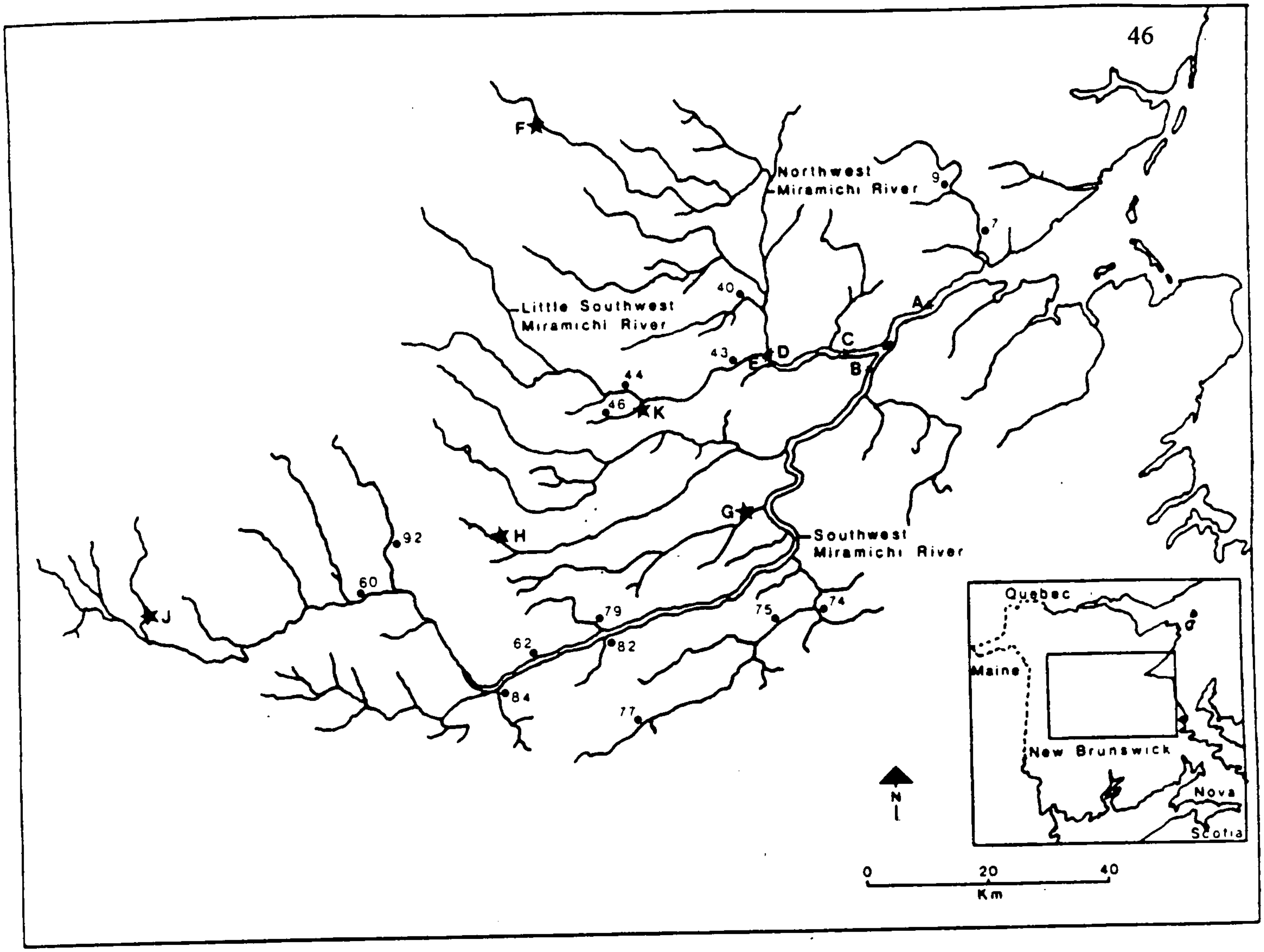
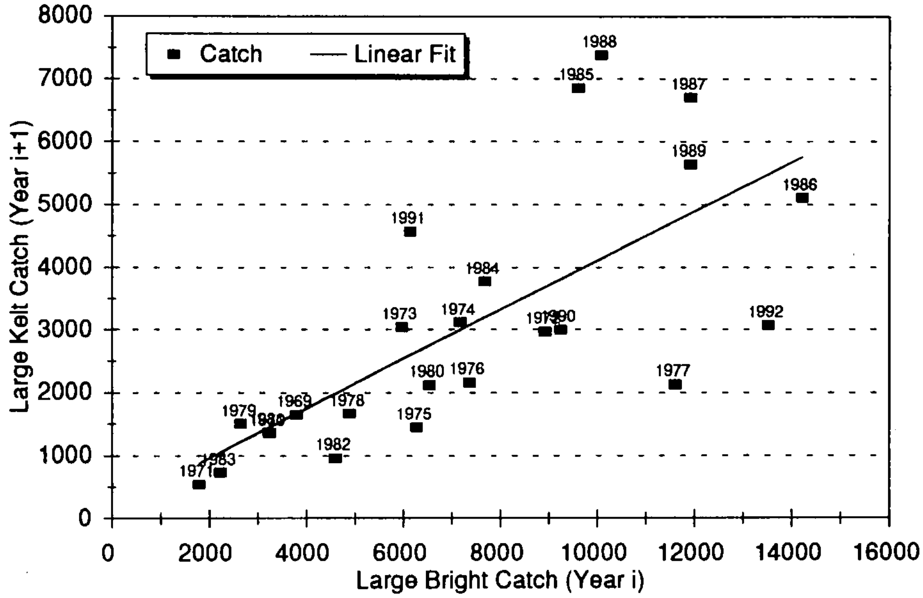


Figure 1. The Miramichi River system. Electrofishing sites are denoted by numbered dots. Counting fences and traps are labelled as follows:

A = Millbank trap
B = SW Miramichi Enclosure trap
C = NW Eel Ground trap
D = NW Red Bank trap
E = LSW Red Bank trap
F = NW Miramichi R. fence
G = Bartholomew R. fence
H = Dungarvon R. fence
J = N Br. SW Miramichi R. fence
K = Catamaran Brook fence



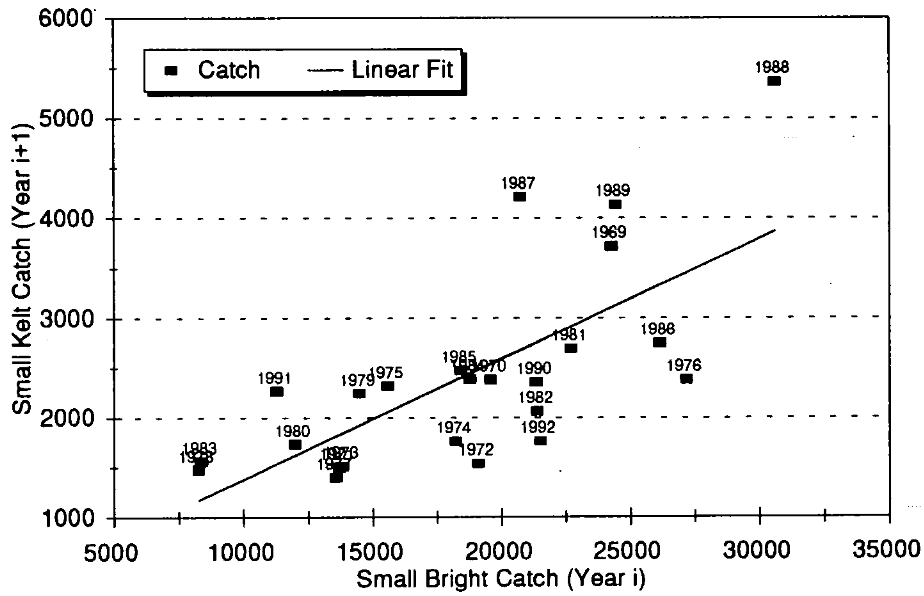
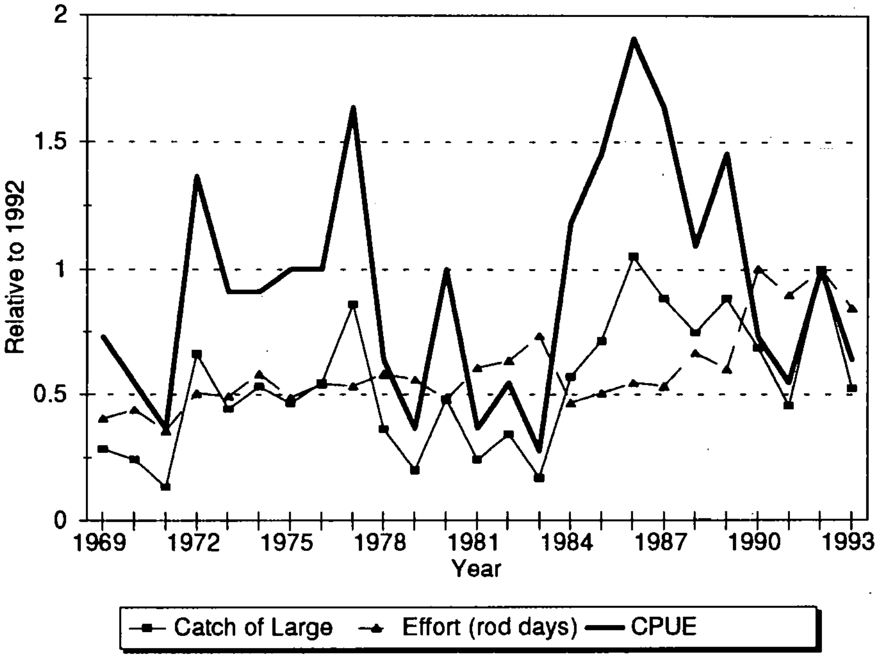


Figure 2. Catch of kelts in year (i+1) relative to catch of bright salmon in year i, for large (upper) and small (lower) salmon, Miramichi River.



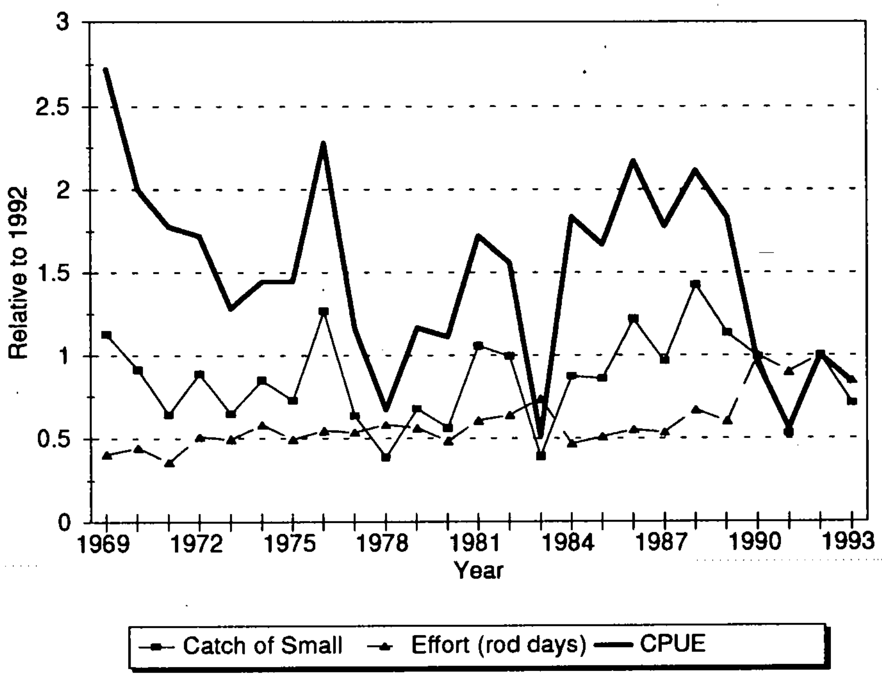


Figure 3. Catch, effort and CPUE of large salmon (upper) and small salmon (lower) from the Miramichi River, 1969 to 1993.

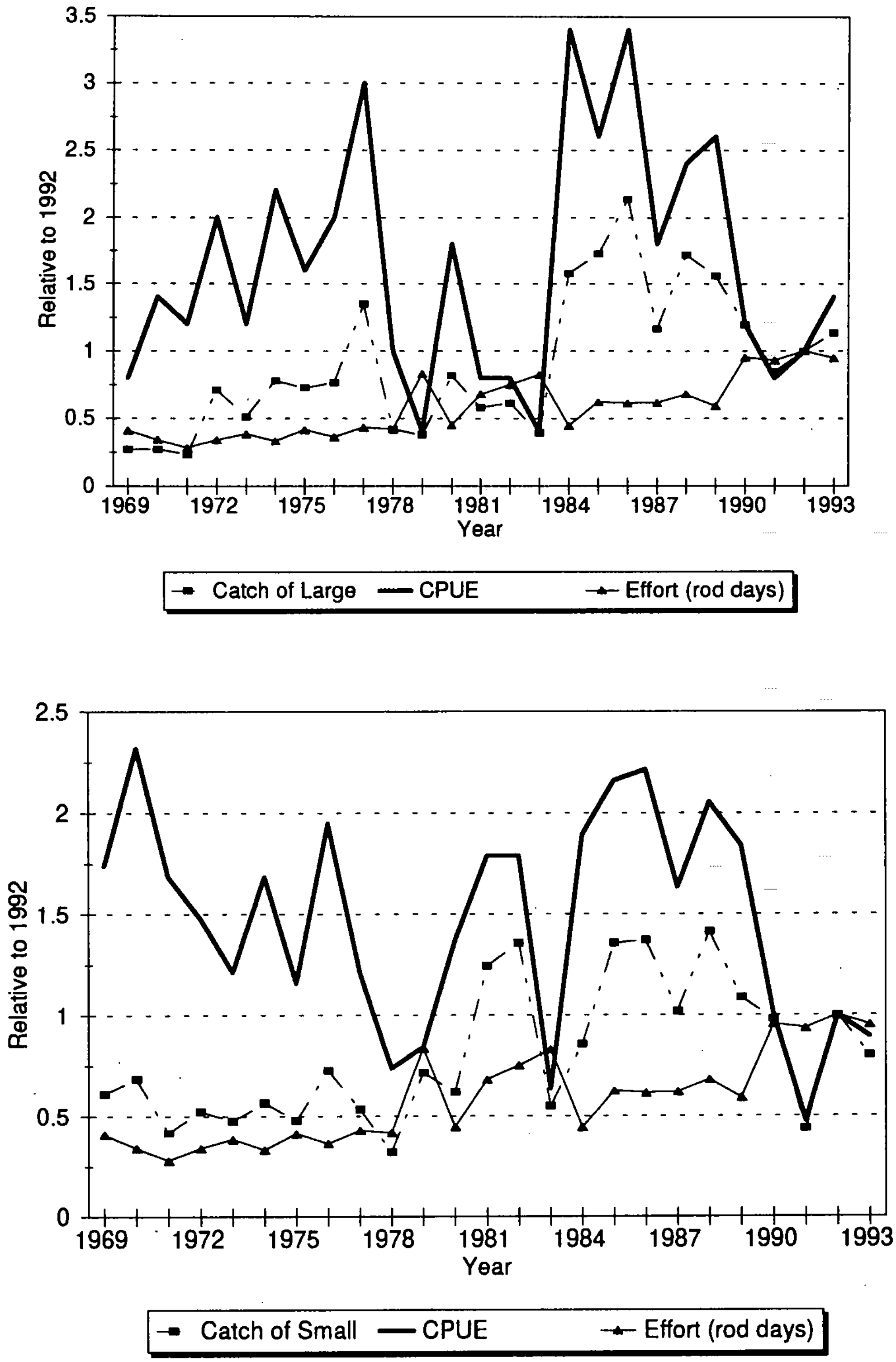
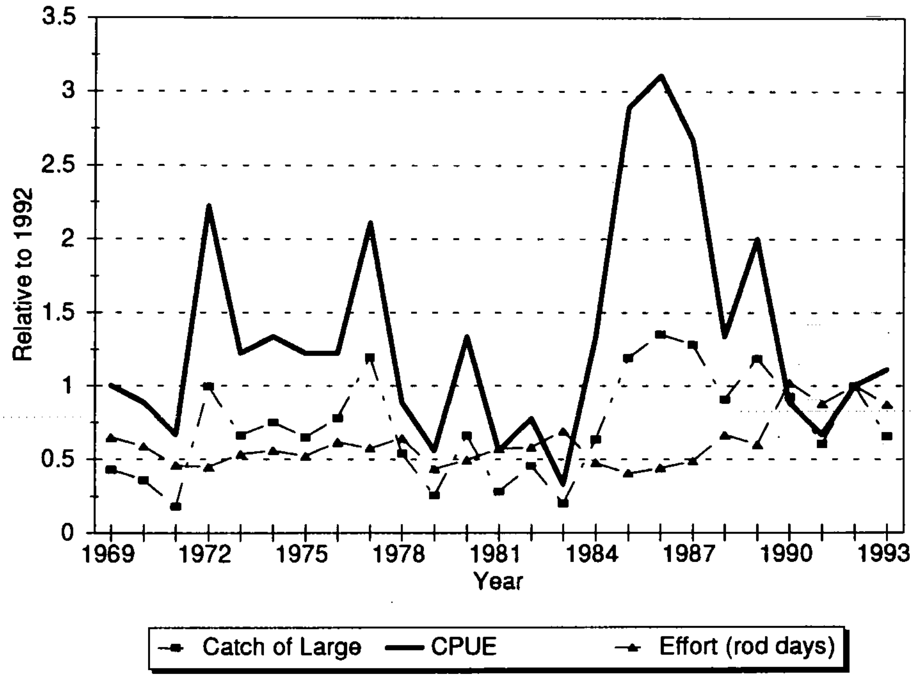


Figure 4. Catch, effort and CPUE of large (upper) and small (lower) salmon from the Northwest Miramichi, 1969 to 1993.



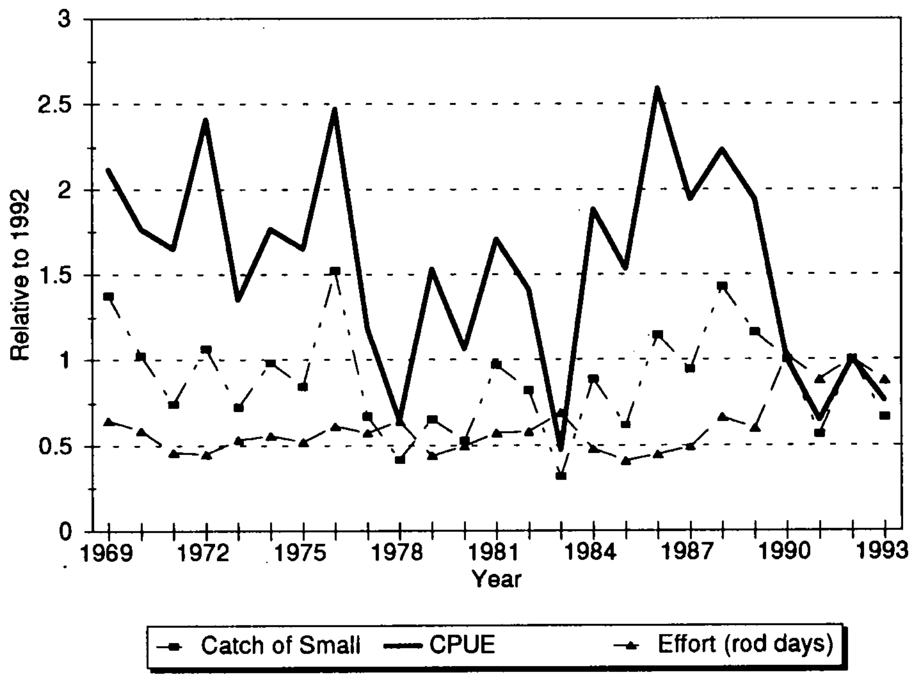


Figure 5. Catch, effort and CPUE of large (upper) and small (lower) salmon from the Southwest Miramichi River, 1969 to 1993.

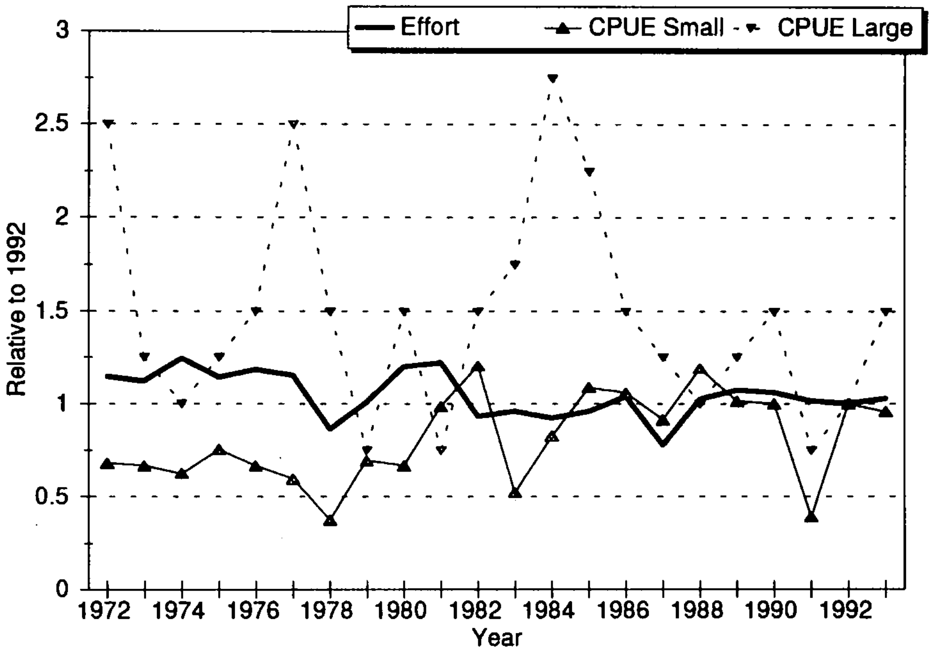
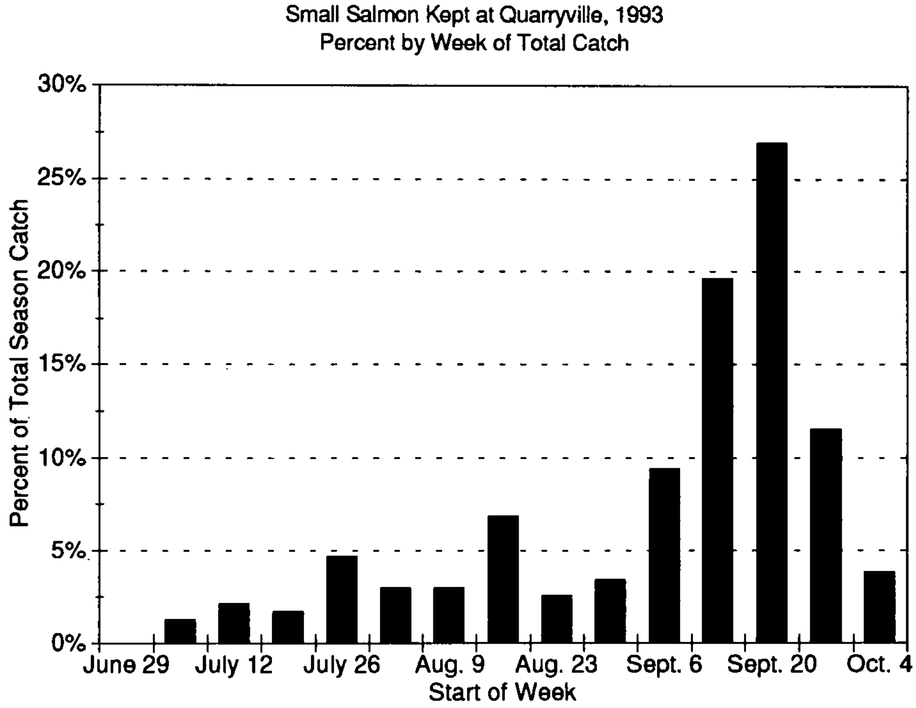


Figure 6. Trends in effort and CPUE of small and large salmon from the Crown Reserve waters of the Northwest Miramichi, 1972 to 1993.



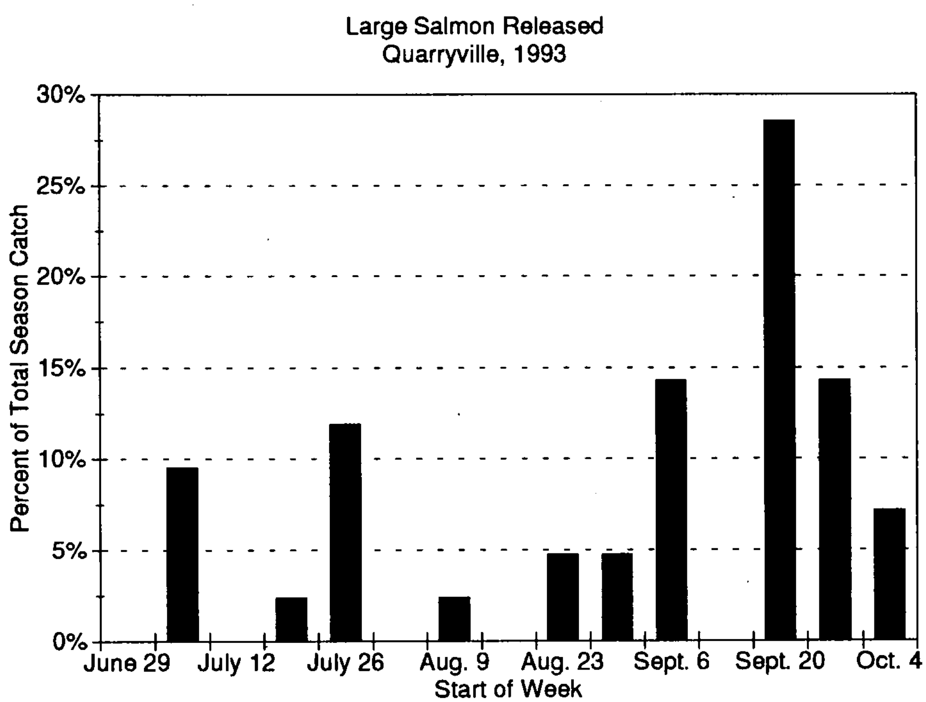
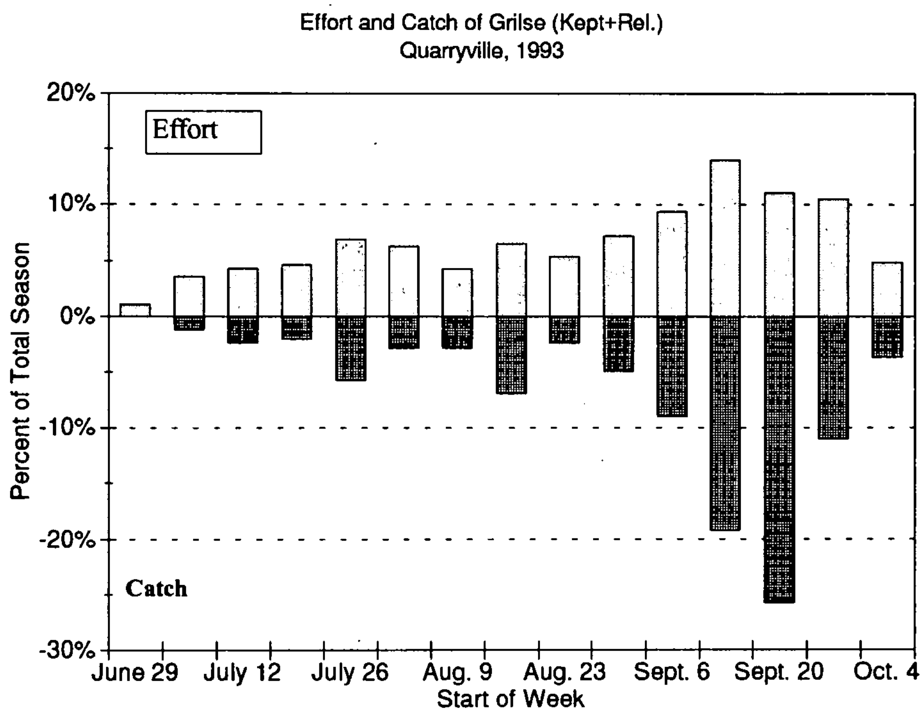


Figure 7. Proportion by week of the total season catch of small salmon (upper) and releases of large salmon (lower) at Quarryville Pool, 1993.



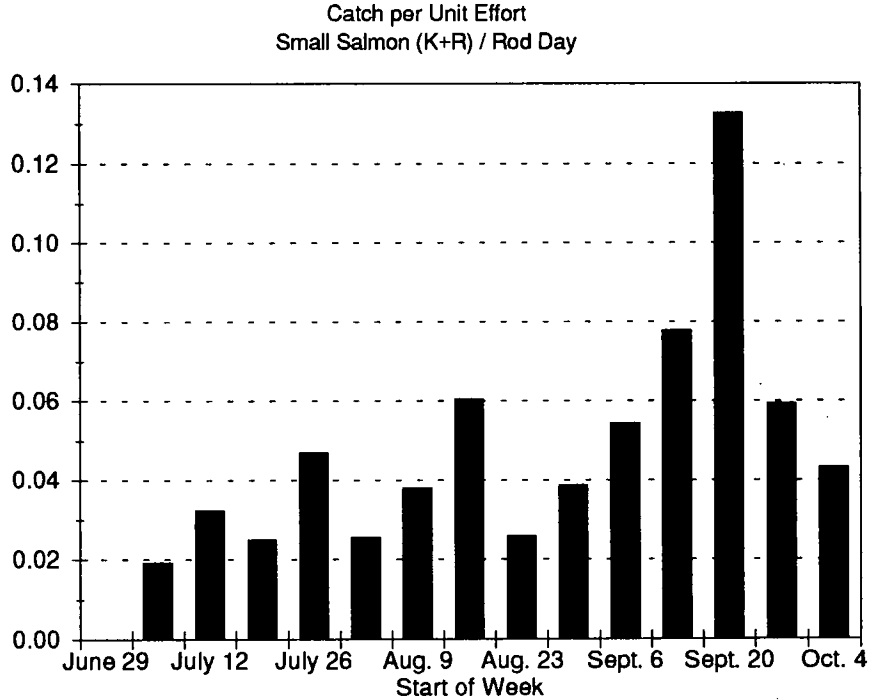
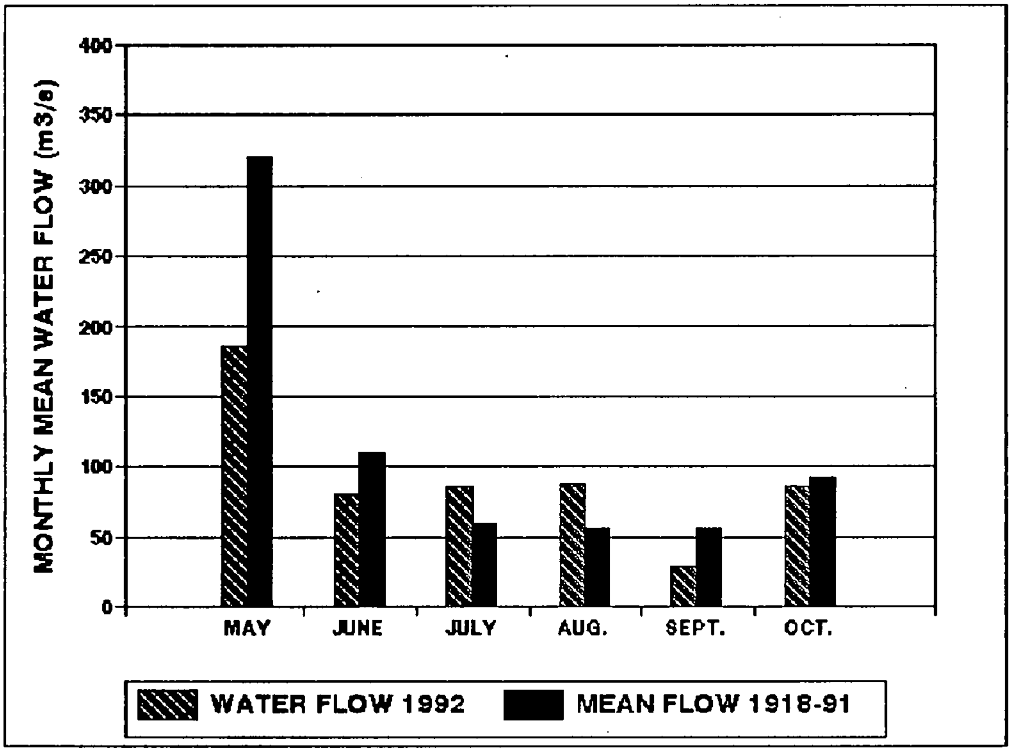


Figure 8. Proportion of total catch and effort (upper) by week and catch per unit effort (lower) at Quarryville Pool, 1993.



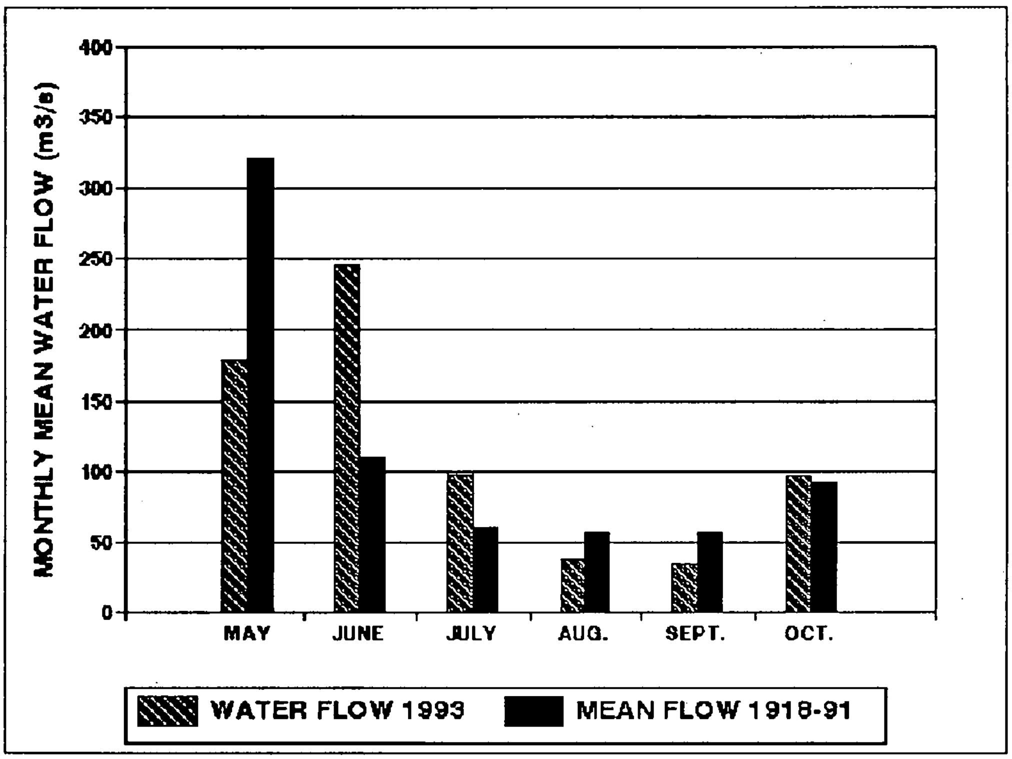


Figure 9. Water discharge for the SW Miramichi River for 1992 (upper) and 1993 (lower).

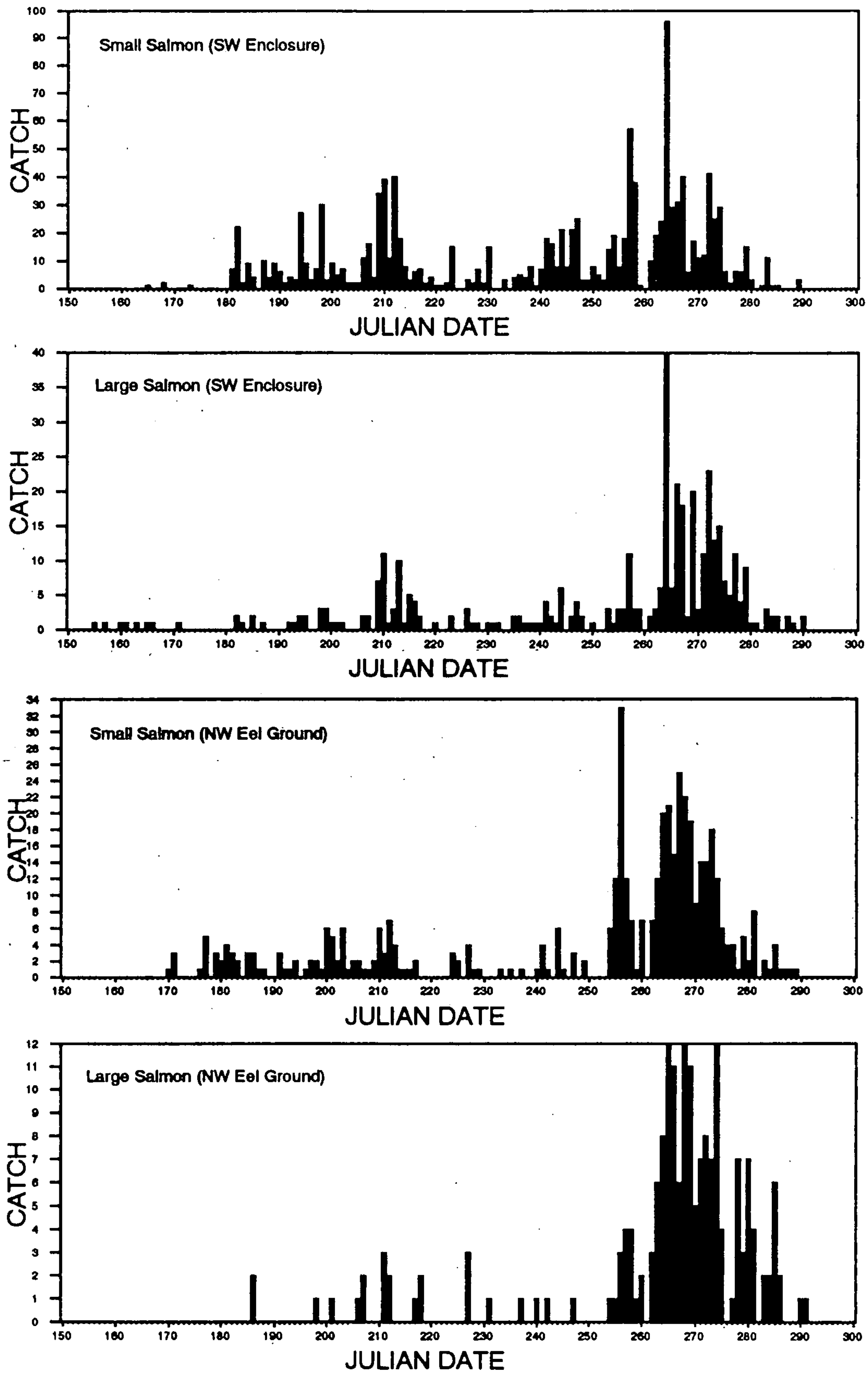


Figure 10. Daily catch of small and large salmon at the SW Enclosure and NW Eel Ground traps, 1993.

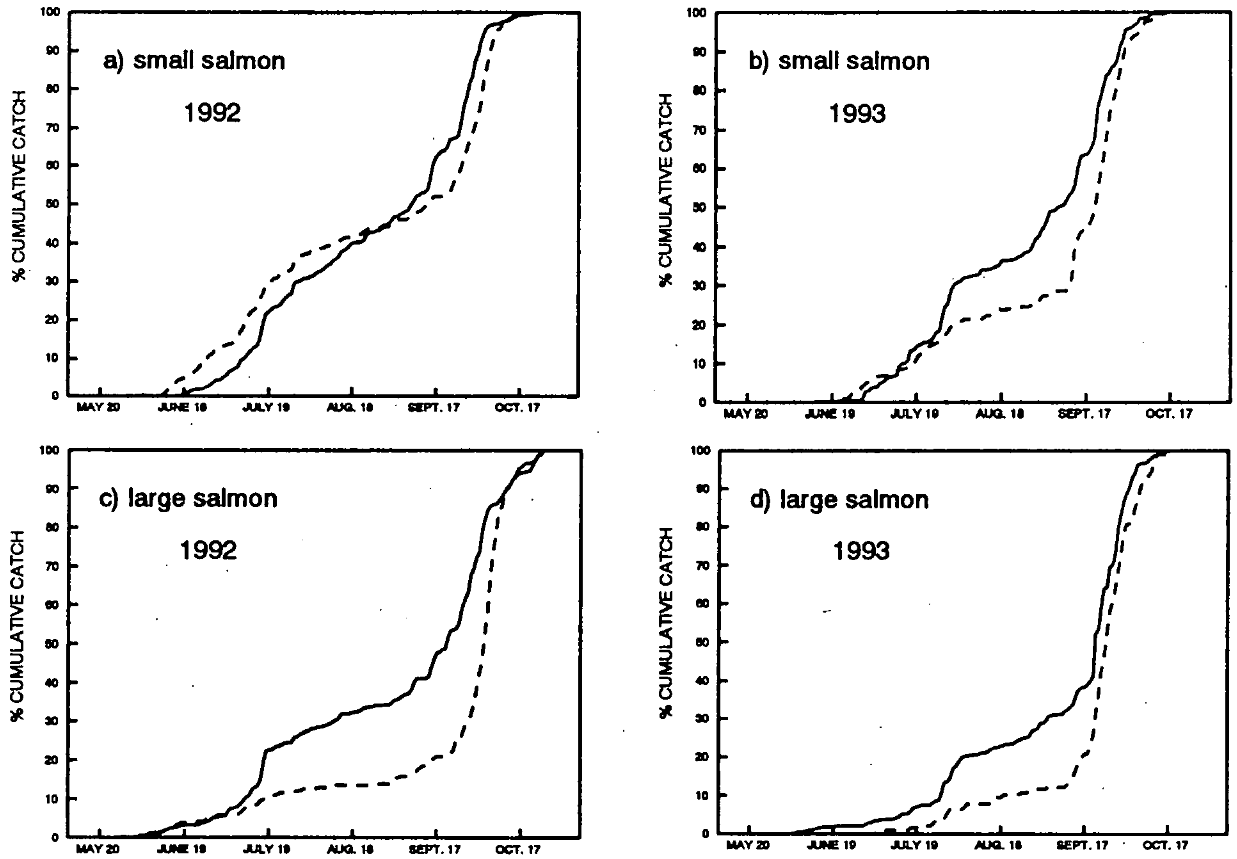


Figure 11. Cumulative catch of small and large salmon at the SW (solid) and NW (dashed) traps in 1992-93.

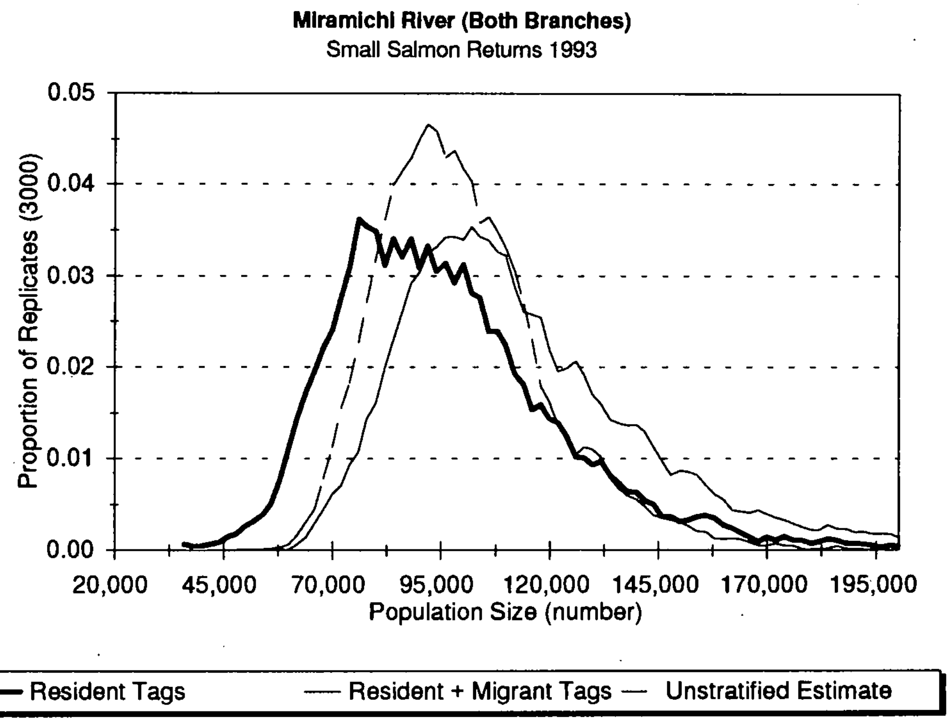
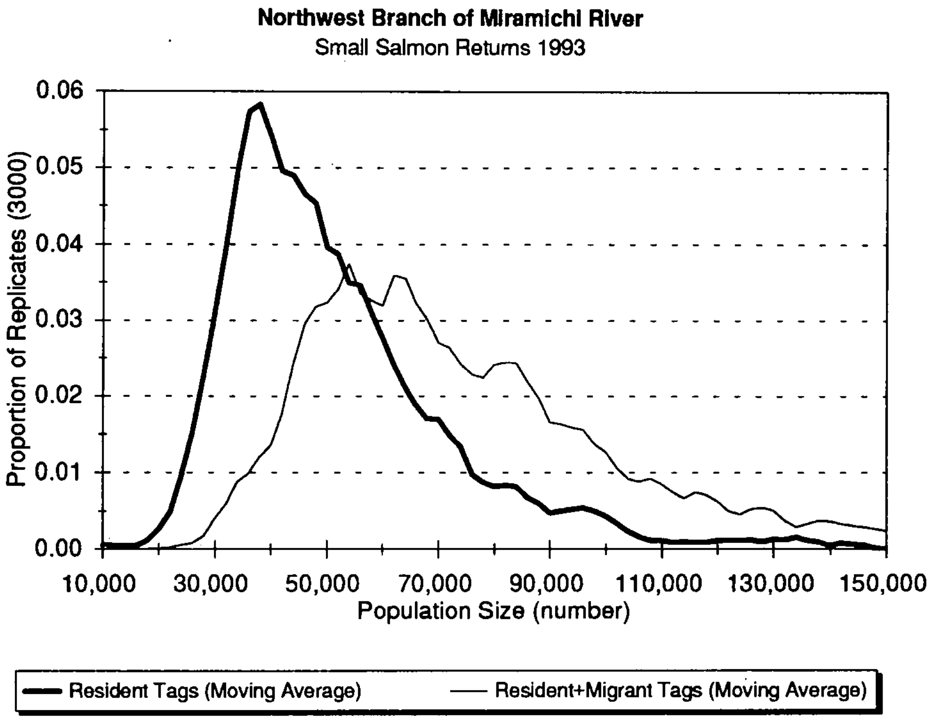


Figure 12. Distribution of the estimated returns of small salmon to the Miramichi River in 1993.



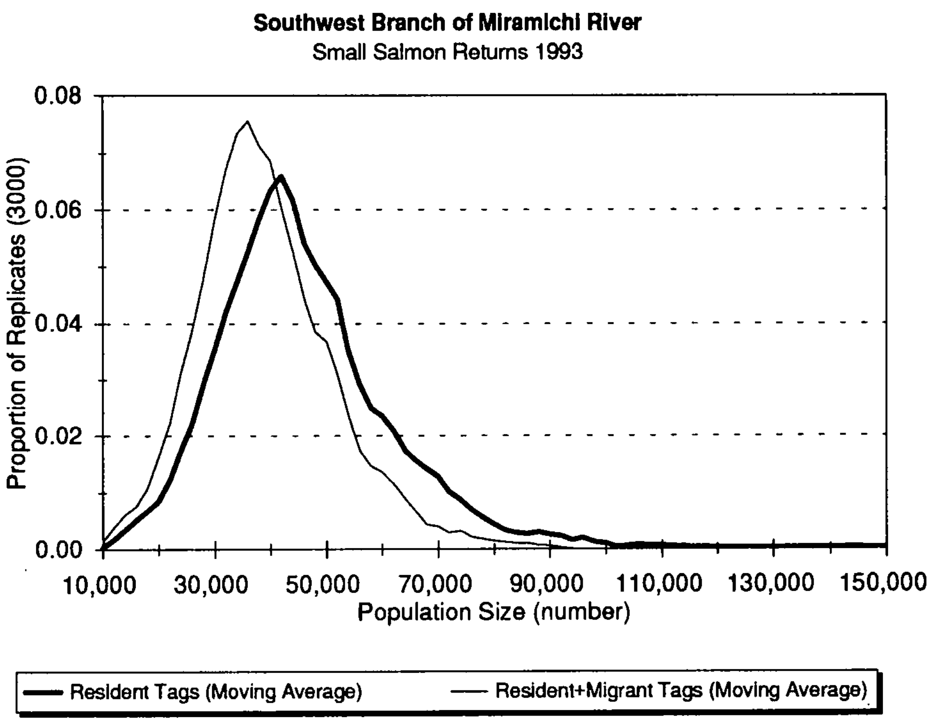
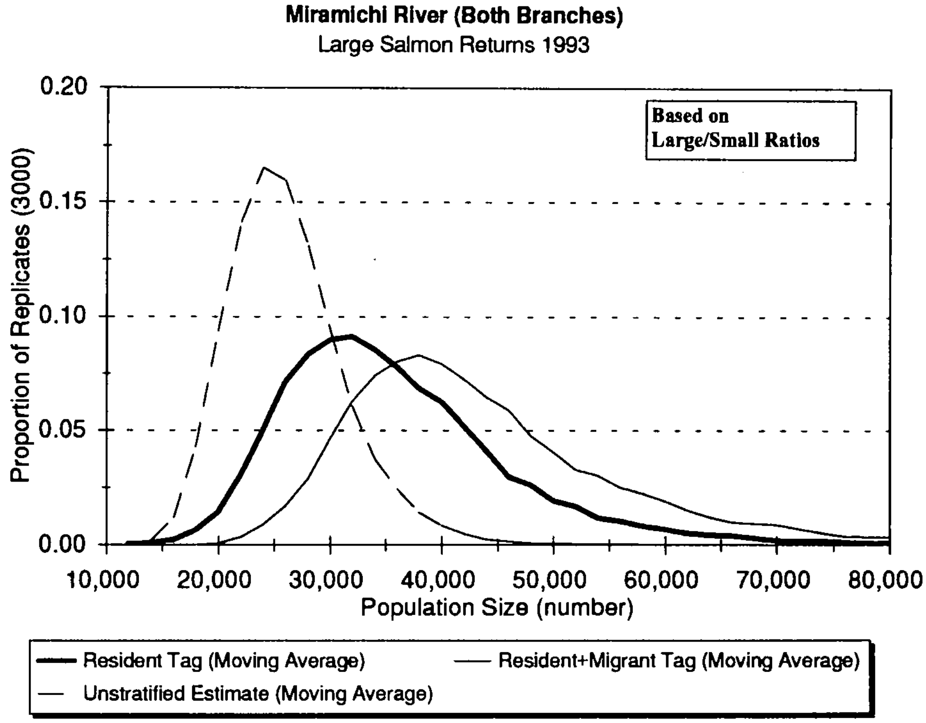


Figure 13. Estimated returns of small salmon to the Northwest branch (upper) and to the Southwest branch (lower) of the Miramichi River, 1993.



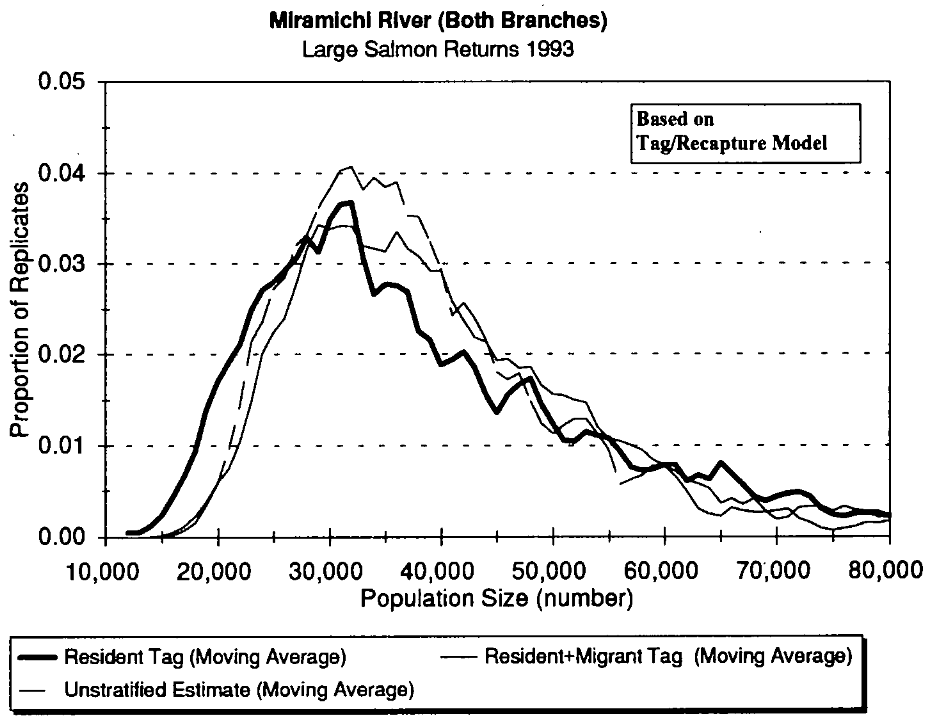
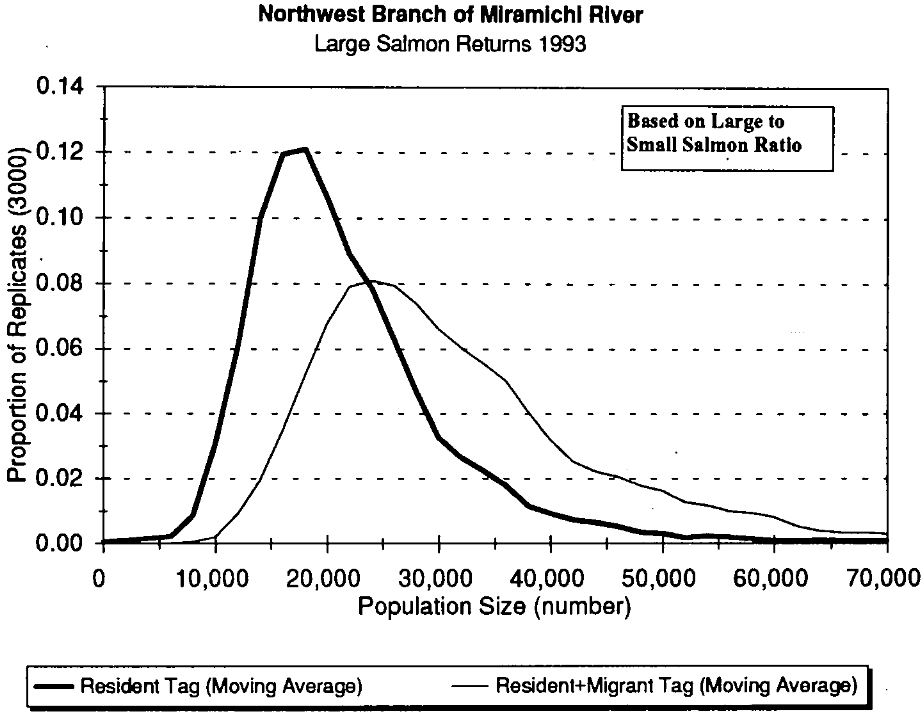


Figure 14. Estimated returns of large salmon to the Miramichi River in 1993 based on the ratio of large to small salmon at the trapnets (upper) and on the mark/recapture data for large salmon (lower).



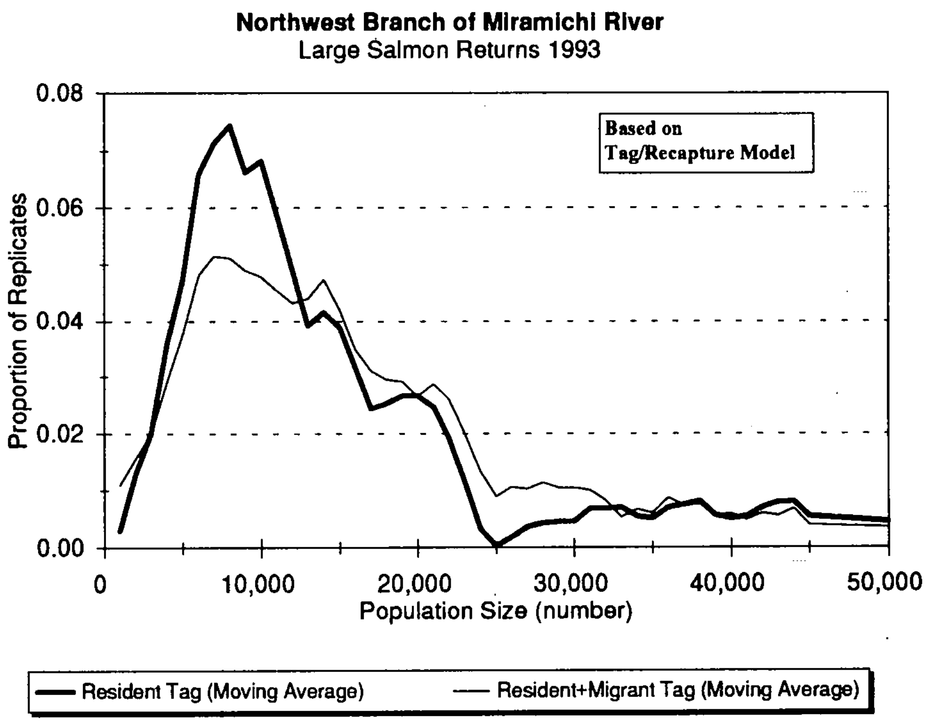
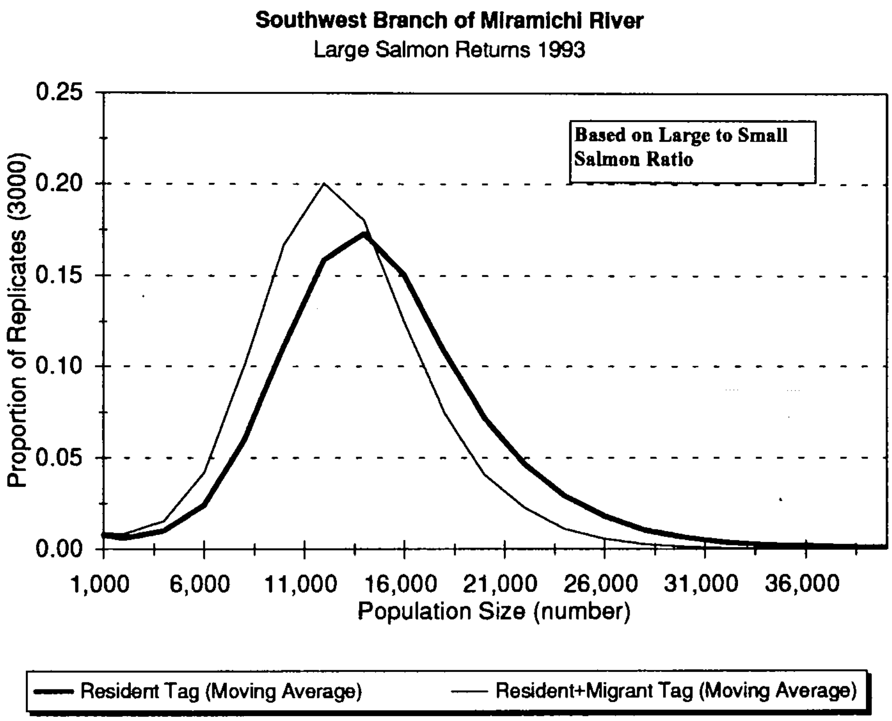


Figure 15. Estimated large salmon returns to the Northwest Miramichi River in 1993 based on the large to small salmon ratio at the trapnets (upper) and on the tag/recapture data for large salmon (lower).



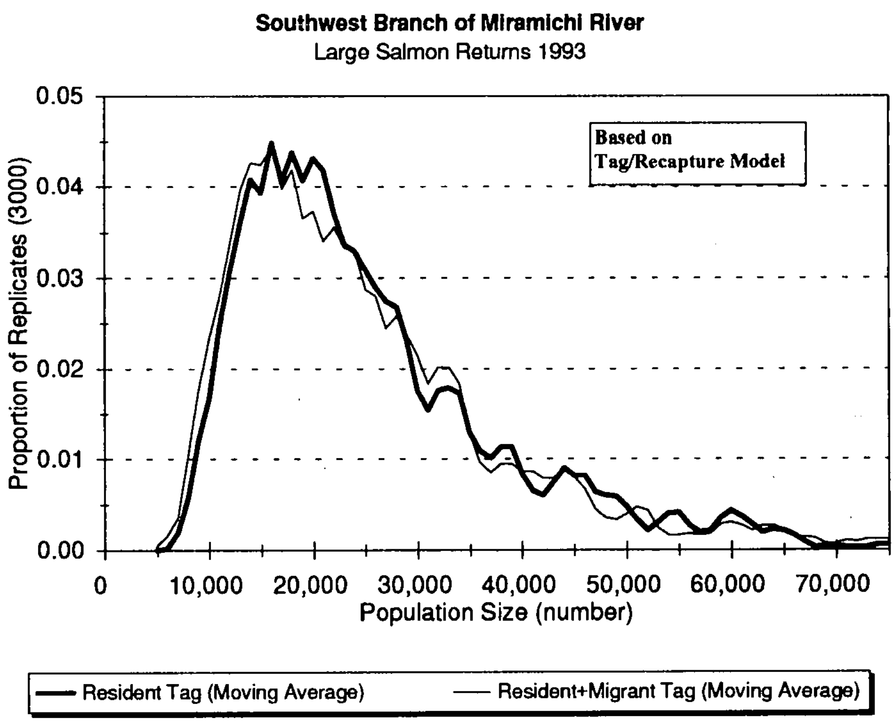


Figure 16. Estimated returns of large salmon to the Southwest Branch of the Miramichi River in 1993 based on the ratio of large to small salmon at the trapnet (upper) and on tag/recapture data for large salmon (lower)

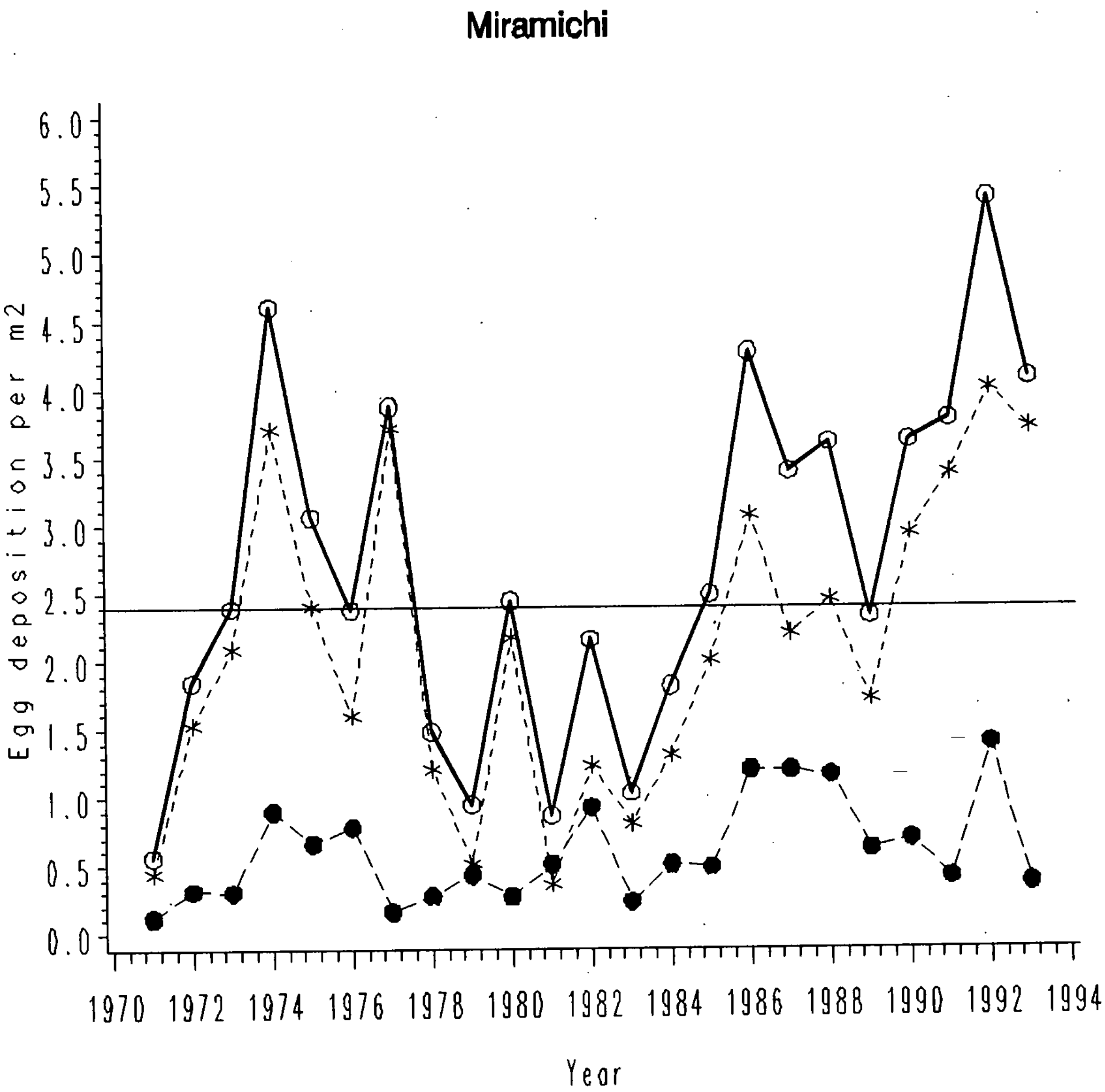


Figure 17. Eggs per square meter for large (stars), small (dots), and total (open circles) spawners for 1971-93.

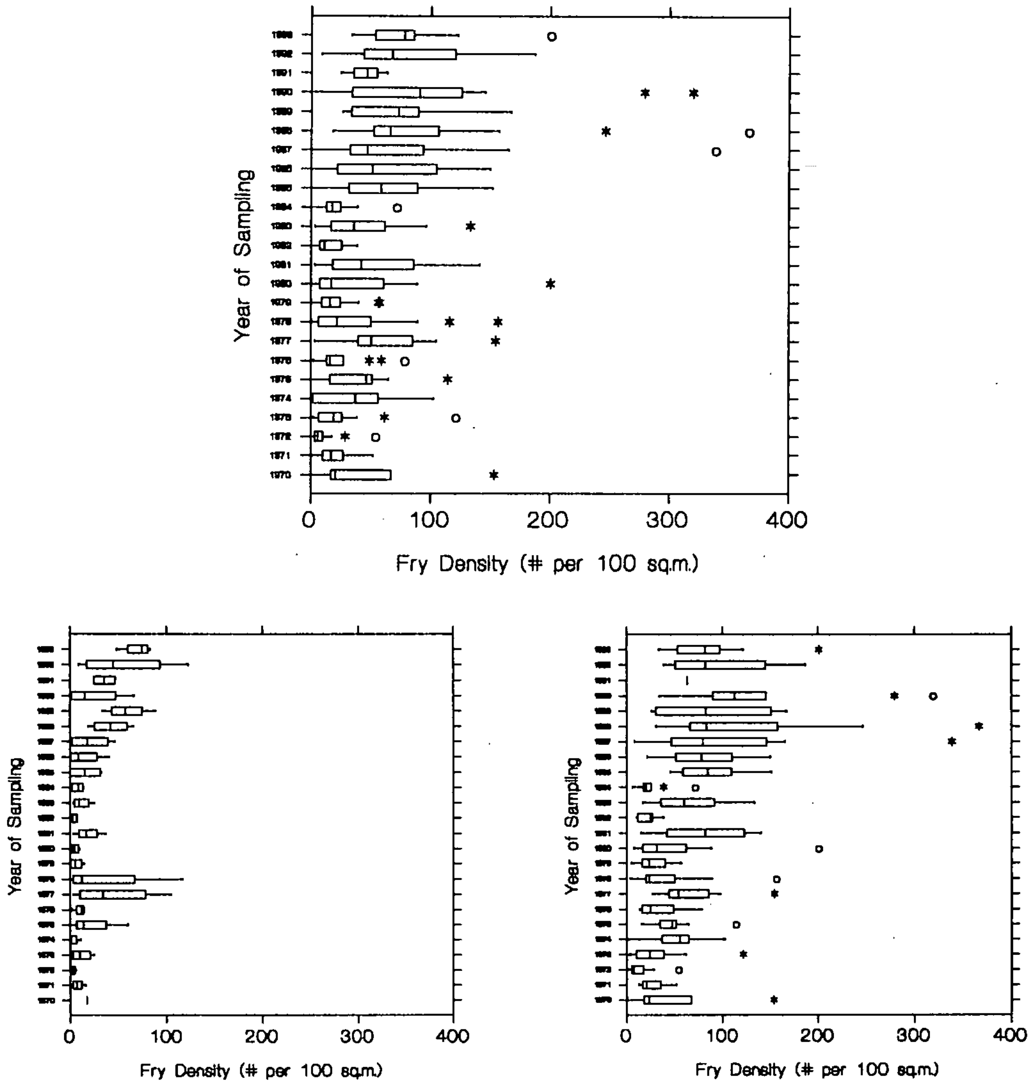


Figure 18. Box and whiskers plots of densities (#/100m^2) of fry in the Miramichi (upper), Northwest Miramichi (lower left) and Southwest Miramichi (lower right).

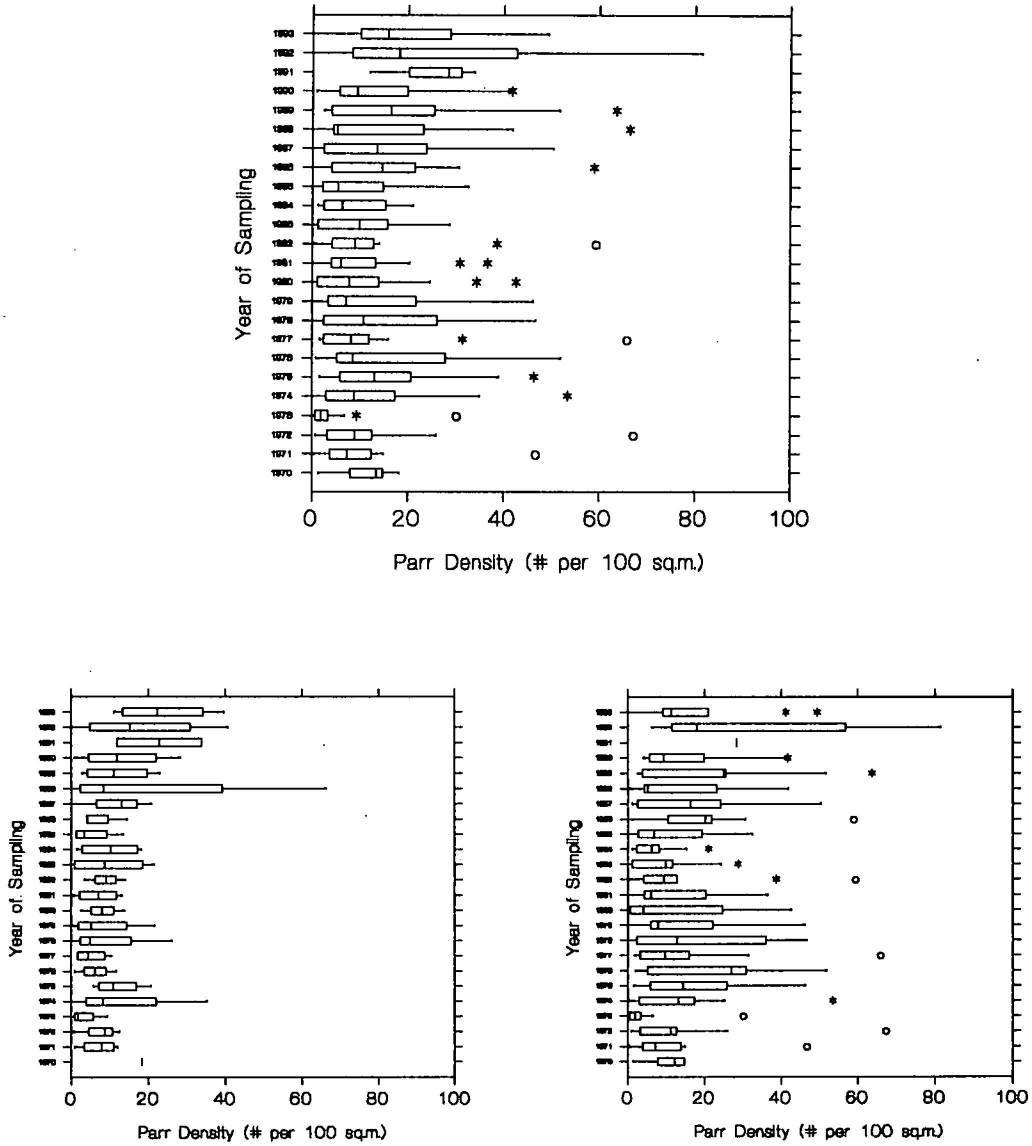


Figure 19. Box and whiskers plots of densities (#/100m^2) of parr in the Miramichi (upper), Northwest Miramichi (lower left) and Southwest Miramichi (lower right).

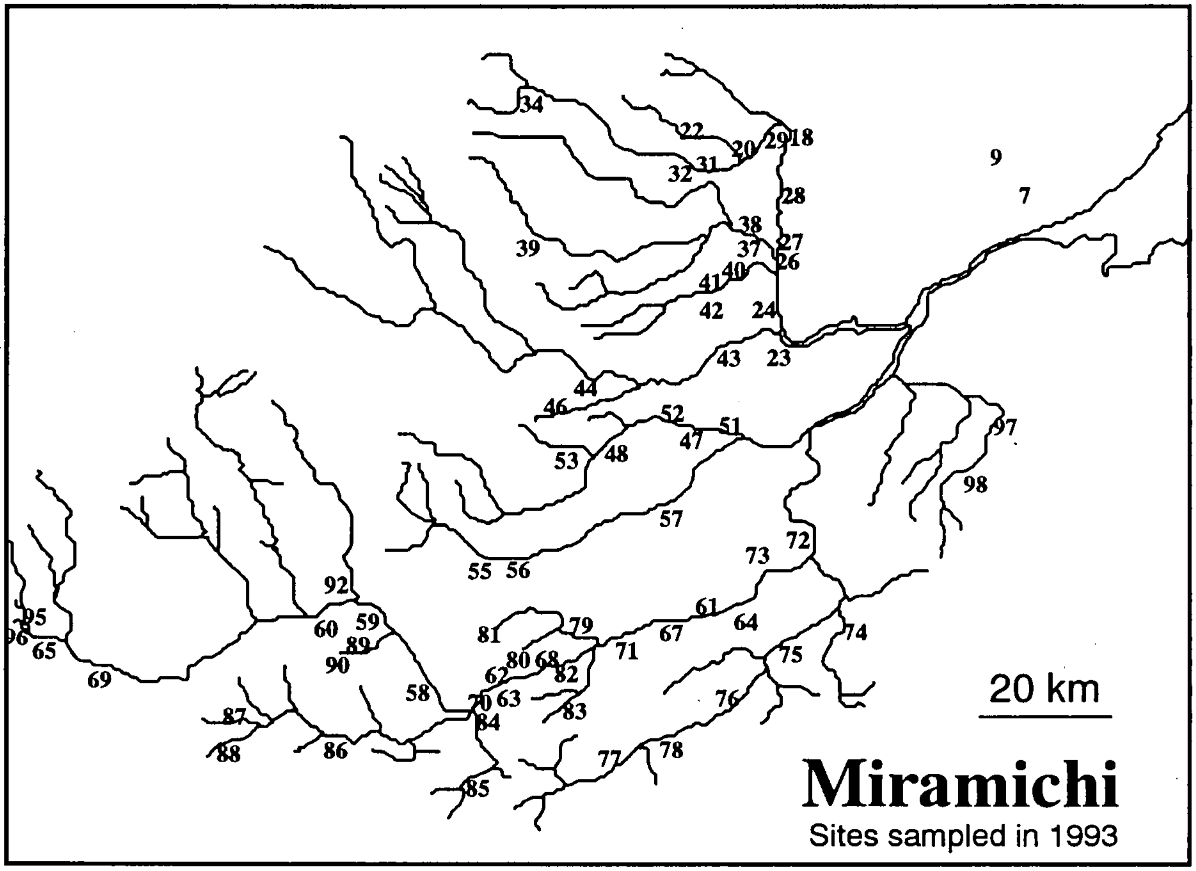


Figure 20. Electrofishing sites sampled in the Miramichi River system in 1993.

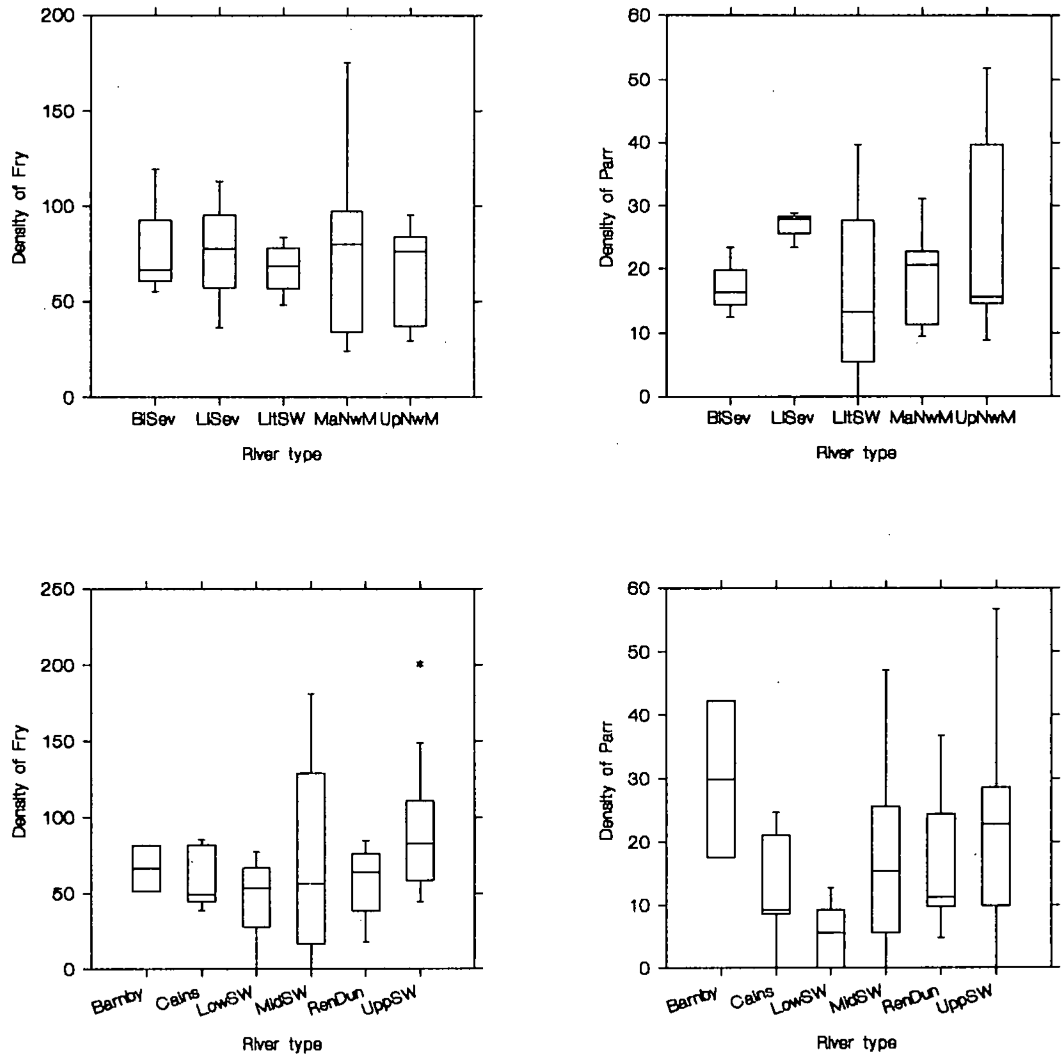


Figure 21. Box and whiskers plots of densities (#/100m^2) of fry and parr from the Northwest Miramichi (upper panels) and the Southwest Miramichi (lower panels) by river section in 1993.

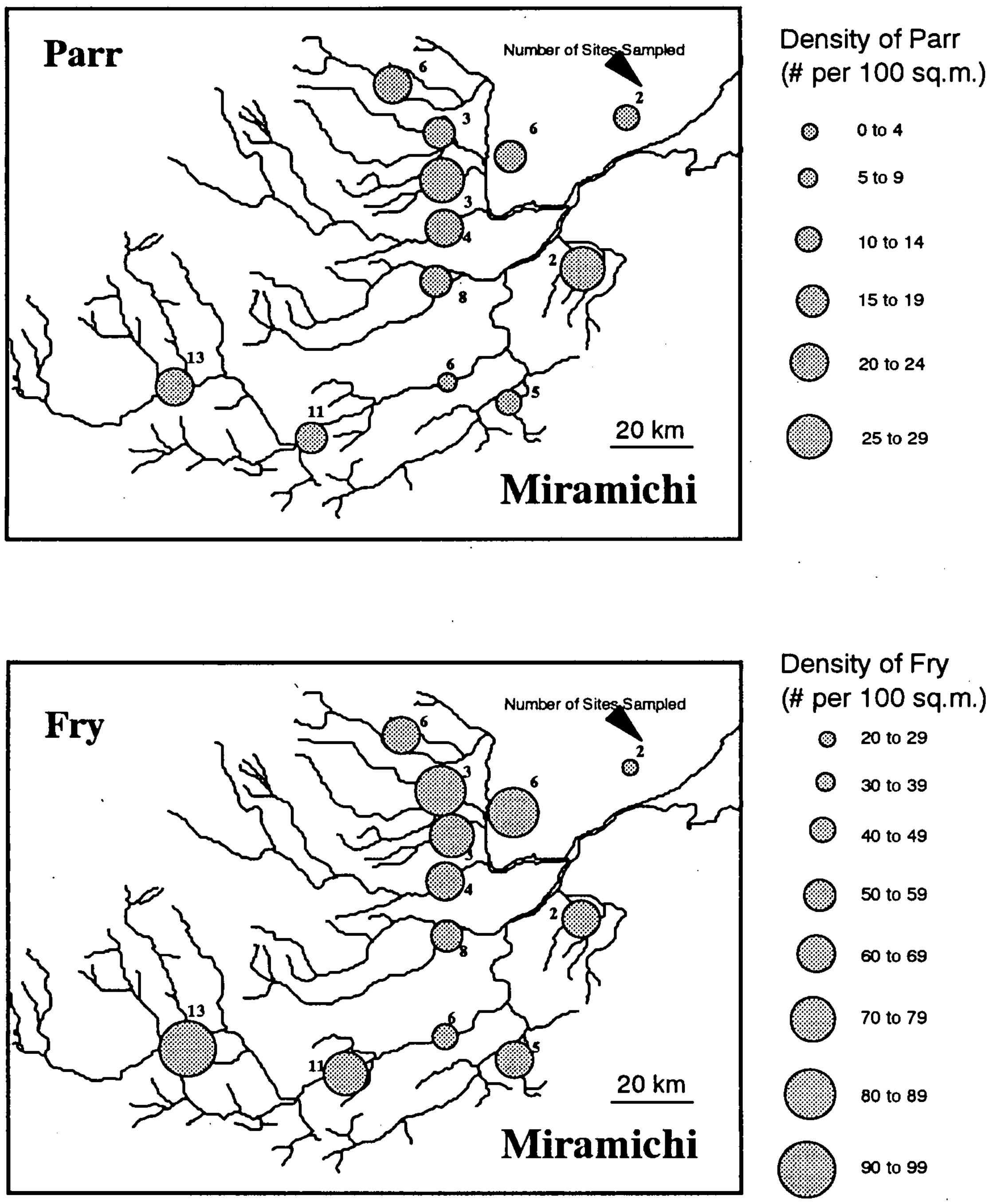
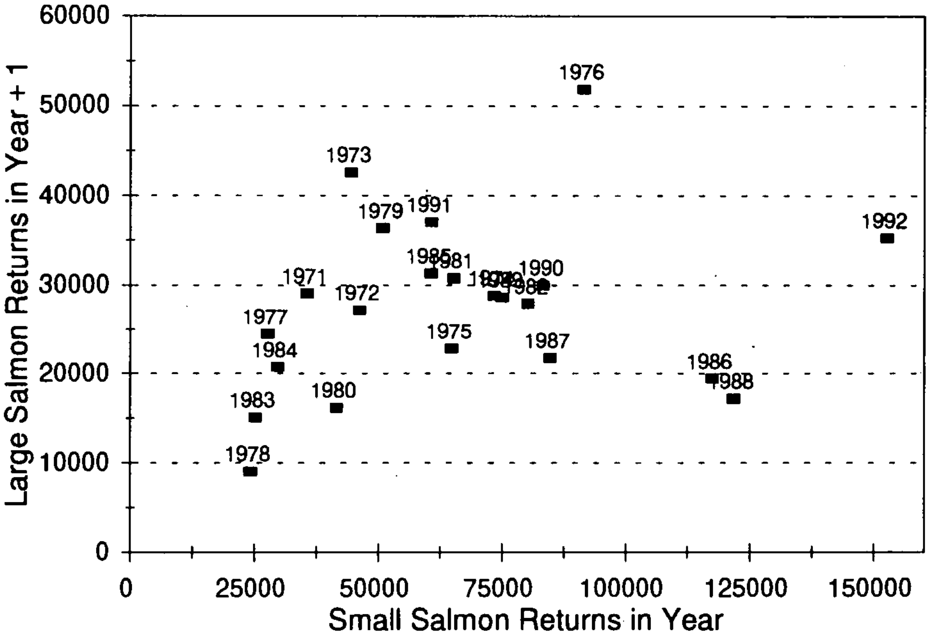


Figure 22. Average fry densities (lower) and parr densities (upper) observed in the Miramichi River in 1993.



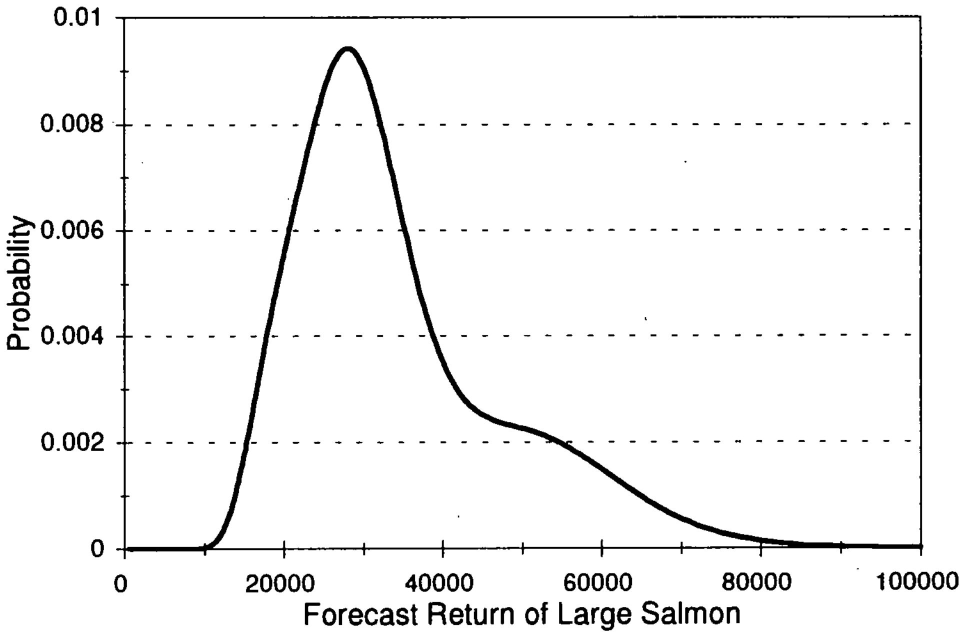


Figure 23. Relationship between small salmon in year i and large salmon in year i+1 (upper panel) and forecast of large salmon returns in 1994 (lower panel) based on a return of 92,400 small salmon in 1993.

Appendix A. Minutes of the stock status workshop for the Miramichi River.

MINUTES OF THE MIRAMICHI STOCK WORKSHOP
Eel Ground, N.B. (Training Centre, Eel Ground First Nation)
0930-1700 Hours, Thursday, 20 January 1994

Chairperson:

Mike Chadwick	DFO, Science, Moncton

Recording Secretary:

John Peppar	DFO, Science, Moncton

Attendees:

Eugene Patles	Eel Ground First Nation
Jim Ward	Eel Ground First Nation
Clifford Ginnish	Eel Ground First Nation
Toni Paul	Red Bank First Nation
Danny Surette	Atlantic Salmon Federation
Lewis Hinks	Atlantic Salmon Federation
Norman Rogers	Northumberland Salmon Protection Assoc.
Dennis Hare	Northumberland Salmon Protection Assoc.
Gerry Hare	Hare Fisheries & Environmental Consultants
Alex Mills	NB Outfitters, Doaktown
Bill Hooper	NB DNRE, Fredericton
Bernie Dubee	NB DNRE, Newcastle
Wayne Olsen	DFO, C&P, Newcastle
Stephen Savoy	DFO, C&P, Newcastle
James Porter	DFO, C&P, Doaktown
Mark Hambrook	DFO, Science, Miramichi SEC
John Hayward	DFO, Science, Miramichi SEC
Joe Sheasgreen	DFO, Science, Miramichi SEC
Ross Claytor	DFO, Science, Moncton
Gerald Chaput	DFO, Science, Moncton
Dave Moore	DFO, Science, Moncton
Kevin Davidson	DFO, Science, Moncton
Tim Lutzac	DFO, Science, Moncton

1. Introduction - Purpose of Meeting and Framework of Workshops.

Mike Chadwick provided a general overview of the purpose of this meeting and an explanation of the "workshop" approach and its framework.

Appendix A (continued).

An overview was provided of the four major features associated with the **"Stock Workshop"** framework or approach:

1. **Roles of government and the public:** the public wants to participate, money is scarce, agencies must remove redundancy, horizontal links in resource management, combine enhancement and assessment, DFO focus on analysis and structure,
2. **Scientific basis for resource management:** what are the problems?, assemble knowledge, make a model, where is model sensitive?, ask an answerable question, develop test, document repeatable methods, improve model, ask another important question.
3. **Watershed management:** fine-scale information, in-season management, all stocks, knowledge accessible to everyone, identify problems in order of priority, best projects distinguish between alternative views of the resource, share tasks.
4. **Stock assessment process:** stock workshops, stock assessments, peer review, research document, summary sheets, zonal meetings, national roll-ups.

There is a different dynamic now, with more stakeholders involved in the stock assessment process. CAFSAC is gone. There will still be peer review of assessments, but these assessments will be developed and assembled through the stock workshop process first. Research documents will be prepared, with summary sheets provided for wider distribution.

2. Salmon Stock Status - Salmon Assessments.

Ross Claytor provided a general overview of how salmon assessments are developed.

He outlined the **"Assessment Process"** as incorporating a framework of four basic components:

1. **Landings** (catches): from the First Nations, angling, and commercial fisheries.
2. **Targets** (spawning requirements): using the value of 2.4 eggs/square metre.
3. **Where we are now** (spawning escapements): total returns minus removals.
4. **Forecasts**: pre-season and in-season updates.

Bill Hooper presented an overview of the roles played by the NB DNRE. He presented a list of the "what we do" of his department, as follows: strategic planning, stocking, operation of barriers and fish counting fences, protection/regulations, information/education, electrofishing operations, 'FISHSYS' angling catch data system, licences/summary, watercourse alterations, leases/crown reserves, riparian buffers, socio-economic studies, harvest studies and employment source (habitat surveys).

Miramichi Salmon

Gerald Chaput presented information on the status of the Miramichi salmon stock; a handout, detailing all material presented, was provided to the attendees.

Appendix A (continued).

Points of Discussion

Landings

- Angling catch data come from two sources -- NB DNRE and DFO; what data should be used? DFO data available earlier than DNRE data, thus, DFO's has been used in the past, even though data from DNRE considered more accurate once data are 'complete' each year. Should proceed with one approach, having two methods is obviously duplication of effort. Better to go with FISHSYS (DNRE's system), if data can be timely; efforts must be made to improve the timeliness of FISHSYS and to assess the reliability of stub-return programs such as in Nova Scotia.
- Early season angling catch down from 1992; late season angling catch up from 1992 (but season was extended somewhat in 1993).
- Results of Crown Reserve angling survey (90% return rate) indicate rod days up about 3% from 1992, grilse catch same as 1992, large salmon 'catch' about 44% more than in 1992, total angling catch about 2% higher than previous 5-year mean; catch per rod day identical to 1992 and 10-year mean.
- There is no estimate of First Nation catches off-reserve prior to week 28; this needs to be estimated.
- DFO and DNRE to provide tables of violations (numbers of apprehensions, nets seized, etc.) for the past years, to give an indication of level of illegal activity each year.
- An angler's logbook program needs to be developed.
- By-catch in alewife traps should be estimated.

Target

- Should be working towards better documentation of the required conservation level (number of eggs per rearing area of stream); reality seems to be higher than 2.4 eggs per square metre; need a value more specific to this watershed.
- Stocking densities and locations should be documented.

Returns

- There is a need for more tags and better assessment of tag loss at barrier pools, etc.; broodstock should also be used to estimate tag loss.
- There is a need to increase the reporting of tags; this should be examined, crown reserve anglers should be called, etc.

Appendix A (continued).

- Migration patterns (NW vs SW), speed of movement through the different tributaries, and exploitation rate should be examined and compared.
- Barrier pools need to be evaluated to test why the densities are less variable than other measures of abundance; are the pools full?
- Electrofishing operations (DFO and DNRE) should be coordinated as much as possible (if techniques are the same); to reduce duplication of effort, etc.; surveys by Heath Steele on Tomogonops should be included.
- Differences in DNRE habitat types should be documented (in electrofishing data).
- Work should proceed on developing inseason forecasting.
- The use of alewife traps to sample bycatches of salmon (lower river, estuary) should be investigated.
- Biological sampling at First Nation traps should be increased.
- More salmon should be tagged and released.
- A way to assess the stock status of the Little SW Miramichi should be developed; traps could be considered at Red Bank First Nation; Catamaran Brook project should be consulted re: discharge over the years, etc.
- Means for evaluation of enhancement projects and the effects of stocking on system productions must be developed and implemented.
- Hatchery returns and survival rates should be included in assessment.

Miramichi Trout

- DNRE census data every 5-years; data should be tabled.
- Regulation changes required to reduce trout harvests.
- There is a need for further information re: biological characteristics of specific stocks.
- Creel surveys should be initiated on Crown Reserves.
- A short-term creel survey should be developed for the annual trout derby at Red Bank First Nation.
- Catches at barriers, traps, etc., should be tabled; information would increase the consideration of trout as species we need to assess.

Miramichi Striped Bass

- Monitoring of the catches of juvenile striped bass by the alewife and smelt fisheries is needed.
- The assessment of incidental catches of striped bass should be of first focus, as we know nothing at present about landings.
- A presentation of R. Bradford's study needs to be made to user groups and other stakeholders on the Miramichi.

Appendix B. Minutes of the peer review of anadromous stocks Gulf Region, Feb. 21, 1994

Review Committee:

M. Chadwick (Chair)
J. Allard
S. Bates
A. Chiasson
R. Cunjak
J.-G. Godin

General Comments

1. The error associated with extrapolating information from one watershed to another should be estimated using the prorating techniques in hydrological studies. This type of error could be estimated from smaller watershed within rivers where the populations are well estimated.
2. In order to account for possible longterm trends, comparisons should be made with means over long time periods in addition to 5-year means.
3. A logbook program similar to the program in Nova Scotia should be considered for New Brunswick and PEI.
4. The mark-recapture experiments should be encouraged, but other independent estimates of stock abundance such as sport catch data and electrofishing should also be continued.
5. An introductory document summarizing terminology, the basics of mark-recapture experiments, and methods used in electrofishing, creel surveys, and fish fences should accompany next year's assessments. The stock assessment documents should have the same format.
6. Summary sheets should be pictorial, perhaps maps with pie graphs by watershed of catches, spawning requirements, and spawning escapements.
7. A description of multi-species factors such as the abundance and dynamics of other stocks should be included in the assessments.
8. With some minor changes all the assessments were suitable to be published as research documents; however future assessments should be put into a standardized format.
9. Estimate tag-loss function using brood-stock experiments at hatcheries for Miramichi, Restigouche, and Nepisiguit rivers. The tag loss rate contributes significantly to the error in population estimates.
10. More time is required for reviews in the future and reviewers should focus on 1 or 2 assessments for critical evaluation.
11. Techniques to summarize results from several estimators should be explored.
12. The decision of whether or not a value is a constant or a variable needs to be standardized. Variables are re-evaluated every year, where as constants can be aggregated over years to reduce the confidence interval.

Appendix B (continued).

Miramichi River

1. Mixing rates in the two tributaries need to be estimated with more accuracy. This will require more tags to be released and higher recapture rates, especially in the Southwest.
2. Spawning requirements should be studied with a sensitivity analysis, comparing the expected variance of each parameter and the cost of collecting more information to improve the precision of the parameter.
3. Stock-recruitment analysis needs to be done.
4. Biological data collected at the hatchery such as fecundity, grilse-salmon ratios, should be used to update spawning requirements.

Participants:

R. Claytor
G. Chaput
F. Mowbray
G. Atkinson
K. Davidson
M. Biron
D. Moore
R. Pickard
R. Jones
D. Caissie

Appendix C. Summary sheets of the Miramichi River as well as the Northwest and Southwest branches.

Stock: Miramichi River, SFA 16
Life Stage: Small and large salmon
Target: 132 million eggs (23,600 large, 22,600 small salmon)

	1988	1989	1990	1991	1992	1993	MIN[1]	MAX[1]	MEAN[7]
Angling harvest[2]									
Large	10090	11928	9258	6147	13525	7082	1792	14223	10189
Small	30620	24426	21372	11300	21509	15271	8265	30620	21845
Native harvest[3]									
Large	348	540	609	544	608	208	200[6]	898[6]	530
Small	944	1085	2110	1111	1652	601	100[6]	2110[6]	1380
Other harvest[4]									
Large	114	153	99	131	142	166	99[7]	166[7]	128
Small	77	155	142	189	198	236	77[7]	236[7]	152
Spawning escapement									
Large (x 1000)	21	16	28	29	36	35	4	36	26
Small (x 1000)	90	48	60	48	135	76	13	135	76
Total returns									
Large (x 1000)	22	17	29	30	37	35	9	52	27
Small (x 1000)	122	75	83	61	153	92	24	153	99
% Egg target met	151	98	152	159	242	170	23	242	160

[1] MIN MAX over the period 1971-1991 unless stated otherwise.
[2] Angling harvest of hook and release estimates of catch.
[3] Native harvest includes catch reported by Burnt Church, Red Bank, and Eel Ground Indian Bands.
[4] Other harvest includes broodstock removals, mortalities at all index traps, and all samples.
[6] For 1975 to 1991.
[7] For 1988 to 1992.

Recreational catches: Have ranged from 7685 to 14,266 large and 11,300 to 30,620 small salmon during the past 10 years. Effort in rod-days has increased in recent years. Angling catches for 1993 are preliminary. Large and small salmon catches in 1993 were 25 and 30% below average.

Data and assessment: For 1988-1991, returns were estimated from trap efficiency at a DFO trap operated in the estuary of the Miramichi River at Millbank. The efficiency of this trap was calibrated from tag recapture experiments in 1985 thru 1992. Index traps were operated in the estuaries of the Northwest and Southwest Miramichi Rivers in 1992 and 1993. Returns of small and large salmon were estimated separately from marks applied at these traps and recaptures upstream. Escapements were estimated as returns minus known removals.

State of the stock: Target egg deposition rates have been almost met or exceeded in each of the last eight years.

Forecast for 1994: The probability distribution model prediction for large salmon returns in 1994 is 28,200 with a probability of meeting the spawning target (23,600) of 69% (i.e., a 31% chance of returns being less than 23,600).

Appendix C (continued).

STOCK: Northwest Miramichi River, SFA 16
TARGET: 41 million eggs (7316 large, 7006 small salmon)

	1988	1989	1990	1991	1992	1993	MIN[1]	MAX[1]	MEAN[7]
Angling harvest[2]									
Large	3082	2805	2142	1519	1794	2038	419	3836	2268
Small	9825	7567	6827	3056	6960	5569	2232	9825	6847
Native harvest[3]									
Large	270	462	502	462	580	54	200[6]	898[6]	455
Small	892	1054	2095	1109	1616	477	100[6]	2110[6]	1353
Other harvest[4]									
Large	25	26	39	44	56	100			38
Small	0	0	0	29	61	106			18
Spawning escapement									
Large (x 1000)	n.a.	n.a.	n.a.	n.a.	9	10			
Small (x 1000)	n.a.	n.a.	n.a.	n.a.	22	40			
Total returns									
Large (x 1000)	n.a.	n.a.	n.a.	n.a.	10	11			
Small (x 1000)	n.a.	n.a.	n.a.	n.a.	31	46			
% Egg target met	n.a.	n.a.	n.a.	n.a.	198	175			

[1] MIN MAX over the period 1972 to present unless stated otherwise.
[2] All angling catches are NB DNRE Fishsys values. Angling harvest for large salmon are hook and release estimates of catch.
[3] Native harvest includes catch reported by Red Bank, and Eel Ground Indian Bands.
[4] Other harvest includes broodstock removals, mortalities at all index traps, and all samples.
[6] For 1972 to present.
[7] For 1988 to 1992.

Recreational catches: New Brunswick Department of Natural Resources and Energy FISHSYS estimates indicate that over the period 1987-1991, 27-34% (mean: 31%) of total angling in the Miramichi River has occurred in the Northwest Miramichi.

Data and assessment: Returns of small salmon and large salmon to the Northwest Miramichi River were estimated in 1992 and 1993 from a mark-recapture program, applying tags at Eel Ground Enclosure trap and recovering tags from traps at Redbank (NW), and from fences in the headwaters of the Northwest Miramichi and in Catamaran Brook. Spawners were estimated as returns minus known and estimated removals.

State of the stock: The spawning target for large salmon was exceeded in 1992 and 1993.

Forecast for 1993: Because 1993 is only the second year of data on returns, no quantitative forecast can be made of returns in 1994.

Appendix C (continued).

STOCK: Southwest Miramichi River, SFA 16
TARGET: 88 million eggs (15730 large, 15063 small salmon)

	1988	1989	1990	1991	1992	1993	MIN[1]	MAX[1]	MEAN[7]
Angling harvest[2]									
Large	7008	9123	7116	4628	7682	5044	1373	10387	7111
Small	20790	16858	14545	8244	14549	9702	4570	22137	14997
Native harvest[3]									
Large	0	0	0	0	0	0			
Small	0	0	0	0	0	0			
Other harvest[4]									
Large	71	78	49	39	75	66			62
Small	0	0	0	39	26	130			13
Spawning escapement									
Large (x 1000)	n.a.	n.a.	n.a.	n.a.	27	22			
Small (x 1000)	n.a.	n.a.	n.a.	n.a.	106	33			
Total returns									
Large (x 1000)	n.a.	n.a.	n.a.	n.a.	27	22			
Small (x 1000)	n.a.	n.a.	n.a.	n.a.	121	43			
% Egg target met	n.a.	n.a.	n.a.	n.a.	259	150			

[1] MIN MAX over the period 1972 to present unless stated otherwise.
[2] All angling catches are NB DNRE Fishsys values. Angling harvest for large salmon are hook and release estimates of catch.
[3] No Native harvests have occurred in the Southwest branch.
[4] Other harvest includes broodstock removals, mortalities at all index traps, and all samples.
[6] For 1972 to present.
[7] For 1988 to 1992.

Recreational catches: New Brunswick Department of Natural Resources and Energy FISHSYS estimates indicate that over the period 1987-1991, 66--73% (mean: 69%) of total angling in the Miramichi River has occurred in the Southwest Miramichi.

Data and assessment: Returns of small salmon and large salmon to the Southwest Miramichi River were estimated in 1992 and 1993 from a mark-recapture program, applying tags at Enclosure trap and recovering tags from creel surveys, and from fences and barriers in the Southwest Miramichi. Spawners were estimated as returns minus known and estimated removals.

State of the stock: The spawning target for large salmon was exceeded in 1992 and 1993.

Forecast for 1993: Because 1993 is only the second year of data on returns, no quantitative forecast can be made of returns in 1994.

Appendix D. Bright salmon angling season dates for 1993.

SFA16: June 8 - September 30, with the following exceptions:

Bartibog River	June 1 - October 15
Southwest Miramichi	
Main, from Quarryville Bridge upstream to Burnt Land Brook	June 8 - October 15
Main, from Burnt Land Brook up to fork of the N. & S. branches	June 8 - September 30
North & South branches	June 8 - September 15
Bartholomew River	June 8 - October 15
Cains River	June 8 - October 15
Dungarvon River above Furlong Bridge	June 8 - September 15
Renous River	June 8 - October 15
North & South Branches of Renous River	June 8 - September 15
Trib. above Cains River except Rocky Brook	June 8 - September 15
Rocky Brook	June 1 - August 31
Northwest Miramichi	
NW Miramichi River & tributaries above Little River	June 8 - August 31
NW Miramichi River below Little River	June 8 - October 15
Little Southwest Miramichi River above Catamaran Brook	June 8 - September 15
Little Southwest Miramichi River below Catamaran Brook	June 8 - October 15
Sevogle River above Square Forks	June 8 - September 15
Sevogle River below Square Forks	June 8 - October 15

Appendix E. Calibration of the fixed effort electrofishing procedure for the Miramichi River, 1993.

Results of model fitting for fry, using a log-log model
Predictor Variable = Catch in 180 seconds of electrofishing
Dependent Variable = Density of fry per $100m^2$.

Sites 34, 46 and 79 have been deleted because of influential or outlier status (Fig. E1).

N = 15
MULTIPLE R: 0.926 SQUARED MULTIPLE R: 0.857
ADJUSTED SQUARED MULTIPLE R: .846 STANDARD ERROR OF ESTIMATE: 0.220

VARIABLE	COEFFICIENT	STD ERROR	STD COEF	TOLERANCE	T	P(2 TAIL)
CONSTANT	3.023	0.147	0.000	.	20.612	0.000
LNCATCH	0.603	0.068	0.926	1.000	8.828	0.000

ANALYSIS OF VARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
REGRESSION	3.764	1	3.764	77.929	0.000
RESIDUAL	0.628	13	0.048		

DURBIN-WATSON D STATISTIC 1.678
FIRST ORDER AUTOCORRELATION .122

Results of model fitting for parr, using a log-log model
Predictor Variable = Catch in 180 seconds of electrofishing
Dependent Variable = Density of parr per $100m^2$.

Site 79 deleted from the analysis (outlier) (Fig. E2).
N: 16
MULTIPLE R: 0.803 SQUARED MULTIPLE R: 0.644
ADJUSTED SQUARED MULTIPLE R: .619 STANDARD ERROR OF ESTIMATE: 0.526

VARIABLE	COEFFICIENT	STD ERROR	STD COEF	TOLERANCE	T	P(2 TAIL)
CONSTANT	2.138	0.206	0.000	.	10.352	0.000
LNCATCH	0.724	0.144	0.803	1.000	5.036	0.000

ANALYSIS OF VARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
REGRESSION	7.013	1	7.013	25.362	0.000
RESIDUAL	3.871	14	0.277		

DURBIN-WATSON D STATISTIC 1.506
FIRST ORDER AUTOCORRELATION .138

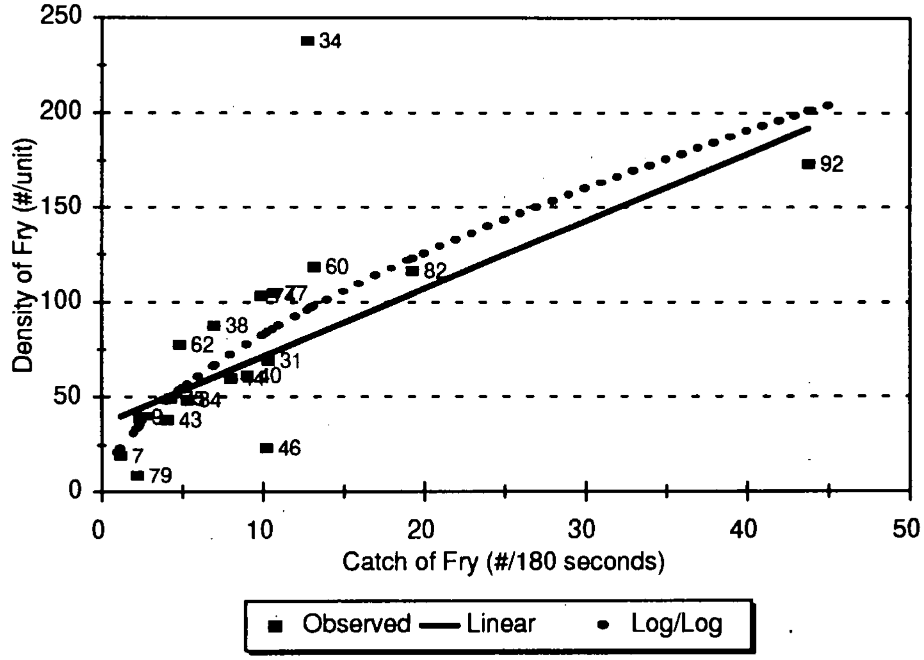


Figure E1. Relationship between density of fry (#/100 m^2) and catch of fry in 180 seconds of electroseining.

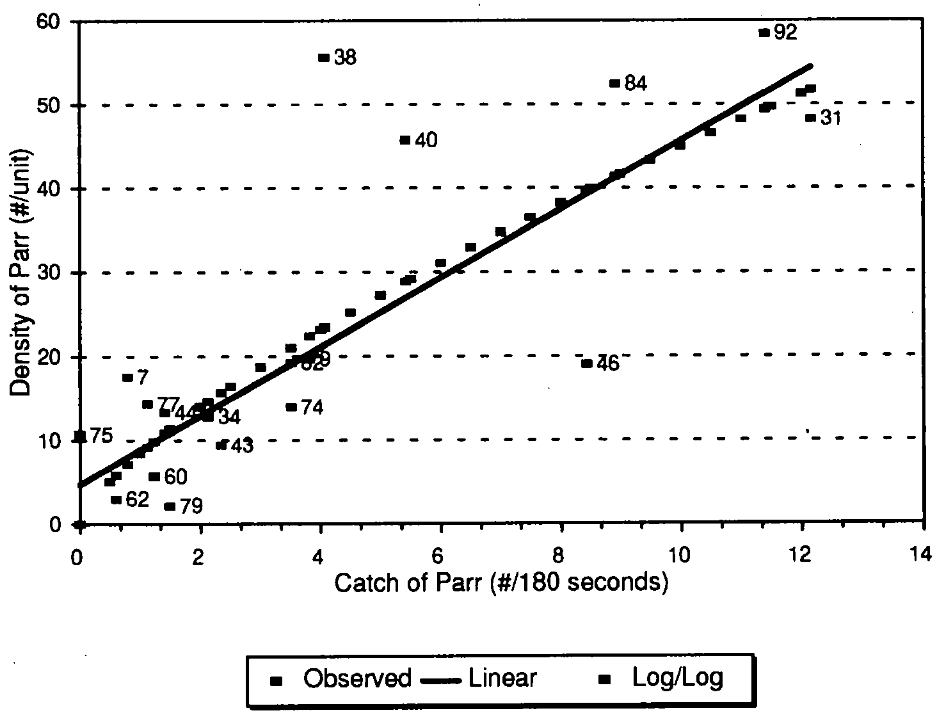


Figure E2. Relationship between the density of parr (#/100m^2) and the catch of parr in 180 seconds of electroseining.