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STOCK STATUS OF ATLANTIC SALMON (*Salmo salar*) IN THE MIRAMICHI RIVER, 1998

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ABSTRACT

Atlantic salmon (*Salmo salar*) in the Miramichi River, New Brunswick, were harvested by two user groups in 1998; First Nations and recreational fishers. The Aboriginal food fishery catches in 1998 represented a decrease of 44% for small and 26% for large salmon relative to the previous five years. Harvest of large salmon were 83% from the early-run (prior to Sept. 1) and 88% of the small salmon harvests were taken prior to Sept. 1 in 1998. Recreational fishery catch data for 1998 had not yet been analysed. The Crown Reserve catches were improved from 1997 but generally similar or lower than the previous five-year mean. For the Southwest Miramichi, 24000 small salmon and 7000 large salmon were estimated to have returned in 1998. After accounting for removals, egg depositions in the Southwest Miramichi by both small and large salmon will be less than 70% of the conservation requirement. For the Northwest Miramichi, 7900 small salmon and 2200 large salmon were estimated to have returned. Egg depositions by small and large salmon in the Northwest in 1998 will be less than 57% of conservation requirement. Egg depositions had exceeded the conservation requirements in each branch during the last five years except for the Southwest Miramichi in 1997. Large salmon returns in 1999 are expected to be about 13000 fish with only an 11% chance of meeting conservation requirements. The increased densities of juvenile salmon, since 1985 for fry and 1986 for parr, at the index sites sampled since 1971, indicate that the long-term prospect for the Atlantic salmon stock of the Miramichi should be good if smolt production is as high as inferred from juveniles and sea survivals improve.

RÉSUMÉ

Le saumon de l'Atlantique (*Salmo salar*) de la rivière Miramichi, Nouveau-Brunswick, a été exploité dans les pêches autochtones et dans les pêches récréatives. En 1998, les captures de grands saumons dans les pêches autochtones ont diminué de 26% par rapport à la moyenne des années antérieures tandis que les captures de madeleineaux (<63 cm longueur à la fourche) ont diminué de 44%. Près de 83% des grands saumons et 88% des madeleineaux récoltés par les autochtones provenaient de la remontée d'été (avant le 1é septembre). Dans la pêche récréative, les données de captures en 1998 n’étaient pas disponibles. Dans la pêche sportive des eaux de réserves de la couronne, les captures étaient supérieures à 1997 mais semblables ou inférieures à la moyenne des années antérieures. La montaison de saumon dans la rivière Miramichi sud-ouest s'est situé à 24 000 madeleineaux et 7 000 grands saumons. Les géniteurs auraient contribué à une ponte d'oeufs maximale de 70% des besoins de la conservation pour la rivière Miramichi sud-ouest. Dans la Miramichi nord-est, la montaison a été estimée à environ 7 500 madeleineaux et 2 200 grands saumons. Les géniteurs de cette montaison auraient contribué une ponte d'oeufs maximale de 57% des besoins de conservation. Durant les cinq dernières années, les pontes d'oeufs ont été supérieures aux besoins pour les deux affluents principales de la Miramichi, sauf en 1997 pour l’affluent sud-ouest. La prévision de la remontée de grands saumons pour 1999 est d’environ 13 000 poissons. Il est toutefois improbable, à seulement 11%, que la remontée soit supérieure au niveau de conservation. Une amélioration des densités de juvéniles depuis 1985 pour les tacons d'age 0+ et de 1986 pour les plus vieux, a été observée aux sites repères échantillonnées annuellement depuis 1971. Les prévisions à long-terme pour le stock de saumon de l'Atlantique de la rivière Miramichi sont de montaisons soutenues voire supérieures si la production relative de saumonneaux est similaire à l’abondance des juvéniles et si les taux de survie en mer s’améliorent.

INTRODUCTION

The Miramichi River, at a maximum axial length of 250 km and draining an area of about 14,000 km^2, has the largest Atlantic salmon run of eastern North America. 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. 1989). The two branches drain into a common estuary and subsequently drain into the Gulf of St. Lawrence at latitude 47°N (Fig. 1).

Annual assessments of the Atlantic salmon (*Salmo salar*) stock of the Miramichi River have been prepared since 1982 (Randall and Chadwick 1983a, b; Randall and Schofield 1987, 1988; Randall et al. 1985, 1986, 1989, 1990; Moore et al. 1991, 1992). Since 1992, assessments of the Northwest and Southwest branches have been prepared (Courtenay et al. 1993; Chaput et al. 1994b, 1995, 1996, 1997, 1998).

Two size groups of salmon return to the river to spawn. The small salmon category consists of fish less than 63 cm fork length and are generally referred to as grilse. These fish have usually spent only one full year at sea (one-sea-winter) prior to returning to the river but the size group may also contain some previously spawned salmon. The large salmon category consists of fish greater than or equal to 63 cm fork length. This size group is generally referred to as multi-sea-winter or just salmon and contains varying proportions of one-sea-winter, two-sea-winter and three-sea-winter maiden (first time) spawners as well as previous spawners (Moore et al. 1995). Salmon which have spawned and have not returned to sea in the spring of the year are referred to as kelts or black salmon in contrast to bright salmon which are mature adult salmon moving into freshwater from the ocean.

In addition to the different runs and size groups, the Miramichi River also contains several stocks of Atlantic salmon (Saunders 1981, Riddell and Leggett 1981). Separate branch assessments were introduced to account for some of this diversity and for the differences in exploitation between the Northwest and Southwest branches. Aboriginal fisheries were historically conducted almost exclusively in the Northwest Miramichi (exploitation also occurs in the estuarial waters of the Miramichi River, downstream of the confluence of the two branches) and recreational fisheries exploitation also differs between the Northwest and Southwest branches.

Temporal stock distinctiveness has also been highlighted as an important component of the Atlantic salmon resource (Saunders 1967). The early-run consists of salmon returning to the river up to August 31 whereas the late-run is considered to consist of salmon returning from September 1 onwards. Early runs and late runs have different composition in terms of small and large salmon proportions and sex ratios. The early runs in both branches are also exploited more heavily than the late runs.

The objectives of the assessment are to estimate the returns of salmon, the spawning escapement after removals and to compare the egg deposition to the conservation requirement for the river. The status of the resource is assessed on the basis of whether the conservation requirement was attained/exceeded, on the trends in returns, the juvenile densities, and the prospects. The returns and escapements are estimated on a spatial and temporal scale corresponding to the available data. Returns by size group to the whole river are partitioned into Northwest and Southwest Miramichi returns and when possible into early and late run. The egg depositions in each branch were estimated by incorporating the variability in run composition (sex ratio and size of fish which determines the fecundity) and the uncertainty in the estimates of escapement. Juvenile surveys provide finer spatial scale assessments of spawning activity in the previous year. Finally, using time series of returns, escapements, and juvenile surveys, we provide a prognosis of the future stock status of Atlantic salmon from the Miramichi River.

Additional features of this assessment include:

1. description of a smolt estimation experiment for the Northwest Miramichi in 1998
2. quantification of risk of meeting conservation in 1999 relative to fisheries scenarios, and
3. an evaluation of the possibility for in-season assessment of the probability of meeting or exceeding the conservation requirements for the Miramichi.

Input from industry, user groups and other government agencies was obtained during a science assessment workshop held in Miramichi City (NB) on December 15, 1998 (minutes in Appendix 1). Peer review notes are available under separate cover (Anon. 1999).

DESCRIPTION OF FISHERIES

A distinction is made between catches and harvests. Catches consist of fish which are caught but not necessarily retained. Harvests represent fish which are caught and retained.

Atlantic salmon were harvested by two user groups in 1998: First Nations and recreational fishers. Aboriginal food fishery harvesting agreements were signed between DFO, the Eel Ground First Nation and the Red Bank First Nation (Table 1). The agreements focused on the selective harvest of small salmon over large salmon through the use of food fishery trapnets. In 1998, the Eel Ground First Nation fished one food fishery trapnet in the Northwest Miramichi and two food trapnets in the Southwest Miramichi. A partial counting fence was also operated at Big Hole Tract for the selective harvest of small and large salmon, similar to 1996 and 1997 (Table 1). Two food trapnets were fished by Red Bank First Nation at similar locations to previous years (confluence of the Northwest and Little Southwest Miramichi). A communal license was issued to Burnt Church First Nation (Table 1).

There were some changes in recreational fishery regulations in 1998 relative to previous years (Moore et al. MS1995) (Table 2). Individual recreational quotas were modified for the beginning of the year: daily limit of one small salmon kept (<63cm fork length) (reduced from two small salmon in previous years) and a maximum of 8 kept for the year, hook and release only of all large salmon (>= 63 cm fork length). At the start of the season, a maximum hook-and-release daily limit of two fish was imposed. Fishing was to cease when either one small salmon was retained or two fish of any size were hooked and released. After an end of July review of returns, the daily hook and release limit was relaxed to four fish of any size, a level similar to previous years. The single small salmon daily retention limit was maintained. There were no river closures in 1998 resulting from low water levels or warm temperatures (Table 2). An extended hook-and-release angling fishery for the period Oct. 1 to 15 was in effect in the Southwest Miramichi River between Doaktown and Deersdale bridge (a length of about 75 km). The season extension to Sept. 15 for the Little Southwest crown reserve stretches remained in effect although under complete hook-and-release regulations. Other changes introduced in 1996 and which remained in effect in 1998 are described in Chaput et al (MS1997).

Aboriginal Food Fisheries

With the exception of the Burnt Church fishery, which occurred in estuary waters of Miramichi Bay, large salmon harvests were exclusively from the Northwest Miramichi (Table 3). Small salmon harvests were divided 67% from the Northwest Miramichi and 33% from the Southwest Miramichi River. The catches by size and week are summarized in Table 3. Reported harvests from food fisheries in the Northwest Miramichi in 1998 were 195 large salmon and 782 small salmon. A total of 378 small salmon were harvested from the Southwest Miramichi. The harvests reported in Table 3 are exclusive of those taken off waters specified in the Aboriginal Communal Fishing licenses.

The Aboriginal food fishery harvests in 1998 represented declines of 44% for small salmon and 26% for large salmon relative to the previous 5-year mean (Table 4).

Gillnets accounted for 61% of the large salmon harvest and 37% of the small salmon harvest from the Northwest (Table). The Eel Ground First Nation released all the large salmon from the food fishery trapnets (417 salmon) and 64% of the small salmon catch (761 of 1182 small salmon, mostly from the fall run). The Red Bank First Nation released less than 1% of the large salmon catch (1 of 72 large salmon) and 5% of the small salmon catch (13 of 272 small salmon). The food fisheries mainly targeted the early run for small salmon (88% of harvests were taken prior to September 1) and 83% of the large salmon were harvested from the early-run.

Recreational Fisheries

Angling catch data have in the past been available from two sources: FISHSYS from the New Brunswick Department of Natural Resources and Energy (DNRE), and from the Government of Canada Department of Fisheries and Oceans (DFO) (Moore et al. MS1995). 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, which have generally been lower than the DNRE estimates, were not collected after 1994.

FISHSYS catch data for 1998 were not available to date. On average (1991 to 1995), 13284 small salmon were harvested, 4666 small salmon were released and 6404 large salmon were released during the bright salmon fishery (Table 5, Fig. 2). The Southwest Miramichi represented 67% of the catch of small salmon and 75% of the large salmon catch. The FISHSYS survey was not conducted in 1996.

Historical catches from the Miramichi and each branch are summarized in Figure 2. Large salmon catches (kept and released) in the Miramichi peaked in 1986 and declined to 3146 salmon in 1995 (Fig. 2). Small salmon catches have fluctuated annually, having peaked in 1989 at almost 31000 fish and declining to 5622 in 1995. The catches of small and large salmon increased the most in the Northwest Miramichi since the closure of commercial fisheries and the introduction of hook and release angling in 1984 (Fig. 2). Catches of large salmon in the Southwest Miramichi decreased after 1986 and declined to less than 2600 fish in 1995. Catches in 1995 were abnormally low because of numerous closures resulting from warm and low water conditions (Chaput et al. MS1996).

The Crown Reserve waters of the Northwest Miramichi are regulated in terms of effort and catches in these waters represent the best indicator of relative availability and abundance of salmon from the early-run component in the Northwest Miramichi. Total effort in 1998 was similar to 1997 and among the highest since 1982 (Fig. 3; Table 5). Catches of small salmon were 31% below the 1991 to 1995 mean but 20% above catches in 1997. Large salmon catches were similar (-1%) to the 1991-1995 mean but 9% above catches of 1997.

Timing of Harvests

Recreational fisheries exploit both the early and late runs. The small salmon catch from the Miramichi River has been historically comprised of 81% early and 19% late (after Aug. 31) run whereas 74% of the large salmon catch is taken in the summer (Moore et al. MS1995). These proportions differed for the two major branches. Catches in the Northwest tend to be high from the early run whereas Southwest catches are only slightly higher in the early season: 75% of large and 83% of small for the Northwest, 56% of large and 61% of small for the Southwest.

In 1998, recreational exploitation of tagged small salmon was greatest for fish marked in Augsut and September although the percent of tags returned by anglers was the lowest since 1992 (2% overall). Exploitation has generally been heaviest on the early run fish and decreases progressively for September and October tag groups.

Percent of tags returned by anglers from fish marked in each month					
Grilse	June	July	August	September	October
1992	16%	16%	10%	9%	6%
1993	11%	14%	13%	8%	5%
1994	6%	6%	6%	8%	2%
1995	3%	5%	4%	3%	2%
1996	8%	6%	3%	4%	3%
1997	3%	5%	2%	5%	2%
1998	1%	2%	3%	3%	2%

Summary of fisheries removals

Aboriginal fisheries in the Northwest Miramichi account for the majority of large salmon removed, on average 81% of the annual total (Table 4). In the Southwest Miramichi, there are no aboriginal fisheries for large salmon and all the removals are attributed to the angling fishery. Overall in the Miramichi, aboriginal fisheries account for 59% of the large salmon removals and angling accounts for 41% of the fisheries losses (Table 4).For small salmon, the angling fishery removes the majority of fish in both the Northwest (76%) and Southwest (95%) branches and overall in the Miramichi River (87%).

Illegal removals/seizures

There were no seizures or apprehensions of illegally caught salmon in 1998.

Broodstock collections

In 1998, a total of 51 large salmon and 21 small salmon were collected and spawned at the Miramichi Hatchery Inc. (Table 6). Collections were made from specific tributaries and the number of fish removed corresponded to the intended stocking intensity at the specified locations. The collections in 1998 were reduced from 1997 (64 large salmon and 32 small salmon), 1996 and 1995 (Chaput et al. MS1997). Reduced numbers in 1998 were in part the result of a lower requirement and high water conditions which hindered seining operations (Mark Hambrook, Miramichi Fish Hatchery Inc., pers. comm.).

Furunculosis losses

Atlantic salmon mortalities collected and sent to the DFO Fish Health Unit in Moncton (NB) confirmed again the presence of furunculosis causing bacteria in the river in 1998. There were no reports of numbers of dead salmon in the river in 1998. Mortalities at the DNRE protection barriers in 1998 were minimal and comparable to those of previous years.

CONSERVATION REQUIREMENT

The conservation spawning requirement for the Miramichi River and each branch separately was based on an egg requirement of 2.4 eggs/m^2 of spawning and rearing habitat area (CAFSAC 1991). Habitat area estimates are from Amiro (MS1983). The objective is to obtain all the egg depositions from large salmon. Fish required are calculated using the average biological characteristics of the Miramichi stock. The small salmon requirement is to provide a theoretical 1:1 sex ratio. The spawning requirements in terms of fish were based on the average biological characteristics of salmon during 1971 to 1983: 86% female and a fecundity of 6816 eggs per female resulting in an average of 5862 eggs per large salmon spawner, 75% male for the small salmon (Randall MS1985).

			Fish required	
	Habitat area (million m^2)	Egg requirement (millions)	Large salmon	Small salmon
Miramichi River	54.6	132	23,600	22,600
Main Miramichi	1.1	3	554	531
Southwest Miramichi	36.7	88	15,730	15,063
Northwest Miramichi	16.8	41	7,316	7,006

Point estimates of the required number of spawners ignore the annual variation in fecundity and the female proportion of the large salmon returning to the Miramichi River. It has also been shown that the fish returning to the Miramichi since 1984 are larger than was observed prior to 1985 (Moore et al. 1995). Larger fish contribute more eggs which results in fewer fish required to achieve the conservation egg requirements. Based on the biological characteristics of salmon from

1992 to 1996 (corresponding to the most recent significant change in management, the moratorium in the insular Newfoundland commercial salmon fishery), the spawning requirements for the Miramichi are reduced to 21800 large salmon and 21095 small salmon (averaging 86% male).

The conservation principles for Atlantic salmon also include provision for the complex stock structure within a river. There are natural boundaries for the further stratification of the Miramichi River beyond the Southwest/Northwest separation. Tidal influence extends to just above the junction of the Renous River and the Southwest Miramichi. Production of juveniles in the main stem of the Southwest Miramichi below this point is expected to be minimal. Similarly in the Northwest Miramichi, the junction of the Little Southwest Miramichi and the Northwest Miramichi would be an appropriate dividing line. This stratification produces three production areas in each of the main branches with the following egg and spawner requirements:

			Fish equivalents	
	Habitat area (m^2)	Eggs required	Large	Small
Southwest Miramichi				
Barnaby	1.31 million	3.1 million	560	536
Renous/Dungarvon	5.82 million	14.0 million	2499	2393
Southwest (above Renous)	29.53 million	70.9 million	12671	12133
Northwest Miramichi				
Northwest Millstream	0.49 million	1.2 million	212	203
Little Southwest	8.07 million	19.7 million	3517	3368
Northwest Miramichi	8.23 million	20.1 million	3587	3435

The estimation of risk of meeting or exceeding conservation requirements relative to the number of salmon returning to the Miramichi was calculated as follows. Large salmon returning to the Miramichi River were allocated to one of the six production areas based on the relative sizes of each area (for example, the Southwest Miramichi above Renous represents 55.2% of the total area therefore 55.2% of the large salmon returning to the Miramichi would return to the Southwest Miramichi). Using the entire 26 years of biological characteristics variation, an escapement of 21400 large salmon to the Miramichi provides a 50% chance of meeting or exceeding the Miramichi River conservation requirements but only a 25% chance of meeting or exceeding the conservation requirements in all six subareas simultaneously. For a high probability (90%) of meeting or exceeding conservation requirements, escapements of 26100 large salmon for the entire Miramichi River and 27400 large salmon for simultaneous escapement into all six sub-areas would be required.

RESEARCH DATA

Data collected in 1998 pertain to the estimation of returns, size distribution, sex ratios, abundance of juvenile salmon, and hatchery stocking. Returns are estimated from mark and recapture experiments. The size distribution and sex ratio data are collected at the tagging and recapture trapnets, from food fishery trapnets and from broodstock seining operations. The abundance of juvenile salmon is estimated from electrofishing surveys.

Estimation of returns

Trapnets were operated below head of tide in both branches of the Miramichi River (Fig. 1). Details of trapnet construction are provided in Chaput et al. (MS1997). The food/science trapnets operated by Eel Ground First Nation (one in the Northwest, two in the Southwest) upstream of the confluence of the Southwest and Northwest branches of the Miramichi River were the main tagging trapnets. An upstream trapnet on the Southwest Miramichi (Millerton, Fig. 1) was used for tagging and recapture. The Red Bank trapnets were the main recapture gear for the Northwest Miramichi. In 1998, a new adult trapnet was installed about 5 km below the Red Bank trapnets. It served for both tagging and recapture of downstream tags. The trapnets were fished once a day at slack tide, sometimes twice a day at Red Bank. The dates of operation, total fish caught, and total tags released, by size group, are summarized in Table 7. In addition, salmon were sampled at the partial fence at Big Hole tract in the Northwest Miramichi.

Salmon were marked with individually numbered blue Carlin tags (dimensions 9.5 mm by 4.6 mm by 1.0 mm thick) attached to the back just anterior to the dorsal fin with narrow gauge stainless steel wire. Fork length and external sex determination (fall period) were obtained from all salmon at the tagging trapnets. Scale samples, for determination of age, were removed from the standard location (along the imaginary line joining the posterior of the dorsal fin and the anterior of the anal fin, two to four rows above the lateral line) from all large salmon and from every second small salmon. Scale samples were stored dry.

Food fishery catches at Eel Ground and Red Bank were sampled for number of salmon caught (by size) and number as well as sex of salmon harvested (by internal examination). Almost all the large salmon from the Eel Ground trapnets were tagged before being released (Table 7). The number of tags placed and the time and location of recaptures, by size group and month, at each of the tagging facilities in 1998 are summarized in Appendix 2.

Recaptured fish at all trapnets had the tag number recorded, the size (small or large), date and trapnet location where recaptured before being released or when sampled from the food fishery harvests.

Daily counts of salmon, by size, were obtained at several barrier fence and counting fence facilities within the Northwest and Southwest Miramichi (Fig. 1). Tag numbers of marked fish passing through these barriers were recorded prior to release upstream. Broodstock seining also provided samples of size, number of fish, tag numbers of marked fish, and sex ratios.

Juvenile Surveys in the Miramichi River

Electrofishing surveys were conducted at 66 sites (26 in the Northwest Miramichi and 40 in the Southwest Miramichi) between **August 25 and October 3**, 1998. **Thirteen** of these sites have been sampled every year since 1970. A combination of open (**63** in total) and closed (**7** in total) sites were sampled. The density of salmon juveniles at closed sites was estimated using the removal method after enclosing a section of stream with fine mesh barrier nets (Zippin 1956). Open sites provided estimates of abundance based on catch per unit effort. Fishing was conducted bank to bank, in an upstream direction, with three people: one person with the shocker unit, a second person with a meter wide by 0.75 meter high seine, and a third person with the fish holding bucket and dip net. The amount of fishing effort was recorded from a timer on the shocker unit and represented the total seconds of actual shocking time. Catch per unit effort was transformed to density (number of fish per 100 m^2) by calibrating the open site technique within closed sites (see Chaput et al MS1995). Results from calibrations made at 44 sites between 1993 and 1997 are given in Appendix 3. Percent habitat saturation (PHS) values were calculated for each site (Grant and Kramer 1990).

All fish were identified to species and measured for length (fork length except for lamprey and American eel for which total length were recorded). Large eels were counted but not measured. Fish were anesthetized, using sodium bicarbonate salts, before measuring.

ESTIMATION OF STOCK PARAMETERS

Estimation of Returns

Returns are estimated to each branch and to the Miramichi River. The tagging and recapture matrices are summarized in Table 8. Small and large salmon tags and recaptures were combined and the total returns of both size groups combined were estimated. The returns of small and large salmon were estimated using the ratio of small salmon and large salmon in the total recapture trapnet samples. This approach assumes the trapnet efficiencies are similar for small and large salmon. This approach is similar to that used in 1997. Emigration of tagged fish between the branches is accounted for in the spatially stratified model (Table 8). Estimates were obtained with the Schaeffer model (Ricker 1975).

The uncertainty around the estimation of returns in the spatially stratified model consists of two components:

1 - Random variation in the tag loss/tag mortality factor was incorporated as a uniformly distributed function between 0% and 20% (mean of 10%).

2 - Uncertainty in the temporally-stratified recapture matrix was estimated by resampling within the rows of the observed matrix of recaptures at the trapnets. In this case, the prior probabilities for a marked fish in the catches at the trapnets was set at the observed proportion for each tag release stratum. Recoveries were assigned to one of the temporal strata (movement of tagged fish among recovery strata) based on the observed distribution of recoveries.

Returns to each branch were obtained using a resampling technique:
Step 1: select a tag loss/tag mortality factor and define recapture matrix.
Step 2: calculate returns using Schaeffer, Darroch and Petersen, save result.
Step 3: repeat steps 1 and 2 a large number of times (1000 replications were performed)
Step 4: summarize distribution of returns from step 3.

Only marks placed up to and including Oct. 15 are considered to be available for recapture.Tagging in the Southwest finished on Oct. 9 while in the Northwest, the last day of tagging was Oct. 12. The recapture trapnets in the Northwest Miramichi fished until Oct. 14 and the Millerton trapnet on the Southwest Miramichi fished until Oct. 23. Returns are estimated up to the point of the recapture trapnets in each branch (would exclude harvests which occurred downstream of each recapture trapnet) and constitute the returns up to and including Oct. 15. Total returns are obtained by adding downstream removals.

At the recapture traps, both the previously marked fish and the unmarked fish are known without error but the marks available for recapture are not.

1 - In 1998, salmon with tagging scars were recorded at the tagging trapnets in the Northwest Cassilis and the SW Millerton trapnets. The tags may have been shed or could have resulted from anglers removing tags and releasing the fish. This would necessitate a fall-back to tidal waters of angled fish which has been observed in 1995, 1996 and 1997 with the capture of salmon with artificial flies embedded in the jaw. Since all fish at the trapnets are examined for tags and tagging scars, recaptures were considered known without error.

2 - Mortality of tagged fish resulting from tagging and handling has not been estimated although there have not been any recorded mortalities of tagged fish held in hatchery facilities (Chaput et al. MS1994a, Courtenay et al. MS1993). In the absence of survival rate data, a combined tag loss/tagged fish mortality factor of 10% was assumed (varying between 0% and 20%), similar to previous assessments (Randall et al. MS1989).

Returns to the Southwest Miramichi in 1998

Large salmon returns were estimated at 7000 fish with a 95% probability that the returns were at least 6000 fish (Table 9, Fig. 4).Small salmon returns were estimated at 24000 fish with a 95% probability that the returns were more than 19000 fish (Table 9, Fig. 4).

The overall efficiency of the Millerton recapture trap for both size groups combined in 1998 was about 5.5%, lower than 1997 but within the range of efficiencies estimated in previous years. No washouts occurred in 1998.

	Southwest Millerton Trapnet Efficiency				
	1998	1997	1996	1995	1994
Small salmon			7.5%	7.7%	7.9%
Large salmon		6.7%	4.8%	8.8%	6.9%
Combined	5.5%				

Returns to the Northwest Miramichi in 1998

About 2200 large salmon returned to the Northwest Miramichi in 1998 with a 95% probability that the returns were more than 2100 fish (Table 9, Fig. 4). Small salmon returns were estimated at 7900 fish with a 95% probability that the returns were at least 6200 fish (Table 9, Fig. 4).

The Red Bank trapnets in 1998 had a their lowest efficiencies ever. This was in large part due to several major washouts of one of the traps in late June and July and generally high water conditions in the Northwest which resulted in frequent tie-ups of the gear.

	Northwest Red Bank Trapnet Efficiencies				
	1998	1997	1996	1995	194
Small salmon			4.1%	6.5%	6.7%
Large salmon		5.3%	4.5%	5.6%	3.9%
Combined	3.3%				

In comparison, the Northwest Cassilis trapnet operated exclusively by DFO Science had an efficiency of 10.4% in 1998.

Returns to the Miramichi River in 1998

In 1998, 9500 large salmon and 33000 small salmon returned to the Miramichi River (Table 9, Fig. 4). There was a 5% chance that returns of large salmon to the Miramichi were less than 7500 fish and small salmon returns were less than 27500 (Table 9, Fig. 4). The pooled Petersen estimate for large salmon based on tagging and recapture data for large salmon only was 47% higher than the Schaeffer estimate derived from the combined size marking and recapture matrix (Fig. 4). For small salmon, the Peterson estimate was 23% lower than the Schaeffer estimate.

Estimation of Egg Depositions in 1998

The egg contribution in 1998 was calculated for the returns to river since the removals data are to date incomplete.

<u>Escapement in 1998</u>

The escapement of salmon refers to fish which were not harvested in fisheries or otherwise removed from the river. Known losses would be included: seizures in nets and reported mortalities in the river. Removals also include broodstock collections, scientific sampling, and incidental mortalities at the tagging trapnets.

To date, only part of the total removals in 1998 are known.The known removals from the Miramichi River, excluding the angling harvests, total 1221 small salmon and 295 large salmon (Table 10). Total removals exclusive of angling in the Northwest Branch were 794 small salmon and 217 large salmon whereas Southwest Branch removals were 406 small salmon and 59 large salmon. Escapement estimates accoounting for only part of the total removals are in Table 11.

The large salmon removals in the angling fisheries have in previous years (1992-1997, excluding 1996) 218 fish (Table 4). In the Northwest Branch, losses have averaged 60 large salmon and in the Southwest Branch, losses have average 158 large salmon. Losses in 1998 are expected to be of the same relative order of magnitude. Losses of large salmon in 1998 were approximated at:

Northwest Branch: 217 + 60 (estimated average) = 277 large salmon
Southwest Branch: 59 + 158 (estimated average) = 217 large salmon
Miramichi River: 295 + 218 (estimated average) = 513 large salmon.

For small salmon, average losses in 1992 to 1997 (excluding 1996 because no data are available) would result in the following preliminary estimated losses of:

Northwest Branch:	794 + 5295 (estimated average)	=	6089 small salmon
Southwest Branch:	406 + 10160 (estimated average)	=	10506 small salmon
Miramichi River:	1221 + 15454 (estimated average)	=	16675 small salmon

Biological Characteristics of Salmon in 1998

All salmon sampled at the tagging trapnets were measured for fork length. All large salmon and every second small salmon were scale sampled. Sex of large salmon from the early run in the Northwest Miramichi was determined from the internal examinations of the Red Bank food fishery harvests. Sex of small salmon from the early run was determined by internal examinations of food fishery harvests of Eel Ground and Red Bank. In the fall, both internal and external sex determinations of small salmon were obtained from Red Bank and Eel Ground harvests. Only external determinations of sex were obtained for large salmon from the Southwest Miramichi in the fall. Additional sex ratio information was obtained from the broodstock seining samples (Table 13).

Sex ratios

Large salmon were the majority female in both the Northwest and Southwest branches (Table 12). The proportion female (79%) observed in 1998 was similar to the values observed in recent years except for 1995 when the female salmon comprised 89% of the large salmon returns (Fig. 5). Small salmon sex ratio was heavily favoured towards the males, with 80% male for the Miramichi, 73% male for the Northwest Miramichi and 84% male for the Southwest Miramichi (Table 12, Fig. 5). There tends to be a higher proportion female in the small salmon from the early run, especially in the Northwest Miramichi where 33% of the early-run small salmon were female compared with 15% in the fall run (Table 12).

Size and age

Previous spawners made up 50% of the large salmon returns in 1998, compared with 29% in 1997 (Table 12). There were equally high proportions of previous spawners in the Northwest Miramichi (53%) and the Southwest Miramichi (50%) with the early run having a higher proportion previous spawners than the fall run (Table 12).

Egg depositions in 1998

In the total returns, large salmon contributed 71% of the total eggs (60 million eggs) in the Miramichi River in 1998 (Table 14). In the Southwest Miramichi, large salmon contributed 75% of the 44 million eggs while in the Northwest Miramichi, large salmon contributed 65% of the 15 million eggs (Fig. 6, Table 14). The egg contibution by small salmon in terms of returns was higher than in recent years because of the low abundance of large salmon in 1998 (Fig. 6). One large salmon returned the equivalent number of eggs of about nine small salmon (Table 12). For the Northwest Miramichi, seven small salmon were equivalent to one large salmon while in the Southwest Miramichi, more than ten small salmon would have been required to equal the egg contribution of one large salmon.

STATUS OF STOCK

The point estimate of the eggs in the returns of large salmon to the **Miramichi River** was 45% of conservation requirements with absolutely no chance of having met the conservation requirement (Table 9 and 14, Fig. 7). Egg depositions by both small and large salmon returns (before harvests) equalled 68% of requirement, with a 0% probability of meeting the conservation requirement (Fig. 7). Actual egg depositions were lower because of the expected loss of as much as 50% of the small salmon return to the river. Egg depositions to the Miramichi River in 1998 would likely be above 50% once harvests are accounted for but with no chance of having met the requirement. This is the second year in a row that the escapements were insufficient to meet requirements and the first year since 1984 that there were insufficient eggs in the total returns to meet requirement (Fig. 8).Since the 1984 management plan, small salmon have contributed on average 22% of the total egg deposition, the most important contribution by small salmon occurred in 1981 at 58% (Fig. 8).

Returns and escapements of small salmon to the Miramichi peaked in 1992 and have since declined (Table 15, Fig. 9). The return in 1998 of 33000 small salmon was a 46% increase from 1997 but 59% below and 65% below the previous 5-year and historical (1971 to 1997) average returns to the river. The large salmon returns since the closure of the commercial fisheries peaked in 1992. The return in 1998 of 9500 large salmon is the lowest since 1979. The 1998 returns were 48% below the 1997 returns and 34% below and 325% below the previous 5-year and historical averages, respectively (Fig. 11, Table 15).

Returns of large salmon to the **Southwest Miramichi** would have contributed about 44 million eggs, equivalent to 50% of the conservation requirement. Returns of small salmon and large salmon combined wold have equalled 70% of requirement (Table 14) but with only a 2% chance of having met the requirement (Table 9, Fig. 7). Egg depositions after accounting for removals would be approximately equal to 60% of requirement assuming that 50% of the small salmon would have been removed in the fisheries. This is the second consecutive year that conservation requirements have not been met. Egg depositions had exceeded the conservation requirements between 1992 and 1996 (Fig. 8).

In the **Northwest Miramichi**, the 15 million eggs contributed by the returns of large salmon represent only 36% of the conservation requirement (Table 14). The contribution which would have been made by the small salmon returns would have increased the egg depositions to 57% of requirement. There was no chance that conservation egg requirements were met in 1998, even before accounting for removals (Fig. 7). Egg depositions had previously exceeded the conservation requirements every year since 1992 (Fig. 8).

Headwater Barrier Fences

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 (Fig. 1; Table 17). The fences are operated for varying periods each year but generally cover the entire migration period. Counts of large salmon in 1998 at the barrier fences of the Southwest Miramichi were down 20% or up 5% relative to the previous 5-year mean whereas the counts of small salmon were down 8% or up 26% (Table 17). Counts of small and large salmon at both protection barriers were improved from 1997 but remained below the levels observed in the early 1990s. In contrast, the count of large salmon at the Clearwater Brook counting fence was down 34% in 1998 relative to 1997 but small salmon counts were improved 39% from the previous year (Table 18). Based on returns of estuary tagged fish in 1997 and 1998 which were almost exclusively September and October marked fish, Clearwater Brook has an important fall-run component.

Returns of large salmon at the Northwest Barrier were up 36% from the previous 5-year average (Table 17). Small salmon counts were improved 55%. The 1998 counts of small and large salmon were among the highest since the beginning of operations in 1988. The counts at Catamaran Brook, a mainly fall-run tributary, were the lowest ever for small salmon and among the lowest for large salmon (Table 19).

Overall trends in returns/escapements since 1992

Small salmon returns were improved from 1997 at all the counting facilities in the Southwest Miramichi. The counts of large salmon were improved from 1997 at the two early run facilities in the Southwest but decreased for the combined runs. Relative to the previous five years, counts of small salmon and large salmon were down. In the Northwest Miramichi, the count at the early run protection barrier was greatly improved from 1997 for both small and large salmon but the fall run Catamaran Brook count and the trapnet estimates were both down from 1997 and the previous five-year mean. Good water conditions through the summer may have facilitated the movement of salmon into the early-run headwater areas and contributed to improved counts from 1997.

	Change in 1998 relative to			
	Small Salmon		Large Salmon	
	1997	1993 - 1997	1997	1993 - 1997
Northwest Miramichi				
Northwest Barrier (early)	+107%	+55%	+90%	+36%
Catamaran Brook (late)	-13%	-51%	-7%	-35%
Trapnet estimate (early & late)	-18%	-66%	-70%	-80%
Southwest Miramichi				
Juniper Barrier (early)	+73%	-8%	+34%	-20%
Dungarvon Barrier (early)	+51%	+26%	+42%	+5%
Clearwater Brook (early & late)	+39%		-34%	
Trapnet estimate (early & late)	+78%	-21%	-36%	-56%

The low abundance of large salmon in 1998 was not unexpected given the low returns of small salmon in 1997. Additionally, the low abundance in 1998 was the result of a very low return of fish during the fall. In the four previous years, catches of large salmon at the trapnet in the Southwest Miramichi were distributed about 25% early (May to August) and 75% late run (September and October). In 1998, the fall run represented only 55% of the total fish sampled (Fig. 10).

This contrasted with the small salmon run timing in 1998 which was identical to previous years when about 50% of the total run occurred early (Fig. 10).

All the indicators suggest that returns of early-run small salmon in 1998 were greatly improved from 1997. Late-run counting facilities had lower returns of small salmon in the Northwest Miramichi but improved returns in the Southwest Miramichi. For large salmon, early-run returns were seemingly improved from 1997 as evidenced by the higher counts of large salmon at the early-run counting facilities in the Northwest and Southwest branches. But the fall-run was surprisingly weak in 1998 relative to previous years and declined in both branches.

ECOLOGICAL CONSIDERATIONS

Seasonal and Environmental Conditions

Discharge profiles in the Southwest Miramichi and Northwest Miramichi in May were lower than recent years (Fig. 11). Generally summer discharge in the Southwest Miramichi was moderate and below the high July 1996 values but fall discharge was above the previous three years. In the Northwest and Little Southwest Miramichi, summer and fall discharges were above recent years and characterized by numerous freshet events especially in the Northwest Miramichi (Fig. 11). There were fewer freshet events in the Southwest Miramichi. Some important precipitation events were localized in the northern part of the bassin, for example, June 15-20 (Fig. 11).

Run timing of small salmon at the Millerton trapnet in the Southwest Miramichi in 1998 was similar to that of 1997, 1994 and 1995 with 25% of the small salmon early-run catch accounted for by July 8 to 13. The dates when 50% of the total summer catch was acconted for was more variable, July 22 in 1998 but varying between July 9 and August 4 in the other years. The run of 1996 was the earliest. Large salmon catches in the summer were more variable with 1996 being the earliest (25% of the total summer catch occurred by July 6) and with 1998 catches being generally earlier than all other years (25% by July 11, 50% by July 25 in 1998 compared to between July 13 and 23 for 25% and July 21 to Aug. 11 in other years). Fall-run timing of both small and large salmon was more consistent with the cumulative count slopes in 1998 similar to other years (Fig. 10). The low abundance of fall-run salmon in 1998 resulted in 50% of the total run being sampled by Sept. 11 compared to around Sept. 27 in the other years (Fig. 10).

Spawner Distribution and Habitat Utilization

In 1997, spawning occurred throughout the Northwest and Southwest Miramichi (Fig. 12). Fry densities were high (> 50 per 100 m^2) at over half of the 29 sites sampled in the Northwest Miramichi with low densities (< 10 per 100 m^2) at 6 sites. Low densities at some of these sites were attributed to inappropriate substrate at the site for fry and lack of spawning due to obstructions (beaver dam). In the Southwest Miramichi, fry densities were also high at over half the 41 sites sampled (Fig. 12). Low densities were noted at five sites and probably attributable to beaver obstructions at some of these. Spawning has been monitored using this method since 1993 and results indicate that spawning has been occurred throughout the basin accessible to Atlantic salmon.

Parr densities were moderate to high at most sites in the Northwest and Southwest Miramichi (Fig. 12).

Relative to recent years, fry densities in the Northwest in 1998 were improved at only 12% of the sites sampled and were down at more than 50% of the sites (Fig. 13). Reduced fry abundance in 1998 is consistent with the lower egg depositions in 1997 relative to recent years (Fig. 8). Parr densities in the Northwest were generally similar or down by 25 to 50% at most sites but 28% of the sites showed improved densities relative to recent years (Fig. 13). In the Southwest Miramichi, fry densities were also improved at only 12% of the sites and were lower than recent years at 58% of locations (Fig. 13). As in the Northwest, lower densities of fry in 1998 is consistent with lower egg depositions in 1997 (Fig. 8). Parr densities were unchanged or improved from recent years at over half the sites sampled.

In the Southwest Miramichi, there are two periods of differing relative fry abundance: between 1970 and 1984 characterized by low abundance, 1985 to 1998 with high abundance (Fig. 14). Abundance in 1998 was the second lowest in the high abundance period. Parr abundance in the Southwest Miramichi was characterized by three periods: low abundance prior to 1986, moderate densities between 1986 and 1990 and high abundance since 1991 (Fig. 14). The 1998 parr densities are median to the high abundance period.

In the Northwest Miramichi, fry abundance is also characterized by two periods: low abundance prior to 1993 followed by high abundance between 1993 and 1998 (Fig. 15). The 1998 fry level was the second lowest in the high abundance period. Parr abundance was also characterized by two periods: low densities prior to 1991 and high densities since (Fig. 15). The 1998 parr densities were also median of the high abundance period. The fry abundance in the Northwest only showed an improvement in 1993 whereas in the Southwest Miramichi, an improvement was observed as early as 1985. Egg depositions in the Northwest Miramichi were apparently low between 1985 and 1992 compared to those of the Southwest Miramichi.

Percent habitat saturation (PHS) index is a relative measure of the habitat use and potential interaction between juveniles within the stream. It considers both the densities of fish and body lengths. A PHS value of 28 is used as a reference point; it represents the value at which density dependent effects have a 50% probability of being expressed (Grant and Kramer 1990). The median PHS value in the Northwest Miramichi in 1998 was 18 (5th to 95th percentile range of 6 to 37) (Fig. 16) In the Southwest, the median PHS value in 1998 was 20 (5th to 95th percentile range of 8 to 45) (Fig. 16). PHS values in 1998 were lower than those of 1997 but remained well above the values observed prior to 1985 in the Southwest Miramichi and prior to 1992 in the Northwest Miramichi (Fig. 16).

<u>Size of adults in 1998</u>

Adults returning to the Miramichi in 1998 were shorter than those of 1997 but had mean lengths among the highest of the 28 year time series (Fig. 17). The 1SW maiden salmon from the early run and late runs had the third and fourth, respectively, highest mean fork lengths of the 1971 to 1998 time series. The summer run 2SW maiden salmon had the third highest mean lengths of the time series but were slightly shorter than in 1997. The fall run 2SW salmon were of shorter mean length than in 1997 and ranked seventh in mean size for the 1971 to 1998 time period (Fig. 17). The mean lengths of both age groups in both season remained well above those in the 1970s and early 1980s. This has been attributed to size-selective fisheries on both the 1SW and 2SW salmon which occurred in the early period.

The skewness coefficient, an index of the symmetry of the length distribution, was the lowest in the time series for the 2SW salmon from the fall run of the Miramichi River in 1998 (Fig. 18).

Shorter 2SW salmon made up a higher proportion of the returns in 1998 than in other years (a negative skewness coefficient indicates an extended distribution of shorter fish whereas a positive coefficient indicates an extended distribution of longer fish). The summer run 2SW salmon had a symmetric length distribution (skewness coefficient was near 0) (Fig. 18). For 1SW salmon, the skewness coefficient has generally been above zero for the fall run fish and near or above zero for the summer run fish since 1985 (Fig. 18). There was no significant temporal trend in the skewness coefficient of any of the age group or seasons.

FORECAST/PROSPECTS

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. 19). Based on this relationship and a 1998 return of 33000 small salmon to the Miramichi River, the most probable large salmon return in 1999 is 24,475 with a 43% probability of meeting spawning requirements (23,600 large salmon). This model has been used to forecast returns since 1992 (95% confidence interval):

Forecast year	Forecast value	Actual return	Performance
1992	29,000	37,000	under predicted by 22%
1993	18,315	35,200	under predicted by 48%
1994	28,200	27,500	over predicted by 3%
1995	30,040	32,583	under predicted by 8%
1996	30,507	24,000	over predicted by 27%
1997	29,933 (13,114 to 51,275)	18,422	over predicted by 62%
1998	22,178 (7,055 to 33,835)	9,500	over-predicted by 133%
1999	24,475 (8,905 to 42,052)		

Considering the very wide confidence intervals, it is very probable that the returns in 1999 will be within the interval.

The association between small salmon (almost exclusively 1SW salmon) and 2SW salmon or large salmon returns the subsequent year was examined over the time series from 1985 to 1998. The ratio of small salmon to 2SW salmon during that time period varied between 2.0 and 10.8 with the most recent year (1997 small, 1998 2SW salmon) ratio at 6.1 (Fig. 20). The ratio of small salmon to large salmon for the same time period varied between 1.6 and 7.1 with the most recent year ratio (1997 small, 1998 large salmon) at 2.7 (Fig. 20). There was also no significant trend over time. Applying these ratios to the small salmon returns of 1998 provides the following expectations for 2SW salmon and large salmon in 1999:

	2SW salmon	large salmon
Using median ratio (4.7; 2.7)	7,000 fish	12,300 fish
Using minimum ratio (2.0; 1.6)	17,000 fish	20,000 fish
Using maximum ratio (10.8; 7.1)	3,000 fish	4,700 fish

The median ratio model for the 1985 to 1998 time period would predict returns of 2SW salmon ranging from 3,000 to 17,000 fish and below the large salmon requirement of the Miramichi River. The large salmon expectation which includes an important previous spawner component ranged between 4,700 and 20,000 fish. Based exclusively on this simple analysis, it is highly improbable that the returns of large salmon in 1999 will meet conservation requirements or approach the predictions from the previously described PDF model.

The contribution of previous spawners to the returns of salmon and to the egg depositions has increased since 1986 in terms of the proportion of the large salmon returns and the absolute number (Fig. 21). In 1998, there were more previous spawners than 2SW salmon returning to the river (Moore et al. 1995). The increased egg depositions since 1984 are in large part the result of higher contributions by previous spawners because the 2SW maiden abundance had until 1998 remained unchanged (Fig. 21). Previous spawners also have a higher fecundity per fish than 2SW maiden fish. At the present time, the abundance of previous spawners can not be predicted. Survival of kelts from the Miramichi appears to be naturally high, probably because of large numbers of holding areas in the river and the abundant food supply early in the spring (smelt for example). Survival rates of 1SW maiden salmon to returns as consecutive spawners has been increasing since 1990 with the 1996 1SW maiden spawners having the highest observed consecutive spawning survival (Chaput et al. 1998). Survival as alternate spawners was high in the late 1980's and early 1990's but declined through 1992 to 1994 (Chaput et al. 1998). Previous spawners destined to return to the Miramichi in 1999 may have been intercepted in the Greenland fishery of 1998 : one large salmon kelt tag was received in 1998 from Greenland but the tag was from a 2SW salmon originally marked in the Miramichi in 1995. Similarly, tags have frequently been returned from the Quebec North Shore (Zone Q9) and in 1998 two tags were received but these fish had originally been marked in 1990 and 1994. It is unlikely that any of the tags returned from sea fisheries in 1998 were actually caught in 1998.

There is no forecast model for small salmon but in previous assessments a relative association was made between small salmon returns to the Northwest Miramichi and the smolt counts at Catamaran Brook fence in the Little Southwest Miramichi (Table 18). The prediction for 1998 small salmon was for an improved return in 1998 relative to 1997 but the actual return in 1998 declined from 1997 (Table 16). The estimated smolt to 1SW survival was the second lowest of the series (Table 18). The smolt count at Catamaran in 1998 was the lowest since counting began in 1990 and a similar relative assessment of expectation for 1999 would suggest the lowest returns of small salmon since 1990 to the Northwest Miramichi.

A mark and recapture experiment to the estimate the smolt production from the Northwest Miramichi was conducted in 1998 (Appendix 4). The smolt run was underestimated in 1998 because of an incomplete sampling of the run at the recapture trapnet. The estimated output from the Northwest Miramichi in 1998 was 130,000 smolts. Applying the range of estimated survival rates of Catamaran Brook smolts (5.0% to 13.6%) to the 1998 smolt run results in expected returns of 6500 to 18000 small salmon, levels within the range of estimated returns of the last three years (Table 16). There is no estimate for the Southwest Miramichi but with high sustained juvenile numbers, the run of small salmon should be sustained at the levels of recent years, about 20,000 to 30,000 fish.

Hatchery Stocking

Various life stages are reared and stocked annually to the Miramichi River. Satellite rearing, initiated in 1984, has resulted in about 80,000 young-of-the-year released annually as fall fingerlings. The survivors of these would return three to four years later. Smolt stocking has also been an important component of the hatchery program. About 45,000 2+ smolts were released to the Miramichi in 1998, 15,000 fewer than in 1997 (Table 19). The majority of these smolts (40,000 fish) were stocked in the Renous/Dungarvon River, Southwest Miramichi (Appendix 5). Stocking levels of 0+ parr were lower in 1998 relative to 1997. These parr would not be expected to become smolts until the spring of 2000. There was an increase in non-feeding fry stocking in 1998 (Table 19); this life stage can not be distinguished from wild fish after they are stocked.

Returns of small salmon from stocking in previous years are expected to decline from the levels observed in 1998 (Table 20). Adipose-clipped fish return mostly as small salmon, the contribution to large salmon returns being less than 0.3% in the 1997 returns and 0% in 1998. Adipose-clipped salmon made up 10% of the small salmon in the early-run catch at the Cassilis trapnet in the Northwest Miramichi in 1998 (Table 20). This is the highest proportion measured at the estuary trapnets in 1998 and in previous years. Based on the estimated efficiency of the Cassilis trapnet (10.4%), just under 600 adipose-clipped small salmon returned to the Northwest Miramichi in 1998.

CONCLUSIONS AND MANAGEMENT CONSIDERATIONS

Was conservation met in 1998?

The point estimates of the egg depositions were below the conservation requirements for the Southwest Miramichi and the Miramichi River system total for the second consecutive year. The egg depositions in the Northwest Miramichi were insufficient to meet conservation for the first time since monitoring began in 1992. There is a higher exploitation rate on the early run small and large salmon but the overall exploitation rate on large salmon in 1998 remained low in the Southwest Miramichi (about 3%) and in the Miramichi River overall (6%) but was higher than recent years in the Northwest Miramichi (about 16%). Small salmon are more heavily exploited; the 1997 levels were 53% of the total returns in the Northwest, 54% from the Southwest Miramichi and 55% from the Miramichi River.

Were returns to the Miramichi in 1998 before any removals sufficient to meet the conservation requirments?

In the absence of any removals from fisheries, the egg depositions in 1998 would not have been sufficient to meet the conservation requirements. In the Miramichi River overall, returns of small and large salmon would have contributed 68% of the requirement whereas in the Northwest Miramichi, only 57% of requirement would have been met. Returns of small and large salmon to the Southwest Miramichi equated to 70% of the egg requirement.

What caused the low returns of large salmon in 1998?

The low returns of large salmon in 1998 were not unexpected considering the record low returns of small salmon in 1997. Small salmon returns of 1997 were down 70% from the previous five-year average (1992 to 1996) and in 1998, 2SW salmon returns were down 80% from the previous five-year average return (1993 to 1997). The large salmon, comprised of maiden 2SW salmon and previous spawners was down 66% from the previous five-year average. The 1996 smolt run was impacted by unexpected mortality factors in the ocean.

Will the returns of large salmon in 1999 exceed the conservation requirements for the Miramichi River?

The most probable return of large salmon in 1999 based on the small salmon to large salmon retrun model is over 24,000 fish. The usefulness of this model for 1999 is again suspect. There is large uncertainty in the predicted return with the 95% confidence interval ranging between 9,000 and 42,000 large salmon. Also, in recent years the relationship has greatly overpredicted the actual returns. The trend in returns of large salmon and small salmon in recent years, the modest upturn in small salmon returns in 1998 to levels still more than 50% below the recent and historical returns suggest that returns of large salmon in 1999 will be less than conservation requirements. The more pessimistic forecasts of large salmon are in the order of less than 5,000 fish while the most optimistic forecast predicts as many as 20,000 fish.

What are the options for inseason assessments of the risk of not meeting conservation requirements?

The approach to an inseason assessment for the Miramichi is based on counts at the DNRE barrier fences. The approach is qualitative, focusing on whether the counts of fish at the barriers can provide an indication of the kind of year (good, fair, poor) it will be relative to what we observed in the past. The assumptions of this approach are:

- barrier fence counts are indicators of escapement rather than returns,
- run-timing over that time period is variable but generally predictable,
- target escapement of 20000 salmon to the Miramichi. This level of escapement should provide the conservation egg requirement for the river and in recent years based on the level of exploitation on salmon represents about 22000 salmon returns to the river.
- target escapement of grilse of 30000 fish. An escapement of 30000 grilse represents a return of about 45000 to 50000 grilse to the Miramichi. Much higher numbers of grilse have been observed previously although this is the level observed between 1994 and 1996.

Generally, counts at the end of the year relate closely to the estimated escapement of salmon to the Miramichi River, especially for the Juniper and Dungarvon barriers (Fig. 22 and 23). High end of year counts at the barriers generally correspond to high escapements whereas low end of year counts correspond more frequently with low escapement years. The Northwest Barrier counts are not as closely associated but the time series is shorter and excludes the low escapements of 1981 to 1985 which have not been observed since 1985 (Fig. 24). The same if not stronger association is noted for the small salmon counts and total small salmon escapement (Fig. 22 to 24).

The vertical lines in figures 22 to 24 represent a visual evaluation of possible criteria counts which provide the highest probability of predicting end-of-year escapements over the target level. For example, by July 31, if counts of large salmon at Dungarvon and Juniper were greater than 100 fish, there was a very good chance that escapements of salmon would be better than 20000 fish (Fig. 22 and 23). If there were less than 100 salmon at these barriers, it was uncertain based on Juniper but fairly certain based on Dungarvon that escapements would be less than 20000 salmon.

The counts of small salmon and large salmon at the Southwest Miramichi (Millerton) trapnet are summarized in Figure 25.

In terms of 1998, all three barriers were indicating a good escapement year for small salmon and large salmon by July 31. Run timing of early-run small salmon at the Millerton trapnet in the

Southwest Miramichi in 1998 was similar to 1997, 1994 and 1995 with 25% of the small salmon early-run catch accounted for by July 8 to 13. Large salmon catches in the summer were more variable with 1996 being the earliest (25% of the total summer catch occurred by July 6) and with 1998 catches being generally earlier than all other years (25% by July 11, 50% by July 25 in 1998 compared to between July 13 and 23 for 25% and July 21 to Aug. 11 in other years). Fall-run timing of both small and large salmon was more consistent with the cumulative count slopes in 1998 similar to other years (Fig. 10). But the low abundance of fall-run salmon in 1998 resulted in early-run barrier counts being inconsistent with the end of year escapement of large salmon in 1998.

Counts to date should be looked at in the context of the discharge and temperature conditions in the river. For example, some user groups on the Miramichi suggested that sufficient water levels are required for fish to ascend into the Juniper barrier, high water conditions and especially cool temperatures may result in fish not moving into the barrier pools for refuge because they have sufficient holding waters below.

What is the contribution of hatchery origin salmon to the Miramichi?

Adipose-clipped fish return mostly as small salmon. The contribution to large salmon returns was less than 0.3% in 1997 and no adipose-clipped large salmon were observed in 1998 (Table 21). Adipose-clipped salmon made up 10% of the small salmon in the early-run catch at the Cassilis trapnet in the Northwest Miramichi in 1998 (Table 21). This is the highest proportion measured at the estuary trapnets in 1998 and in previous years. Based on the estimated efficiency of the Cassilis trapnet (10.4%), just under 600 adipose-clipped small salmon returned to the Northwest Miramichi in 1998.

What are the risks to meeting conservation egg depositions in 1999 if fisheries occur?

The risk to conservation was analysed by predicting the returns of large salmon in 1999 from the small:large salmon ratio of 1994 to 1998 and assuming that small salmon returns in 1999 would be similar to the previous five-year average (Fig. 19).

The risk to conservation from First Nations fisheries only, in the absence of other inriver fisheries were estimated under the following assumptions:

- for the Southwest Miramichi:
    - assume all harvests of small salmon in the Southwest Miramichi take place from the early run (as per recent harvests)
    - assume any harvest of large salmon in the Southwest Miramichi will also occur in the early run
- for the Northwest Miramichi:
    - assume harvests of small salmon in the Northwest Miramichi take place all early up to and including 2000 fish and partitioned among early:late as (2300:200, 2600:400, 3000:500, 3300:700, 3700:800, 4000:1000, 5000:1000) for subsequent harvest levels
    - assume large salmon harvests in the Northwest Miramichi take place all early up to 400 fish and partitioned early:late as (400:50, 400:100, 450:100, 450:150) for subsequent harvest levels

In the Southwest Miramichi, a harvest of 100 large salmon and 1000 small salmon would result in about the same loss of eggs from the returns as the harvest of 50 large salmon and 1500 small salmon (about 1.5%) (Fig. 26). Large salmon contribute substantially more eggs per fish than small salmon and a harvest of 200 large salmon results in the same loss of eggs as the harvest of about 2000 small salmon.

For the Northwest Miramichi, a harvest of 100 large salmon and 1000 small salmon would result in a potential loss of 6% of the eggs in the returns of small and large salmon and a probability of meeting conservation of 10%, down from 13% with no fisheries (Fig. 27). Harvests of 500 large salmon and 3000 small salmon, near maximum levels recorded between 1992 and 1998 from the Northwest Miramichi, could produce a loss of about 22% of the eggs in the total returns of small and large salmon and a probability of meeting conservation of 3% (Fig. 27).

The impact of angling fisheries on egg loss and the chance of meeting conservation was assessed by initially fixing the aboriginal fisheries harvests to occur before angling and at the recent years maximum level. For the Northwest Miramichi, the aboriginal harvests are 548 large salmon (358 early, 190 late) and 3030 small salmon (2447 early and 583 late) (Table 22). For the Southwest Miramichi, the aboriginal harvests are 1357 small salmon (1148 early and 209 late) and 0 large salmon (Table 22).

The angling scenario analysis considered three options for the start of the year (retention of small with catch-and-release of large salmon, catch-and-release of small and large salmon, closed all salmon angling fisheries) and three options at mid-season review (retention of small with catch-and-release of large salmon, catch-and-release of small and large salmon, closed all salmon angling fisheries). The proportions of the angling catch occurring in each season are summarized from the FISHSYS estimates for 1984 to 1996 (Moore et al. 1995; updated in Chaput et al. 1997) (Table 23). Angling exploitation rates are assumed to be 30%, to not vary with abundance and a catch-and-release mortality assumption dependent on the season (summer vs. fall) (Table 23).

The consequences of a retention fishery in the early season (June through August) are clearly evident (Table 24). For the Southwest Miramichi, starting with a retention fishery and adjusting to hook and release fishery or even closure for the fall season results in little saving of eggs lost in the fishery. In contrast, starting with a hook and release fishery and adjusting to either a retention fishery, hook and release fishery or closure for the fall results in a 2% egg loss at most (median value) but the probability of meeting conservation rises to more than 50%. Attention should also be given to the upper confidence interval for the estimate of egg loss. In the early season retention fishery, losses can be as much as 9% to 12% but the upper loss estimates under the early season hook and release fishery are much less (1% to 4%).

The probability of meeting conservation appears relatively insensitive to the angling management scenarios. This represents the uncertainty in the expected returns in 1999 and under high levels of uncertainty, a risk averse approach would be advised. Egg losses, especially the upper limits of the estimates, should be kept as low as possible.

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Table 1. Food fishery agreements for First Nations on the Miramichi River, 1992 to 1998.

Year	Season	Tributary	Small	Large	Gear
Eel Ground First Nation					
1992	May 1-Dec 31	Northwest	1400	100	trapnet and up to 18 gillnets
1993	May 1-Dec 31	Northwest	1400	100	trapnet and up to 18 gillnets
1994	May 1-Aug 31	Southwest	1000	0	1 trapnet
	May 1-Aug 31	Northwest	1400	0	2 trapnets, up to 14 gillnets, and recreational
	May 1 to Dec 31	Northwest	0	100	up to 14 gillnets
1995	May 1- Aug 31	Southwest	1420	0	1 trapnet and recreational
	Sept 1- Oct 31	Southwest	800	0	1 trapnet and recreational
	May 1- Aug 31	Northwest	1980	100	2 trapnets, up to 10 gillnets, and recreational
	Sept 1- Oct 31	Northwest	800	0	2 trapnets, up to 10 gillnets, and recreational
1996	May 1- Aug 31	Southwest	1320	0	2 trapnets and recreational
	Sept 1- Oct 31	Southwest	780	0	2 trapnets and recreational
	May 1- Aug 31	Northwest	1880	195	2 trapnets, up to 12 gillnets, and recreational
	Sept 1- Oct 31	Northwest	780	0	2 trapnets, up to 12 gillnets, and recreational
	April 15- July 31	Northwest	200	5	counting fence
	Aug 1- Oct 31	Northwest	40	0	counting fence
1997	May 1- Aug 31	Southwest	1320	0	2 trapnets and recreational
	July 22 - Aug 31	Southwest			1 gillnet
	Sept 1- Oct 31	Southwest	780	0	2 trapnets and recreational
	May 1- Aug 31	Northwest	1880	195	2 trapnets, up to 11 gillnets, and recreational
	Sept 1- Oct 31	Northwest	780		2 trapnets, up to 11 gillnets, and recreational
	April 15- July 31	Northwest	200	5	counting fence
	Aug 1- Oct 31	Northwest	40		counting fence
1998	May 1- Aug 31	Southwest	1320	0	2 trapnets, 1 gillnet, and recreational
	Sept 1- Oct 31	Southwest	780	0	2 trapnets and recreational
	May 1 - Oct 31	Both SW and NW		190	gillnets and native recreational fishing
	May 1- Aug 31	Northwest	1880	0	2 trapnets, up to 11 gillnets, and recreational
	Sept 1- Oct 31	Northwest	780	0	2 trapnets, up to 11 gillnets, and recreational
	April 15- July 31	Northwest	200	5	counting fence
	Aug 1- Oct 31	Northwest	40	0	counting fence
Red Bank First Nation					
1992	May 1 - Dec 30	NW and LSW	5000	10	2 trapnets and recreational
1993	May 1 - Dec 31	NW and LSW	5000	10	2 trapnets and recreational
1994	June 1- Aug 31	Little Southwest	1000	5	1 trapnet and recreational
	Sept 1- Oct 31	Little Southwest	1000	5	1 trapnet and recreational
	June 1- Aug 31	Northwest	1000	5	1 trapnet and recreational
	Sept 1- Oct 31	Northwest	1000	5	1 trapnet and recreational
1995	June 1- Aug 31	Little Southwest	1320	60	1 trapnet and recreational
	Sept 1- Oct 31	Little Southwest	680	10	1 trapnet and recreational
	June 1- Aug 31	Northwest	1320	60	1 trapnet and recreational
	Sept 1- Oct 31	Northwest	680	10	1 trapnet and recreational
1996	June 1- Aug 31	Little Southwest	1320	71	1 trapnet and recreational
	Sept 1- Oct 31	Little Southwest	680	141	1 trapnet and recreational
	June 1- Aug 31	Northwest	1320	70	1 trapnet and recreational
	Sept 1- Oct 31	Northwest	680	141	1 trapnet and recreational
1997	June 1- Aug 31	Little Southwest	1320	100	1 trapnet, 2 gillnets, and recreational
	Sept 1- Oct 31	Little Southwest	680	100	1 trapnet, 2 gillnets, and recreational
	June 1- Aug 31	Northwest	1320	150	1 trapnet, 4 gillnets, and recreational
	Sept 1- Oct 31	Northwest	680	150	1 trapnet, 4 gillnets, and recreational
1998	June 1- Aug 31	Little Southwest	1320	100	1 trapnet, 2 gillnets (June 8 -June 17 only), and recreational
	Sept 1- Oct 31	Little Southwest	680	100	1 trapnet, 2 gillnets, and recreational
	June 1- Aug 31	Northwest	1320	150	1 trapnet, 2 gillnets (June 8 -June 17 only), and recreational
	Sept 1- Oct 31	Northwest	680	150	1 trapnet, 2 gillnets, and recreational
Burnt Church First Nation					
1992	May 1- Dec 31	Miramichi Bay	2000	25	up to 25 gillnets plus angling
1993	May 1- Dec 31	Miramichi Bay	2000	25	up to 25 gillnets plus angling
1994	May 1- Dec 31	Miramichi Bay	2000	25	up to 25 gillnets plus angling
1995	May 1- July 31	Miramichi Bay	1300	80	up to 25 gillnets plus angling
	Aug 1- Oct 15	Miramichi Bay	700	120	up to 25 gillnets plus angling
1996	May 1- July 31	Miramichi Bay	1300	80	up to 25 gillnets plus angling
	Aug 1- Oct 15	Miramichi Bay	700	120	up to 25 gillnets plus angling
1997	May 1- July 31	Miramichi Bay	1300	80	up to 25 gillnets plus angling
	Aug 1- Oct 15	Miramichi Bay	700	120	up to 25 gillnets plus angling
1998	May 14- July 31	Miramichi Bay	1300	80	up to 25 gillnets plus angling
	Aug 1- Oct 15	Miramichi Bay	700	120	up to 25 gillnets plus angling

Table 2. Bright salmon angling seasons for 1998

General Season: April 15 - October 31

Exceptions to General Season:

Opens April 15; Closes August 31
- NW Miramichi River upstream from Little River
- Rocky Brook, tributary of SW Miramichi River

Opens April 15; Closes September 15
- All tributaries of SW Miramichi River upstream of the Cains River except Rocky Brook
- Big Sevogle River upstream from Square Forks
- Dungarvon River upstream of the Furlong Bridge
- LSW Miramichi River upstream of Catamaran Brook
- North and South Branches of the SW Miramichi River
- North and South Branches of the Renous River

Opens April 15; Closes September 30:
- SW Miramichi River upstream of the mouth of Burnt Land Bk. to the forks of the North and South Branches at Juniper

Opens April 15; Closes October 15:
- Big Sevogle River, downstream from Square Forks
- Bartholomew River
- Cains River
- Dungarvon River, downstream from the Furlong Bridge
- LSW Miramichi River downstream from Catamaran Bk.
- NW Miramichi River, downstream from Little River
- Renous River, downstream from the confluence of the North and South Branches.
- Southwest Miramichi River downstream from Burnt Land Bk.
- Southwest Miramichi River tributaries downstream of the Cains River which are not mentioned above

Hook and Release Only Angling (salmon angling licence)

Opens October 1; Closes October 15:
- Southwest Miramichi River upstream from Burntland Bk to the forks of the North and South Branches at Juniper

Opens September 16; Closes October 15:
- Little Southwest Miramichi River upstream from Catamaran Bk to and including Cleland's Pool

Opens September 1; Closes September 15:
- Northwest Miramichi River upstream from Little River to a point 200m upstream of the forks of the North and South Branches of the Northwest Miramichi River

Hook and Release Only Angling (with a Hook and Release Licence)

Opens July 1; Closes September 15:
- North Pole Stream from its mouth upstream to Lizard Bk
- Little Southwest Miramichi River , from and including Big Rock Pool upstream to include the east and west branches, not including tributaries or lakes

Opens June 1; Closes September 15:
- Lower North Branch of the LSW Miramichi River, from and including Rocky Rapids Pool upstream to its source including all tributaries
- Cains River, from the river ford located approximately 3/4 km upstream from Hopewell Lodge to and including Lower Otter Brook Pool exclusive of all tributaries

Table 3. Harvest and effort (net days) for aboriginal food fisheries on the Miramichi River in 1998 by early and late runs. Harvests are reported by band councils.

	Burnt Church		Eel Ground							Red Bank				
	Gillnets		Gillnets			SW Trapnets	NW Trapnets	Big Hole counting fence		Gillnets			Trapnets	
	Small	Large	Effort	Small	Large	Small	Small	Small	Large	Effort	Small	Large	Small	Large
Early run														
May 24- May 30	n.a.	n.a.	n.a.	0	0	0	0	0	0	0	0	0	0	0
May 31 - 6	n.a.	n.a.	n.a.	0	0	0	0	0	0	0	0	0	0	0
June 7 - 13	n.a.	n.a.	n.a.	0	0	3	0	0	0	n.a.	8	7	1	0
June 14 - 20	n.a.	n.a.	n.a.	30	37	8	12	6	0	n.a.	10	6	9	4
June 21- 27	n.a.	n.a.	n.a.	8	51	9	2	39	2	0	0	0	5	0
June 28 - July 4	n.a.	n.a.	n.a.	14	0	33	6	80	3	0	0	0	32	2
July 5 - 11	n.a.	n.a.	n.a.	62	18	86	14	40	0	0	0	0	16	5
July 12 - 18	n.a.	n.a.	n.a.	17	9	56	0	0	0	0	0	0	11	5
July 19 - 25	n.a.	n.a.	n.a.	0	0	47	0	9	0	0	0	0	13	5
July 26 - Aug 1	n.a.	n.a.	n.a.	11	20	51	3	11	0	0	0	0	13	2
Aug. 2 - 8	n.a.	n.a.	n.a.	3	3	0	3	0	0	0	0	0	22	6
Aug. 9 - 15	n.a.	n.a.	n.a.	0	0	7	3	1	0	0	0	0	16	5
Aug. 16 - 22	n.a.	n.a.	n.a.	0	0	25	0	1	0	0	0	0	9	1
Aug. 23 - 31	n.a.	n.a.	n.a.	0	0	24	0	0	0	0	0	0	3	0
Subtotal	20	19	n.a.	274	106	349	43	187	5	n.a.	18	13	150	35
Late run														
Sept. 1 - 5	n.a.	n.a.	0	0	0	19	0	1	0	0	0	0	15	2
Sept. 6 - 12	n.a.	n.a.	0	0	0	4	0	0	0	0	0	0	23	10
Sept. 13 - 19	n.a.	n.a.	0	0	0	5	0	0	0	0	0	0	21	5
Sept. 20 - 26	n.a.	n.a.	0	0	0	0	0	0	1	0	0	0	32	13
Sept. 27 - Oct 3	n.a.	n.a.	0	0	0	0	0	0	0	0	0	0	18	6
Oct 4 - 10	n.a.	n.a.	0	0	0	1	0	-	-	0	0	0	0	0
Oct. 11 - 17	n.a.	n.a.	0	0	0	0	0	-	-	0	0	0	0	0
Oct. 18 - 24	n.a.	n.a.	0	0	0	0	0	-	-	0	0	0	0	0
Subtotal	0	0	0	0	0	29	0	1	0	0	0	0	109	36
Total season	20	19	n.a.	274	106	378	43	188	5	40	18	13	259	71
% Early run	100%	100%		100%	100%	92%	100%	100%	100%	100%	100%	100%	58%	49%

Table 4. Removals of salmon in aboriginal and recreational fisheries of the Miramichi River, 1992 to 1998.

Fisheries Removals of Atlantic Salmon in the Miramichi River

Northwest Miramichi		1992	1993	1994	1995	1996	1997	1998	Mean 1993-1995, 1997
Small salmon	Aboriginal	1616	477	2921	1795	1504	871	782	1536
	Angling	7985	5569	4131	5636	5636	3153	?	5295
Large salmon	Aboriginal	580	54	81	172	317	548	195	287
	Angling	78	61	56	60	60	46	?	60
Total losses	Small	9601	6046	7052	7431	7140	4024		6831
	Large	658	115	137	232	377	594		347
% aboriginal	Small	17%	8%	41%	24%	21%	22%		22%
	Large	88%	47%	59%	74%	84%	92%		72%

Southwest Miramichi		1992	1993	1994	1995	1996	1997	1998	Mean 1993-1995, 1997
Small salmon	Aboriginal	0	0	0	1170	1074	326	378	299
	Angling	17608	9702	7072	11258	11258	5158	?	10160
Large salmon	Aboriginal	0	0	0	0	0	0	0	0
	Angling	245	151	98	189	189	106	?	158
Total losses	Small	17608	9702	7072	12428	12332	5484		10459
	Large	245	151	98	189	189	106		158
% aboriginal	Small	0%	0%	0%	9%	9%	6%		3%
	Large	0%	0%	0%	0%	0%	0%		0%

Miramichi River		1992	1993	1994	1995	1996	1997	1998	Mean 1993-1995, 1997
Small salmon	Aboriginal	1652	601	2977	3004	2583	1197	1180	1886
	Angling	25593	15271	11203	16893	16894	8311	?	15454
Large salmon	Aboriginal	608	208	124	185	372	548	214	335
	Angling	323	212	154	249	249	152	?	218
Total losses	Small	27245	15872	14180	19897	19477	9508		15787
	Large	931	420	278	434	621	700		553
% aboriginal	Small	6%	4%	21%	15%	13%	13%		13%
	Large	65%	50%	45%	43%	60%	78%		55%

Table 5. Recreational Atlantic salmon fishery statistics from the Miramichi River, 1998. % change represents 1998 minus mean divided by mean. Detailed catches are in Moore et al. (MS1995) of which 1995 data have been finalized. FISHSYS data for 1997 have been finalized (Hooper and Dryden 1998). Fishsys data for 1998 are not yet available. Fishsys data for 1996 were not collected.

		Miramichi River		**Northwest**		**Southwest**	
Black salmon fishery							
Effort (rod days)	1998						
	1997	9080		1751		7329	
	1991-1995 mean	8563		1461		7101	
	% change						
		Harvest	*Released*	*Harvest*	*Released*	*Harvest*	*Released*
Small salmon	1998						
	1997	1723	3300	437	876	1286	2424
	1991-1995 mean	1666	3098	270	580	1396	2517
	% change						
Large salmon	1998						
	1997		3365		1363		2002
	1991-1995 mean		3175		541		2634
	% change						
Bright salmon fishery							
Effort (rod days)	1998						
	1997	102851		33563		69288	
	1991-1995 mean	100973		32667		68306	
	% change						
		Harvest	*Released*	*Harvest*	*Released*	*Harvest*	*Released*
Small salmon	1998						
	1997	8311	3181	3153	899	5158	2282
	1991-1995 mean	13284	4666	4405	1525	8879	3141
	% change						
Large salmon	1998						
	1997		5078		1432		3646
	1991-1995 mean		6404		1602		4802
	% change						

Northwest Miramichi crown reserve angling

			Individual stretches		
		Total	Little Southwest	Sevogle	Northwest
Effort (rod days)	1998	2488	493	722	1273
	1997	2494	523	728	1243
	1991-1995 mean	2407	524	773	1109
	% change	3%	-6%	-7%	15%
Small salmon (catch)	1998	1044	179	196	669
	1997	868	95	191	582
	1991-1995 mean	1256	165	332	760
	% change	-31%	-42%	-42%	-23%
Large salmon (released)	1998	125	20	40	65
	1997	115	16	43	56
	1991-1995 mean	116	30	34	53
	% change	-1%	-47%	26%	6%

Table 6. Summary of broodstock collections in 1998.

Stock Collected	Date Collected	Female Large	Female Small	Male Large	Male Small	Collection Site
Northwest Miramichi						
Little Southwest	Aug. 29	1	0	0	0	Moose Landing
Northwest	Sept. 17	2	0	2	0	Barrier Pool
Sevogle	Sept. 18	1	0	0	0	Square Forks - Angled
	Sept. 19	1	0	0	0	Square Forks - Angled
	Sept. 27	0	0	1	0	Square Forks - Angled
	Oct. 13	0	2	0	0	Trash Heap Pool
Subtotal		**5**	**2**	**3**	**0**	
Southwest Miramichi						
SW Miramichi	Oct. 15	2	0	0	0	SW Juniper Barrier
	Oct. 16	2	1	0	1	SW Juniper Barrier
	Sept. 25	4	0	1	0	Black Brook - Angled
	Sept. 28	1	0	1	0	Black Brook - Angled
	Oct. 1	0	0	1	0	Black Brook - Angled
	Oct. 11	0	0	0	5	Black Brook - Angled
	Oct. 14	2	0	1	1	Black Brook - Angled
Clearwater	Sept. 28	1	0	1	2	Irving Trap Net
	Sept. 30	2	0	2	0	Irving Trap Net
	Oct. 5	1	0	2	0	Irving Trap Net
	Oct. 6	2	0	0	1	Irving Trap Net
	Oct. 7	1	0	0	1	Irving Trap Net
	Oct. 9	6	0	0	1	Irving Trap Net
Rocky Brook	Sept. 22	5	0	1	3	Cold Spring
Cains	Oct. 1	1	0	0	0	Island pool - Angled
	Oct. 5	0	0	0	1	Island pool - Angled
	Oct. 10	0	0	0	1	Island pool - Angled
	Oct. 11	1	0	0	0	Island pool - Angled
Dungarvon	Sept. 29	1	0	1	1	Furlong Bridge
Subtotal		**32**	**1**	**11**	**18**	
Total		**37**	**3**	**14**	**18**	

Table 7. Summary of trapnet operation dates, catch, and tags applied in the Miramichi River, 1998. Catch represents all fish sampled, including recaptures.

		Catch		Tagged	
Trapnets	Time Period	Small	Large	Small	Large
NW Miramichi					
Eel Ground Lower	June 18 to Oct. 12	239	70	165	57
Red Bank NW	June 10 to Oct. 2	190	45	0	0
Red Bank LSW	June 16 to Oct. 14	82	27	0	0
Cassilis	June 15 to Nov. 12	842	229	743	205
SW Miramichi					
Eel Ground Lower	May 31 to Sept. 18	338	92	147	79
Eel Ground Upper	June 2 to Oct. 9	605	255	360	216
Millerton	May 27 to Oct. 23	1280	384	1147	344

Table 8. Mark and recapture matrices used in the estimation of returns of small salmon and large salmon combined to the Miramichi River and each branch in 1998.

Small and Large Salmon

Stratified by branch and season

		To			
From	Tagged	NWEarly	NWLate	SWEarly	SWLate
NWEarly	757	9	6	2	3
NWLate	423	0	12	0	10
SWEarly	336	2	2	7	4
SWLate	481	0	0	0	34
Unmarked		181	127	701	819
Total Catch		192	147	710	870

Stratified by branch

		To	
From	Tagged	NW	SW
NW	1180	27	15
SW	817	4	45
Unmarked		308	1520
Total Catch		339	1580

Table 9. Estimates returns to the estuary of small salmon and large salmon to each branch and overall to the Miramichi River in 1998. Median is the median value of the 1000 resamplings. 5th and 95th are the 90% confidence limits.

River	Size		Total Returns	Eggs per m²	Probability of meeting/exceeding conservation
Northwest	**Small**	**Median**	**7,900**	**0.5**	
		5th	*6,200*	*0.3*	
		95th	*10,700*	*0.7*	
	Large	**Median**	**2,200**	**0.9**	
		5th	*2,100*	*0.6*	
		95th	*3,100*	*1.3*	
	Small & Large	**Median**		**1.4**	**<0.001**
		5th		*1.0*	
		95th		*1.9*	
Southwest	**Small**	**Median**	**24,000**	**0.4**	
		5th	*19,000*	*0.2*	
		95th	*32,000*	*0.6*	
	Large	**Median**	**7,000**	**1.2**	
		5th	*6,000*	*0.8*	
		95th	*9,500*	*1.8*	
	Small & Large	**Median**		**1.7**	**0.02**
		5th		*1.2*	
		95th		*2.3*	
Miramichi	**Small**	**Median**	**33,000**	**0.4**	
		5th	*27,500*	*0.3*	
		95th	*41,000*	*0.6*	
	Large	**Median**	**9,500**	**1.2**	
		5th	*7,500*	*0.8*	
		95th	*12,500*	*1.6*	
	Small & Large	**Median**		**1.7**	**<0.01**
		5th		*1.3*	
		95th		*2.1*	

Table 10. Removals of Atlantic salmon by size and season from the Northwest Miramichi, Southwest Miramichi and total Miramichi River system in 1998. No angling removal estimates are available to date.

	Northwest Miramichi			Southwest Miramichi			Miramichi River		
	Early	Late	Total	Early	Late	Total	Early	Late	Total
Small salmon									
Food fisheries[1]	672	110	782	349	29	378	1042	139	1181
Angling	?	?	?	?	?	?	?	?	?
Seizures	0	0	0	0	0	0	0	0	0
Broodstock	2	0	2	17	2	19	19	2	21
Incidental mortalities	8	1	9	8	0	8	16	1	17
Furunculosis[2]	1	0	1	1	0	1	2	0	2
Total	**683**	**111**	**794**	**375**	**31**	**406**	**1079**	**142**	**1221**

	Northwest Miramichi			Southwest Miramichi			Miramichi River		
	Early	Late	Total	Early	Late	Total	Early	Late	Total
Large salmon									
Food fisheries	159	36	195	0	0	0	178	36	214
Angling	?	?	?	?	?	?	?	?	?
Seizures	0	0	0	0	0	0	0	0	0
Broodstock	8	0	8	41	2	43	49	2	51
Incidental mortalities	8	2	10	10	0	10	18	2	20
Furunculosis[1]	4	0	4	6	0	6	10	0	10
Total	**179**	**38**	**217**	**57**	**2**	**59**	**255**	**40**	**295**

Notes:
[1]Early native catch of small salmon includes 1 fish retained from angling in the Miramichi reported by the NB Aboriginal Peoples Council
[2]Furunculosis mortalities include fish sent to the DFO Fish Health Unit and 3 mortalities observed by DFO at Red Bank (2) and Millerton (1) which were not sent for lab analysis.

Table 11. Estimated returns, removals (partial, exclusive of angling removals), and escapements (unaccounting for angling removals) of small salmon and large salmon to the Northwest Miramichi, Southwest Miramichi and Miramichi River in 1998.

		Harvest below recapture trapnets	Total returns	Total removals	Escapement
Northwest Miramichi					
Small	Median	335	7,900	797	7,103
	5th		6,200		5,403
	95th		10,700		9,903
Large	Median	119	2,200	229	1,971
	5th		2,100		1,871
	95th		3,100		2,871
Southwest Miramichi					
Small	Median	378	24,000	408	23,592
	5th		19,000		18,592
	95th		32,000		31,592
Large	Median	0	7,000	58	6,942
	5th		6,000		5,942
	95th		9,500		9,442
Miramichi River					
Small	Median	733	33,000	1225	31,775
	5th		27,500		26,275
	95th		41,000		39,775
Large	Median	138	9,500	295	9,205
	5th		7,500		7,205
	95th		12,500		12,205

Table 12. Biological characteristics (fork length, sex ratio, and fecundity[1]) of small salmon and large salmon for the Southwest and Northwest Miramichi and Miramichi River system for 1998.

		Small salmon		Large salmon	
		Estimate	Std. Dev.	Estimate	Std. Dev.
Northwest Miramichi					
% Female	early	32.6		89.1	
	late	14.7		69.8	
	total	26.9		79.6	
Fork length	early	54.5	2.87	80.7	8.85
(cm)	late	56.8	2.85	80.8	10.15
	total	55.2	3.05	80.8	9.49
Fecundity[1]	early	1093		6944	
	late	562		5449	
	total	939		6214	
% Previous	early			62.1	
spawners	late			48.0	
	total			52.8	
Southwest Miramichi					
% Female	early	20.7		82.6	
	late	11.1		74.9	
	total	15.8		78.2	
Fork length	early	54.9	2.73	82.3	9.69
(cm)	late	57.2	2.77	79.1	9.48
	total	56.1	3.00	80.5	9.69
Fecundity[1]	early	711		6618	
	late	434		5674	
	total	581		6073	
% Previous	early			59.1	
spawners	late			41.5	
	total			49.5	
Miramichi River					
% Female	early	26.7		85.2	
	late	12.1		73.1	
	total	20.2		78.7	
Fork length	early	54.7		81.7	
(cm)	late	57.1		79.7	
	total	55.8		80.6	
Fecundity[1]	early	906		6756	
	late	470		5597	
	total	730		6122	
% Previous	early			57.7	
spawners	late			42.9	
	total			49.9	

1 Fecundity (eggs per fish) calculated using fecundity-length relationship (Randall 1989) and sex ratios.
Fecundity (small salmon) = % female * exp(3.1718*Ln(fork length) - 4.5636)
Fecundity (large salmon) = % female * exp(1.4132*Ln(fork length) + 2.7560)

Table 13. Sex ratios (% female) of small and large salmon observed during broodstock. All determinations based on external characteristics.

	Small salmon			Large salmon		
	Female	Male	% female	Female	Male	% female
Southwest Miramichi						
Dungarvon - Furlong Bridge (Sept. 29, 1998)	0	3	0%	1	1	50%
Northwest Miramichi						
NW Miramichi Barrier Pool (Sept.13, 1998)	27	27	50%	7	2	78%

Table 14. Egg deposition (millions of eggs) by small salmon, large salmon and both size groups combined in the Northwest Miramichi, Southwest Miramichi and Miramichi River system in 1998. The % of conservation requirement refers to the egg depositions from the returns (before any removals).

	Small	Large	Total	Contribution by large	% of conservation requirement
Northwest Miramichi					
Total	7.9	14.6	23.5	65%	
90% Conf. Int.	5.4 to 12.1	9.7 to 21.7	18.5 to 31.9		
Conservation requirement			41.0	36%	57% 45% to 78%
Southwest Miramichi					
Total	14.7	44.0	62.0	75%	
90% Conf. Int.	9.9 to 22.4	29.7 to 66.1	44.0 to 80.7		
Conservation requirement			88.0	50%	70% 50% to 92%
Miramichi River					
Total	25.1	60.0	90.0	71%	
90% Conf. Int.	19.3 to 32.1	42.8 to 85.6	69.6 to 112.4		
Conservation requirement			132.0	45%	68% 53% to 85%

Table 15. Estimated returns and escapement to the Miramichi River (to Millbank 1971 to 1991; to Enclosure area 1992 to 1998) of small and large salmon. % change is 1998 minus mean relative to the mean.

	Small Salmon		Large Salmon	
Year	**Returns**	**Escapements**	**Returns**	**Escapements**
1971	35,673	21,946	24,407	4,347
1972	46,275	27,135	29,049	17,671
1973	44,545	30,668	27,192	20,349
1974	73,418	55,186	42,592	34,445
1975	64,902	48,469	28,817	21,448
1976	91,580	62,380	22,801	14,332
1977	27,743	13,247	51,842	32,917
1978	24,287	14,353	24,493	10,829
1979	50,965	30,848	9,054	4,541
1980	41,588	26,894	36,318	18,873
1981	65,273	39,929	16,182	4,608
1982	80,379	56,000	30,758	13,258
1983	25,184	14,849	27,924	8,458
1984	29,707	18,929	15,137	14,687
1985	60,800	41,815	20,738	20,122
1986	117,549	89,398	31,285	30,216
1987	84,816	62,777	19,421	18,056
1988	121,919	90,278	21,745	20,980
1989	75,231	48,385	17,211	15,540
1990	83,448	59,524	28,574	27,588
1991	60,869	48,269	29,949	29,089
1992	152,647	129,288	37,000	35,927
1993	95,000	76,416	35,000	34,702
1994	56,929	42,479	27,544	27,147
1995	54,145	33,347	32,627	32,093
1996	44,377	24,180	24,812	23,478
1997	22,565	12,980	18,381	17,555
1998	33,000		9,500	
Mean				
1993 to 1997	54,603	37,880	27,673	26,995
1984 to 1992	87,443	65,407	24,562	23,578
1971 to 1997	64,141	45,184	27,069	20,491
% change in 1998				
1993 to 1997	-58.7%		-33.6%	
1971 to 1997	-64.8%		-32.1%	

Table 16. Estimated returns of small and large salmon to the Southwest Miramichi and the Northwest Miramichi, 1992 to 1998.

	Small salmon		Large salmon	
	Median	5th to 95th Percentile	Median	5th to 95th Percentile
Southwest Miramichi				
1992	120,701	85,263 to 157,794	25,028	17,657 to 32,744
1993	42,600	22,700 to 73,800	21,900	10,800 to 58,900
1994	33,775	23,450 to 54,150	14,000	9,100 to 22,850
1995	31,675	10,410 to 45,342	17,097	5,661 to 24,150
1996	30,241	20,161 to 44,875	15,734	9,454 to 27,225
1997	13,486	10,441 to 18,677	10,999	8,461 to 14,584
1998	24,000	19,000 to 32,000	7,000	6,000 to 9,500
Northwest Miramichi				
1992	30,321	23,040 to 40,864	10,000	-
1993	46,200	27,700 to 97,500	10,541	3,700 to 37,500
1994	20,600	11,750 to 38,525	12,600	6,450 to 31,300
1995	22,379	7,100 to 32,595	15,227	7,752 to 31,450
1996	18,943	13,256 to 28,044	7,957	4,824 to 13,278
1997	9,788	6,490 to 17,344	7,024	4,434 to 13,145
1998	7,900	6,200 to 10,700	2,200	2,100 to 3,100

Table 17. Number of large salmon and small salmon counted at barriers in three tributaries of the Miramichi River, 1981 to 1998.

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
	1994	877	1223	2100	June 29-Oct. 30	124
	1995	1019	811	1830	June 15-Oct. 28	136
	1996	819	1388	2207	June 20-Oct. 27	130
	1997	519	566	1085	June 23-Oct. 29	131
	1998	698	981	1679	June 1- Oct. 25	147
1993-97	Mean	876	1067	1943		
Change (98-mean)/mean		-20%	-8%	-14%		
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
	1994	153	358	511	June 7-Oct. 20	136
	1995	95	329	424	May 31-Oct. 13	136
	1996	188	616	804	June 4-Oct. 24	143
	1997	115	391	506	June 10-Oct. 30	155
	1998	163	592	755	June 2-Oct. 29	162
1993-97	Mean	155	471	625		
Change (98-mean)/mean		5%	26%	21%		
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
	1994	228	673	901	June 5-Oct. 14	132
	1995	252	548	800	June 1-Oct. 12	134
	1996	218	602	820	June 3-Oct. 24	144
	1997	152	501	653	June 3-Oct. 29	149
	1998	289	1038	1327	June 2-Oct. 28	149
1993-97	Mean	213	672	885		
Change (98-mean)/mean		36%	55%	50%		

Table 18. Counts of small salmon and large salmon at the Clearwater Brook counting fence, 1997 and 1998. Data are courtesy of Fred Whoriskey, Atlantic Salmon Federation (Whoriskey et al. 1999).

	Salmon count				
Year	Small	Large	Total	Operating dates	No. of days
1996[1]	62	16	78		
1997	365	313	678	June 10 to Oct. 24	136
1998[2]	508	208	716	May 21 to Oct. 25	158

[1] Fence counts in 1996 are probably low due to fence location and operating dates
[2] High water levels on Aug. 12 and Oct. 2-3 may have permitted salmon to bypass the fence

Table 19. Counts of salmon of various life stages migrating upstream and downstream at Catamaran Brook, Little Southwest Miramichi River, 1990 to 1998. Data courtesy of P. Hardie (DFO Science, Moncton) and R. Cunjak (University of New Brunswick, Fredericton, N.B.). Survival of smolts to small and large adults are calculated assuming small salmon are 1SW adults and large salmon are 2SW adults.

	Downstream		**Upstream**					**Smolt Survival to**		
	Migrant		**By Size**		**By Age**			**1SW**	**2SW**	**Total**
Year	**Parr**	**Smolts**	**Small**	**Large**	**1SW**	**2SW**	**PS**	**Salmon**	**Salmon**	**Salmon**
1990	851[1]	760	82[1]	28[1]	83	15	12	10.3%	4.4%	14.6%
1991	1684	1165	78	49	78	26	23	11.1%	2.6%	13.7%
1992	1229	2135	127	65	129	33	30	5.0%	0.9%	5.9%
1993	1371	426	106	43	107	30	12	13.6%	10.3%	24.0.%
1994	1779	887	57	25	58	20	4	13.5%	2.7%	16.2%
1995	1620	935	118	72	120[2]	44[2]	26[2]	8.5%	1.9%	10.4%
1996	N/A.	472	78	39	79[2]	24[2]	14[2]	9.9%	3.6%	13.5%
1997	1732	723	46	29	47[2]	18[2]	10[2]	5.5%	N/A.	N/A.
1998		297	40	27	40[2]	17[2]	10[2]			
							median	**9.2%**	**2.7%**	**13.5%**

Notes: [1] Incomplete count because of damage to counting fence
[2] Numbers at age for 1995-1998 are estimated from average age composition of large and small salmon for 1990-94.

Table 20. Distribution of salmon juveniles in the Miramichi River in 1998. AC = adipose-clip, NM = unmarked.

River	Life stage	Mark	Number of fish stocked	Absolute difference from 1997 (%)
Northwest Miramichi	2+ smolts	AC	5,100	-15,968 (-76%)
	1+ parr	AC	0	-37,566
	0+ parr (June - July)	NM	0	-6,038
	0+ parr (Sept.-Oct.)	AC	11,370	-12,408 (-52%)
	Non-feeding fry	NM	30,505	-7995 (-20%)
Southwest Miramichi	2+ smolts	AC	40,000	+1496 (+4%)
	0+ parr (June - July)	NM	0	-8,951
	0+ parr (Sept.-Nov.)	AC	91,374	-143,393 (-61%)
	0+ parr (Oct.)	NM	0	-8,624
	Non-feeding fry	NM	80,714	+57,714 (+251%)
Miramichi (total)	2+ smolts	AC	45,100	-14,472 (-24%)
	1+ parr	AC	0	-37,566
	0+ parr (June - July)	NM	0	-14,989
	0+ parr (Sept.-Nov.)	AC	102,744	-155,801 (-60%)
	0+ parr (Oct.)	NM	0	-8,624
	Non-feeding fry	NM	111,219	+49,714 (+81%)

Table 21. Relative contribution of wild (non-adipose clipped) salmon to the returns in 1998.

	Small salmon			Large salmon		
	Wild	Adipose-clip	% wild	Wild	Adipose-clip	% wild
Southwest Miramichi (received 5,000 smolts in 1996, 38,500 smolts in 1997)						
Sampling at Millerton trapnet						
June to Aug.	529	20	96.4%	172	0	100.0%
Sept. to Oct.	725	6	99.2%	212	0	100.0%
Total	1254	26	98.0%	384	0	100.0%
Dungarvon River (received smolt stocking in 1996 and 1997)						
Seining at Furlong Bridge						
Sept. 29	3	0	100.0%	2	0	100.0%
Rocky Brook (received satellite-reared fall fingerlings annually since 1984)						
Seining at Cold Spring						
Sept. 22	0	0	0.0%	9	0	100.0%
Northwest Miramichi (received 41,500 in 1996, 21,000 smolts in 1997)						
Sampling at Eel Ground trapnet						
June to Aug.	139	8	94.6%	36	0	100.0%
Sept. to Oct.	72	1	98.6%	33	0	100.0%
Total	211	9	95.9%	69	0	100.0%
Sampling at Red Bank trapnets						
June to Aug.	145	12	92.4%	36	0	100.0%
Sept. to Oct.	112	3	97.4%	36	0	100.0%
Total	257	15	94.5%	72	0	100.0%
Sampling at Cassilis trapnet						
June to Aug.	494	54	90.1%	118	0	100.0%
Sept. to Oct.	291	2	99.3%	111	0	100.0%
Total	785	56	93.3%	229	0	100.0%

Table 22. Estimated egg loss as a percentage of the eggs in the total returns of small and large salmon to the Miramichi River in 1999 for some fisheries scenarios. The assumptions are that aboriginal harvests of small and large will equal the maximum annual harvests during 1992 to 1998 (3004 small salmon, 608 large salmon), angling exploitation rates are 30%, catch-and-release mortality from angling is 3% (integrated for the entire angling season), fecundity of small and large salmon is similar to the average of 1994 to 1998. The predicted large salmon return in 1999 is based on the range of $small_i$:$large_{i+1}$ ratios for 1994 to 1998 and an estimated small salmon return in 1998 of 33000 fish. Small salmon returns in 1999 are based on the previous five-year average return.

Fishery scenario	Egg loss (%)	Egg loss (%) (95% C.I.)	Prob. of conservation
1	0%	-	10.6%
2	13.0%	8.5 to 17.0%	0.8%
3	5.3%	3.9 to 7.3%	6.0%
4	9.4%	5.1 to 13.5%	2.0%
5	2.7%	2.2 to 3.4%	8.2%
6	0.9%	0.9 to 0.9%	9.7%

Fishery scenarios:
1. no salmon fisheries
2. aboriginal fisheries for small and large salmon, angling retention on small salmon, catch-and-release angling on large salmon
3. aboriginal fisheries only for small and large salmon
4. aboriginal fisheries on small salmon only, angling fisheries as in scenario 2
5. aboriginal fisheries on small only, catch-and-release angling on small and large salmon
6. no aboriginal harvests, catch-and-release angling on small and large salmon.

Table 23. Assumptions and input values to the fisheries scenario analysis of egg loss and probability of meeting conservation in 1999 for the Southwest and Northwest Miramichi rivers.

Fisheries Scenario Assumptions		**Southwest Miramichi**		**Northwest Miramichi**	
		Large salmon	Small salmon	Large salmon	Small salmon
Proportion of angling catch occurring early					
Based on FISHSYS results (1984 to 1994)		60.0%	64.0%	80.0%	86.0%
Assumed exploitation rates in angling fishery		30.0%	30.0%	30.0%	30.0%
Catch-and-release mortality assumptions					
By season	Early	5.0%	5.0%	5.0%	5.0%
	Late	1.0%	1.0%	1.0%	1.0%
Season weighted		3.4%	3.6%	4.2%	4.4%
Integrated value used in assessments		3.0%	3.0%	3.0%	3.0%
Fecundity of fish by season (average 1994 to 1998) (Fig. __)					
	Early	6355	713	6956	1093
	Late	5888	396	6337	562
First Nations Harvests (maximum harvests achieved 1994 to 1998)					
	Early	0	1148	358	2447
	Late	0	209	190	583
Small:Large Salmon Ratio (1994 to 1998)					
	Min.	1.93		1.35	
	Max.	3.04		4.66	
	Range	1.12		3.31	

Table 24. Probability of meeting conservation and the estimated egg loss as a percent of eggs in returns of small and large salmon in the aboriginal and angling fisheries of 1999. Large salmon forecasted returns are based on the observed $small_i$:$large_{i+1}$ ratios of the returns for 1994 to 1998 and the estimated 1998 return of small salmon to each branch. Assumptions and input values are in Table 22.

Southwest Miramichi		Angling After Midseason		
Begin Angling Season		Retention	Hook&Release	Closed
Retention	Median	8.2%	6.8%	6.7%
	95% C.I.	4.7 to 11.4	4.2 to 9.2	4.1 to 9.1
	PofC	0.4%	0.7%	0.7%
	+Risk	***+5.7%***	***+5.4%***	***+5.4%***
Hook&Release	Median	3.8%	2.3%	2.2%
	95% C.I.	2.9 to 4.6	2.1 to 2.6	2.0 to 2.5
	PofC	2.7%	4.5%	4.6%
	+Risk	***+3.4%***	***+1.6%***	***+1.5%***
Closed	Median	2.8%	1.3%	1.2%
	95% C.I.	2.0 to 3.6	1.1 to 1.6	1.0 - 1.5
	PofC	4.1%	6.0%	6.1%
	+Risk	***+2.0%***	***+0.1%***	-
All salmon fisheries closed	PofC		**7.2%**	

Northwest Miramichi		**Angling After Midseason**		
Begin Angling Season		Retention	Hook&Release	Closed
Retention	Median	38.5%	37.5%	37.4%
	95% C.I.	23.5 to 48.3	23.0 to 47.5	23.0 to 47.4
	PofC	<0.1%	<0.1%	<0.1%
	+Risk	***+3%***	***+3%***	***+3%***
Hook&Release	Median	25.3%	24.2%	24.1%
	95% C.I.	16.2 to 41.9	15.3 to 41.3	15.2 to 41.3
	PofC	2.1%	2.4%	2.5%
	+Risk	***+1%***	***+0.6%***	***+0.5%***
Closed	Median	24.0%	22.9%	22.8%
	95% C.I.	14.9 to 40.9	13.9 to 40.3	13.9 to 40.3
	PofC	2.7%	3.1%	3.1%
	+Risk	***+0.4%***	***+0.1%***	-
All salmon fisheries closed	PofC		**13.1%**	

Median and 95% C.I. represent expected egg loss from fixed aboriginal fishery and angling
PofC represents the probability of meeting conservation after aboriginal and angling fisheries
+Risk is the additional risk to meeting conservation by angling fishery losses

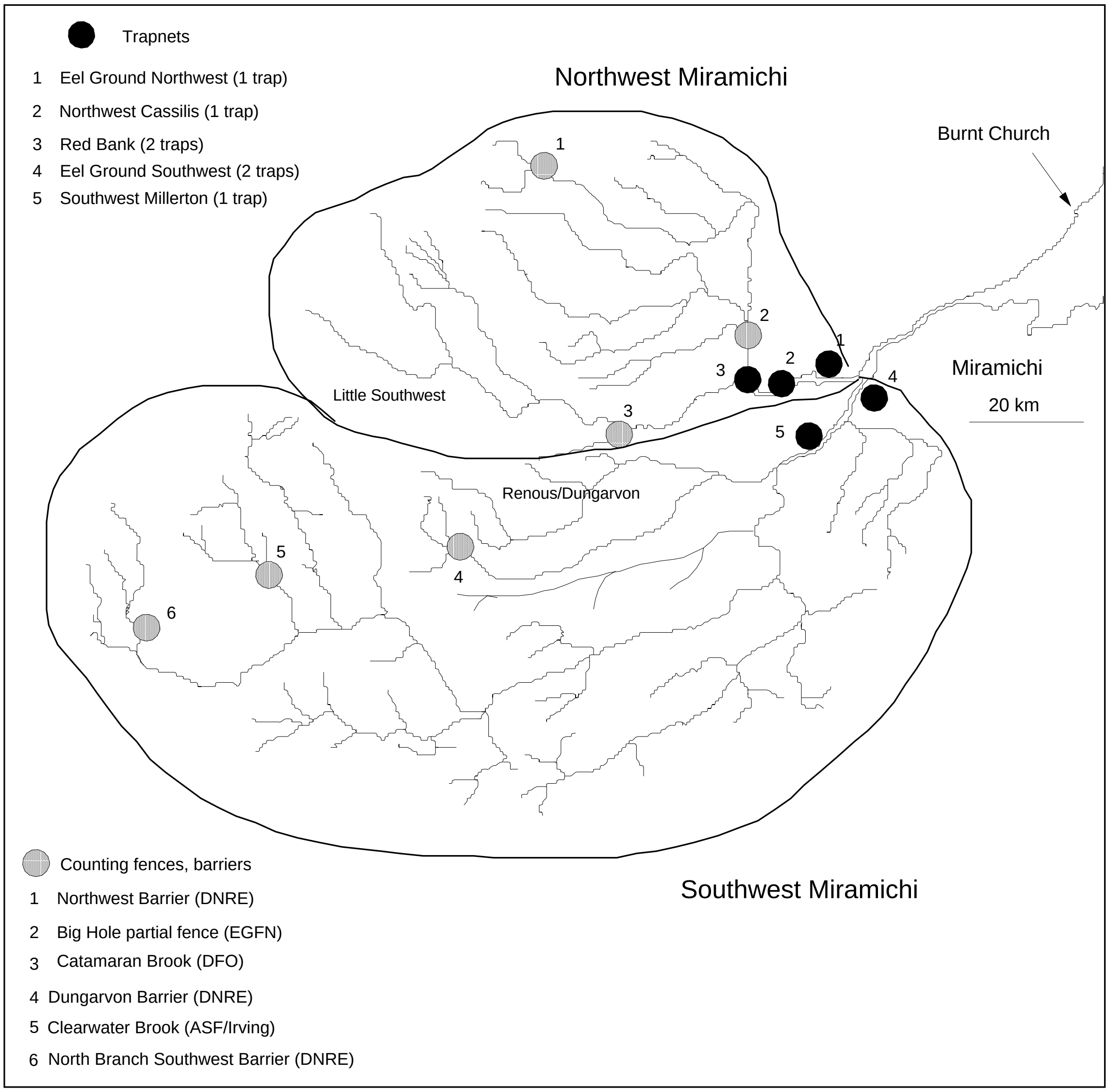


Figure 1. The Miramichi River indicating major branches, major tributaries and location of trapnets and counting fences operated in 1998.

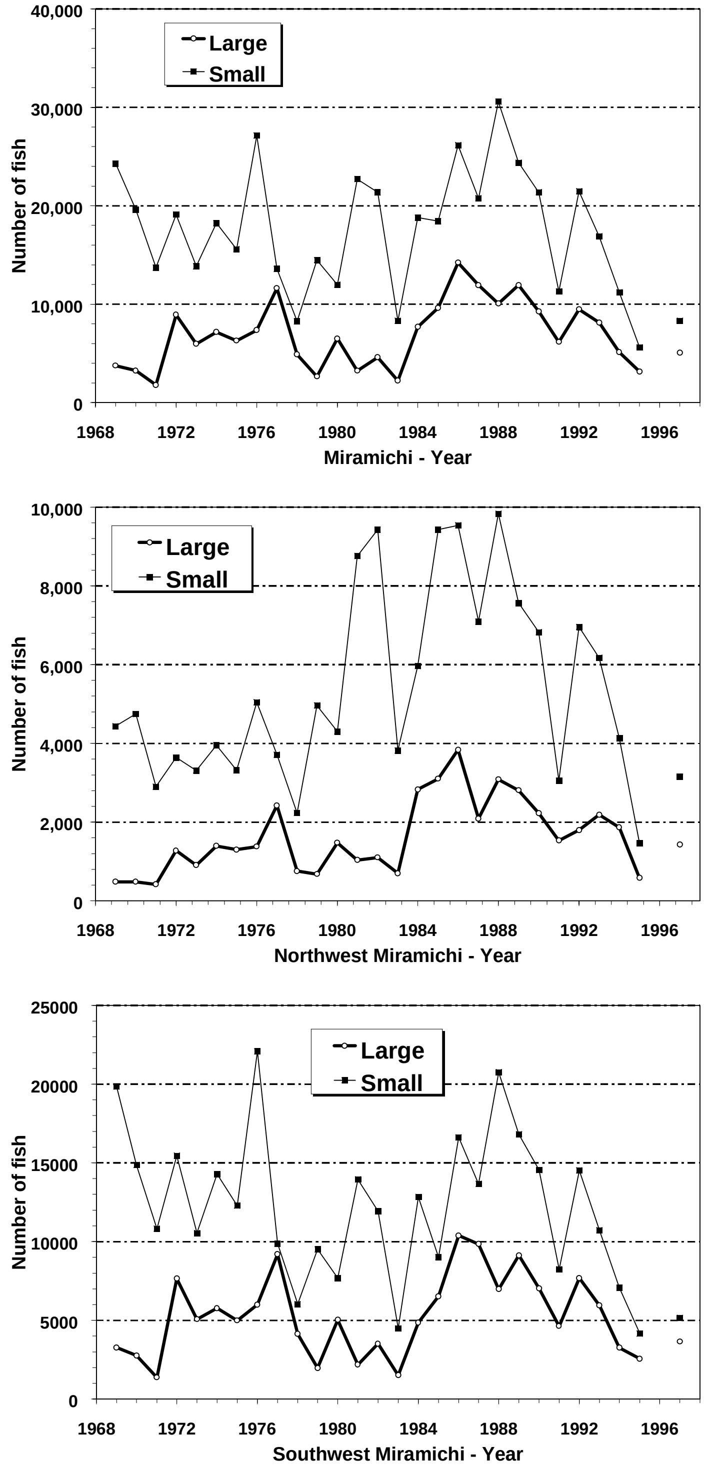


Figure 2. Angling trends of small (harvest) and large (catch) salmon from the Miramichi River (top), Northwest Miramichi (middle) and Southwest Miramichi (bottom) rivers. 1996 data are not available. 1997 data have been finalized. 1998 data are not yet available.

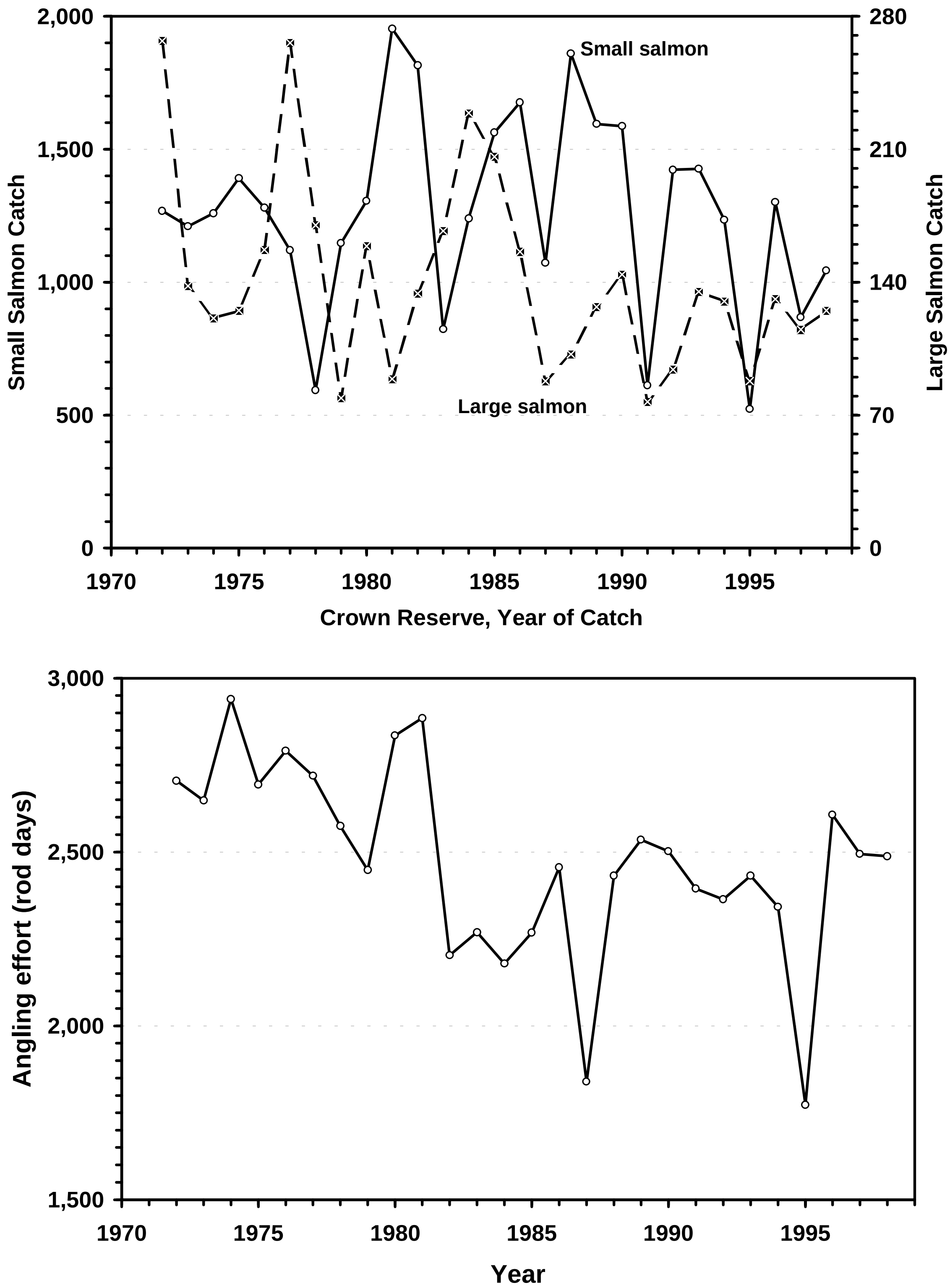


Figure 3. Trends in catches of small salmon and large salmon (upper panel) and angling effort (lower panel) from the Crown Reserve waters of the Northwest Miramichi, 1972 to 1998.

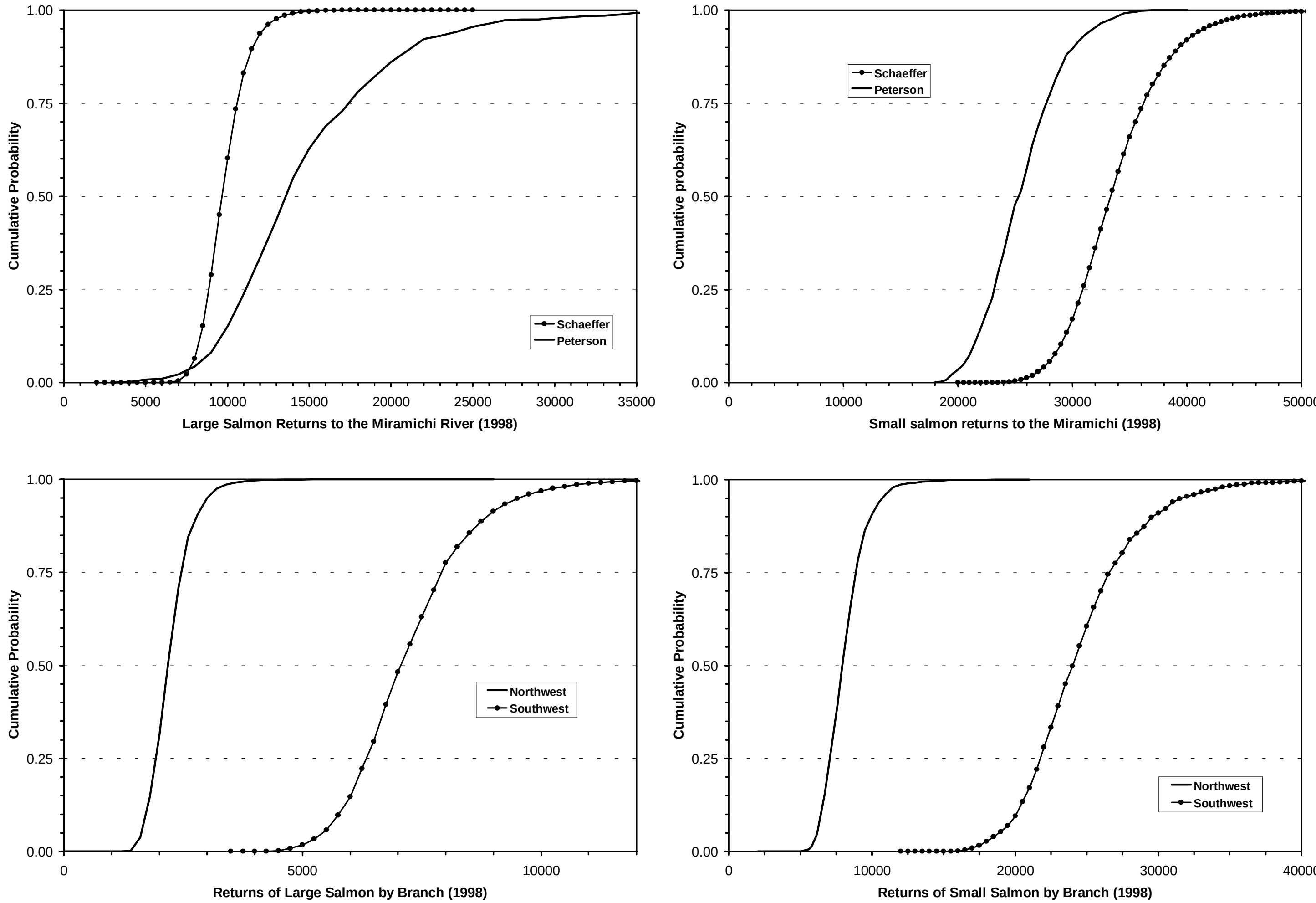


Figure 4. Estimated returns of large salmon (left panels) and small salmon (right panels) for the Miramichi (upper panels) and to the Northwest and Southwest branches in (lower panels) in 1998. In upper panel, estimated returns from Schaeffer are based on the branch and season stratified matrix of Table 8. Peterson estimates are based on size stratified tagging and recapture data for both branches combined. In the lower panels, separate branch estimates are from Schaeffer model using the branch and season stratified matrix of Table 8..

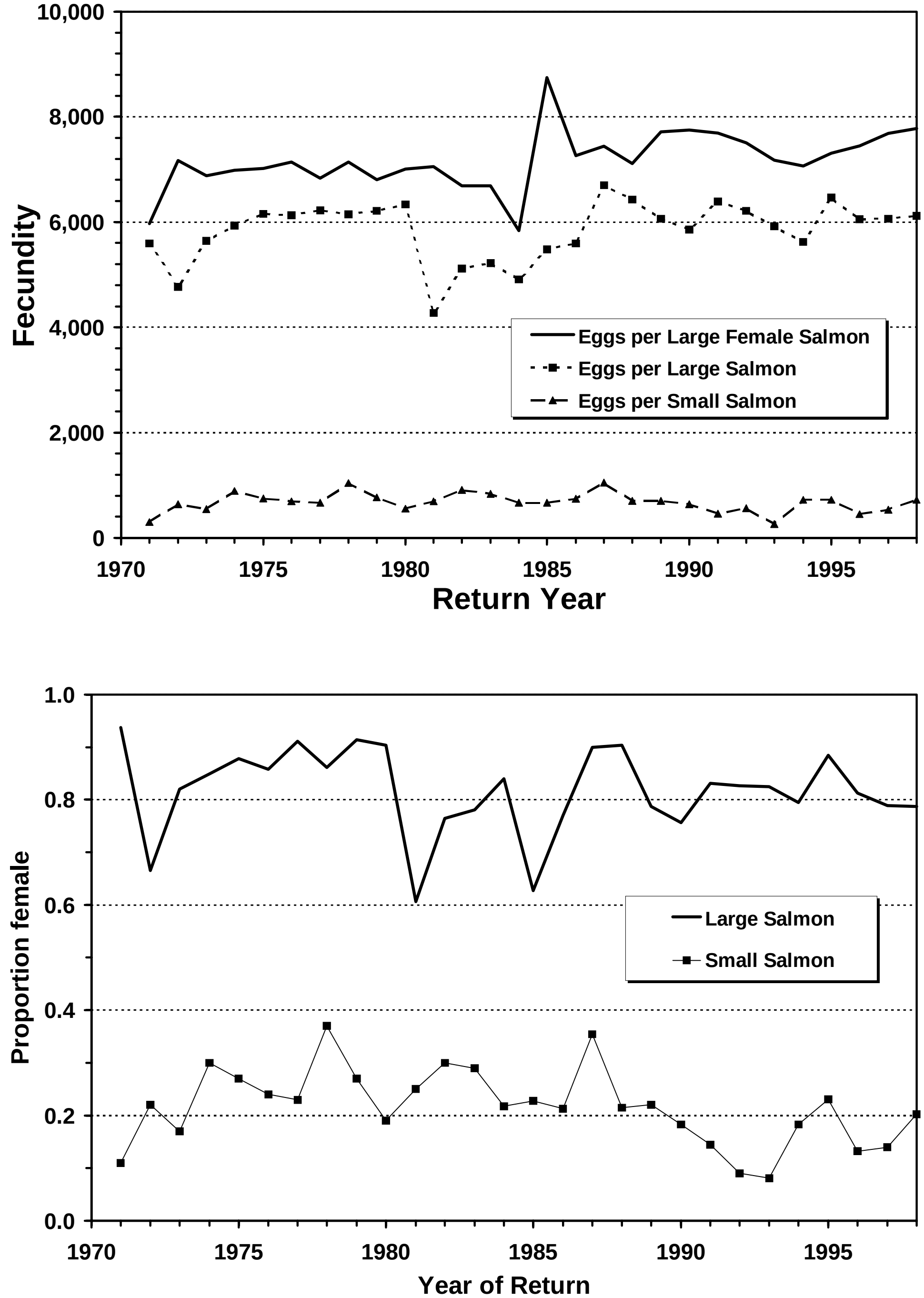


Figure 5. Annual variation in the fecundity (upper, number of eggs) and proportions female (lower) of small and large salmon from the Miramichi River, 1971 to 1998.

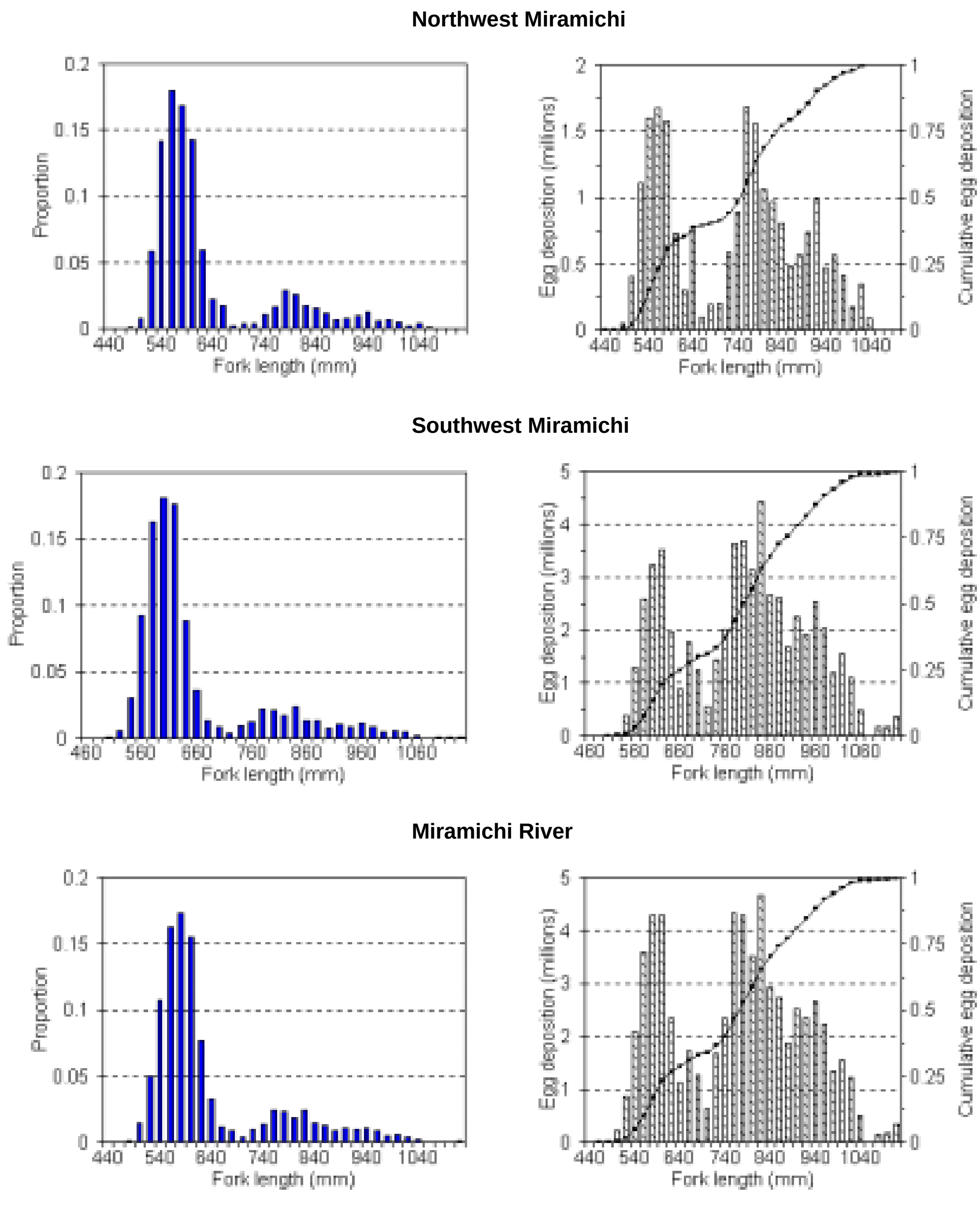


Figure 6. Proportion at length, egg deposition at length and cumulative egg deposition at length for the total spawners of the Northwest Miramichi (top panel), Southwest Miramichi (middle panel) and the Miramichi River (bottom panel) during 1998.

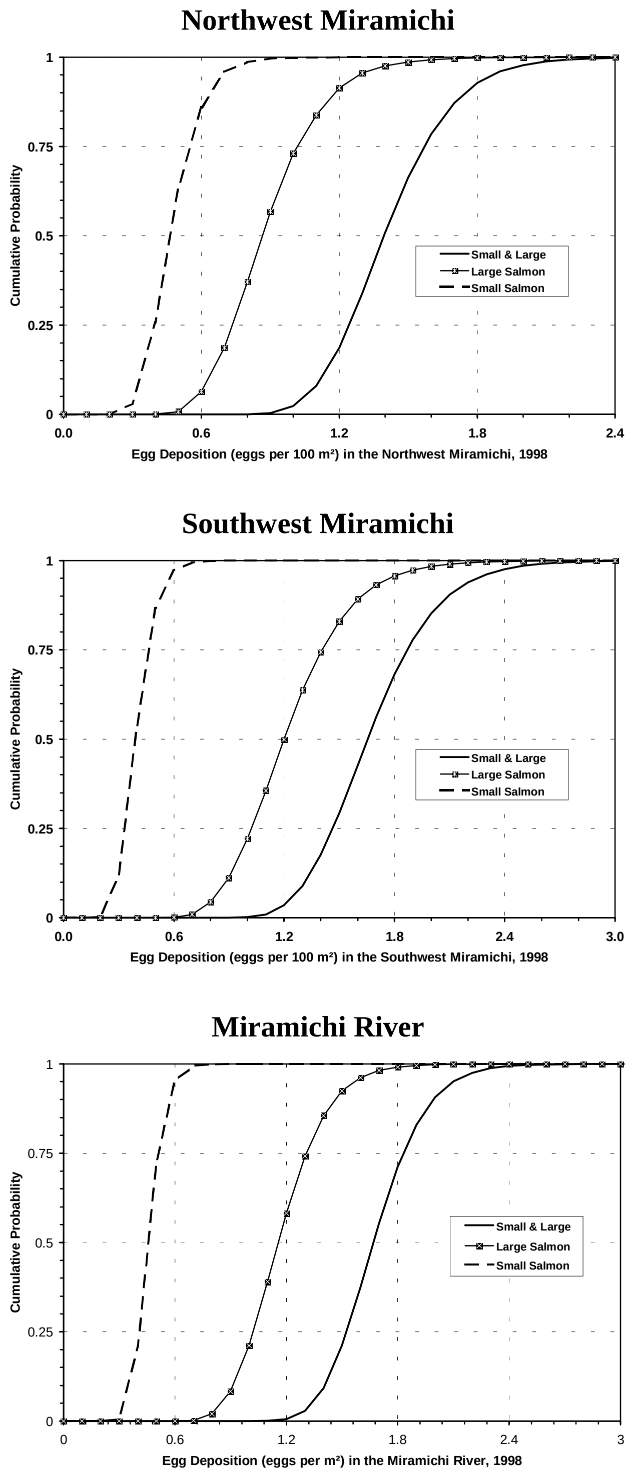


Figure 7. Probable egg depositions (eggs per m^2) in the Northwest Miramichi (top), Southwest Miramichi (middle) and Miramichi River (bottom) by small salmon, large salmon, small and large combined in 1998. Egg depositions are plotted for the estimated returns (assuming no removals had occurred in 1998).

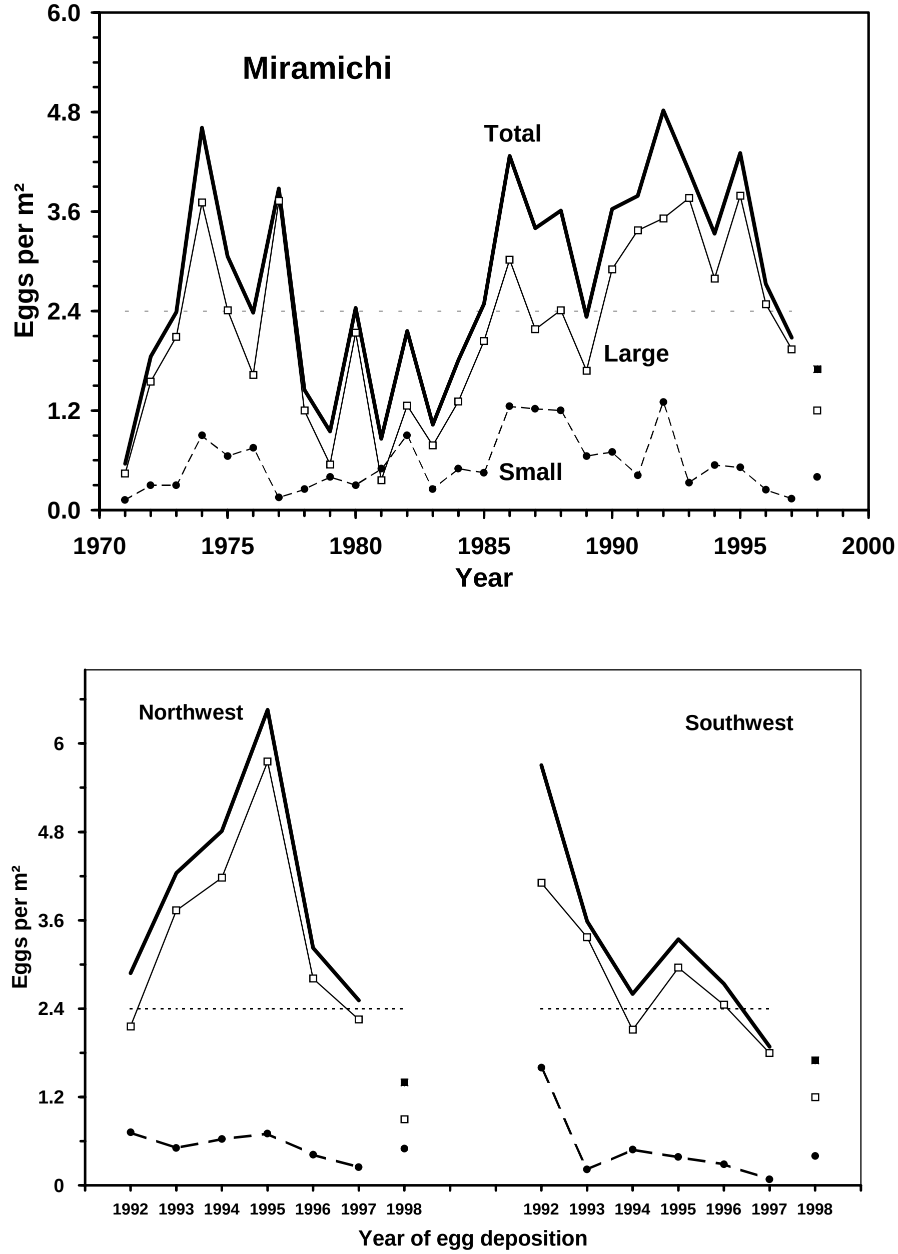


Figure 8. Point estimate annual egg depositions (eggs per m^2) by small (circle dashed line), large (dots and narrow line) and combined (thick line) for the Miramichi River, 1971 to 1998 (upper panel) and for the Northwest and Southwest branches, 1992 to 1998 (lower). Got 1998, egg depositions are for the total returns of salmon before removals. Egg depositions from estimated escapement (total removals for 1998 are not completely tabulated) in 1998 would be lower, especially for small salmon. Dashed line is the conservation egg requirement of 2.4 eggs per m^2.

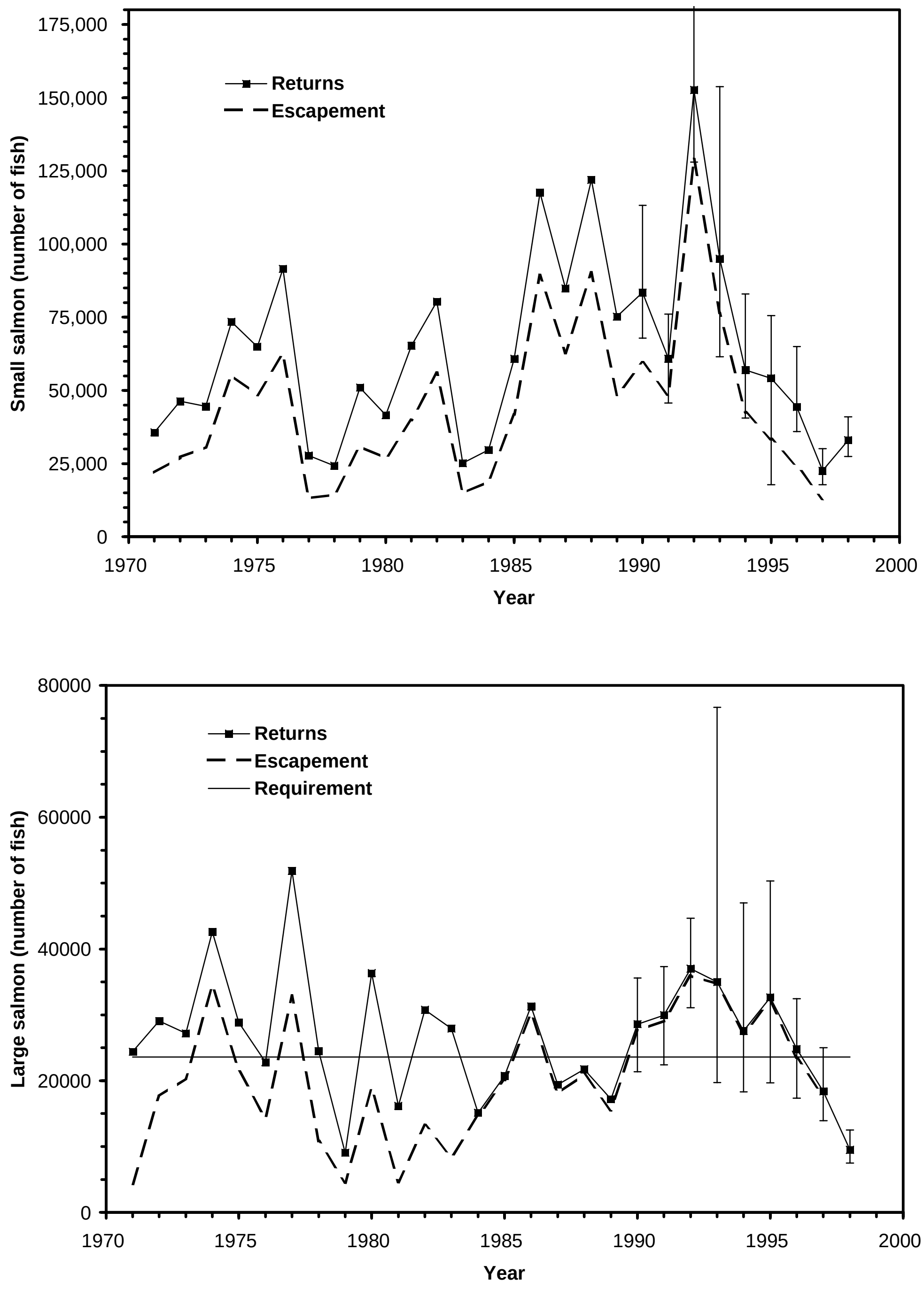


Figure 9. Estimates of total returns to the Miramichi River estuary and number of spawners for small salmon (upper) and large salmon (lower), 1971 to 1998. The vertical lines represent the 90% confidence limit range of the estimated returns.

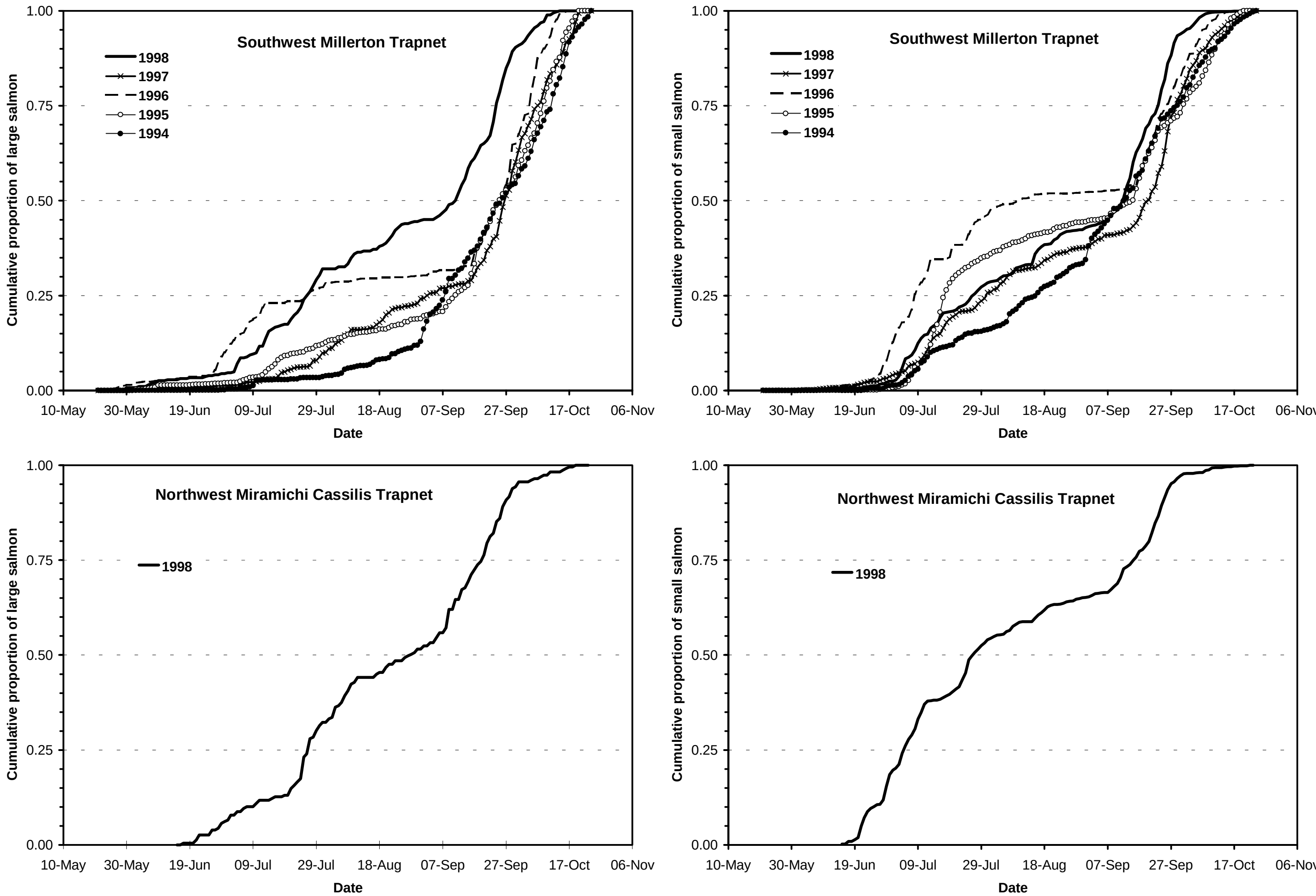


Figure 10. Timing of large salmon (left panels) and small salmon (right panels) catches at the Millerton trapnet in the Southwest Miramichi (upper panels) and at the Cassilis Northwest Miramichi trapnet (lower panels) during 1994 to 1998.

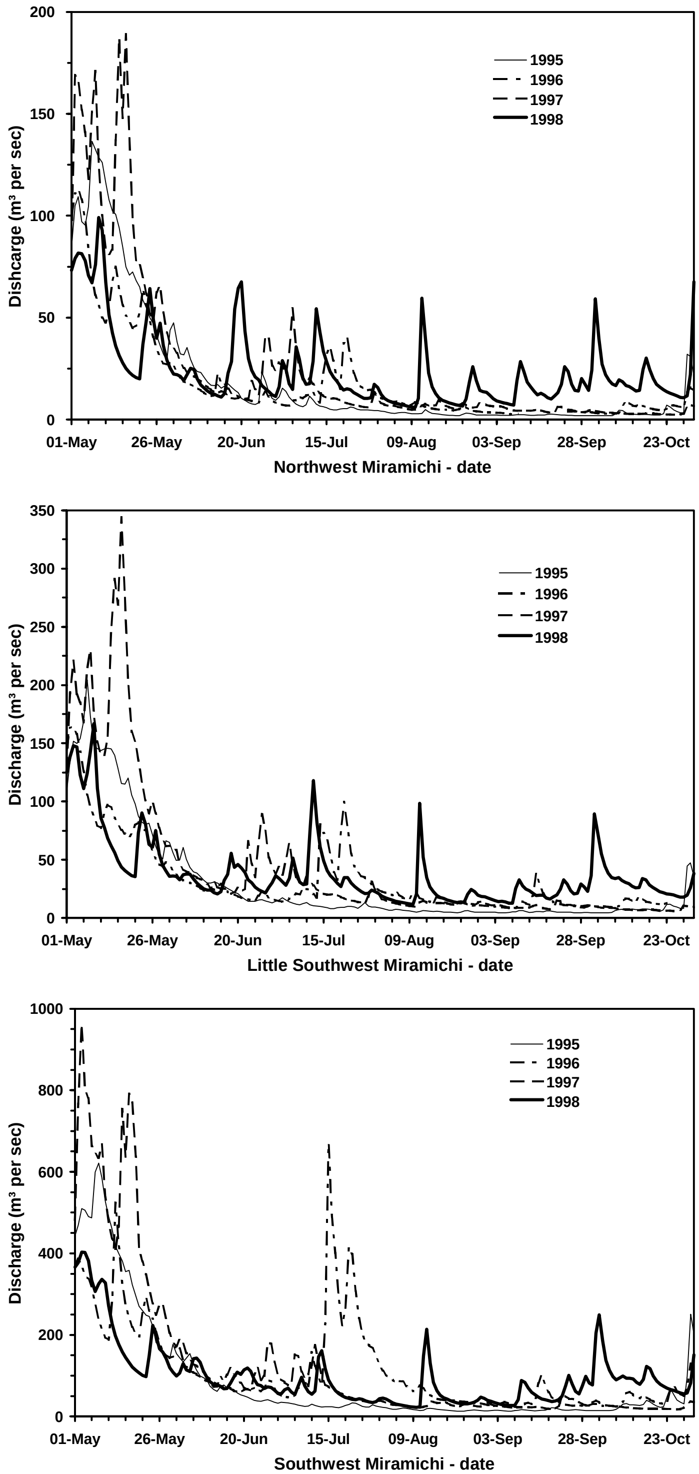


Figure 11. Discharge (m^3 per sec) profiles for the Northwest Miramichi (upper), Little Southwest Miramichi (middle) and Southwest Miramichi (lower) from May 1 to October 31, 1995 to 1998.

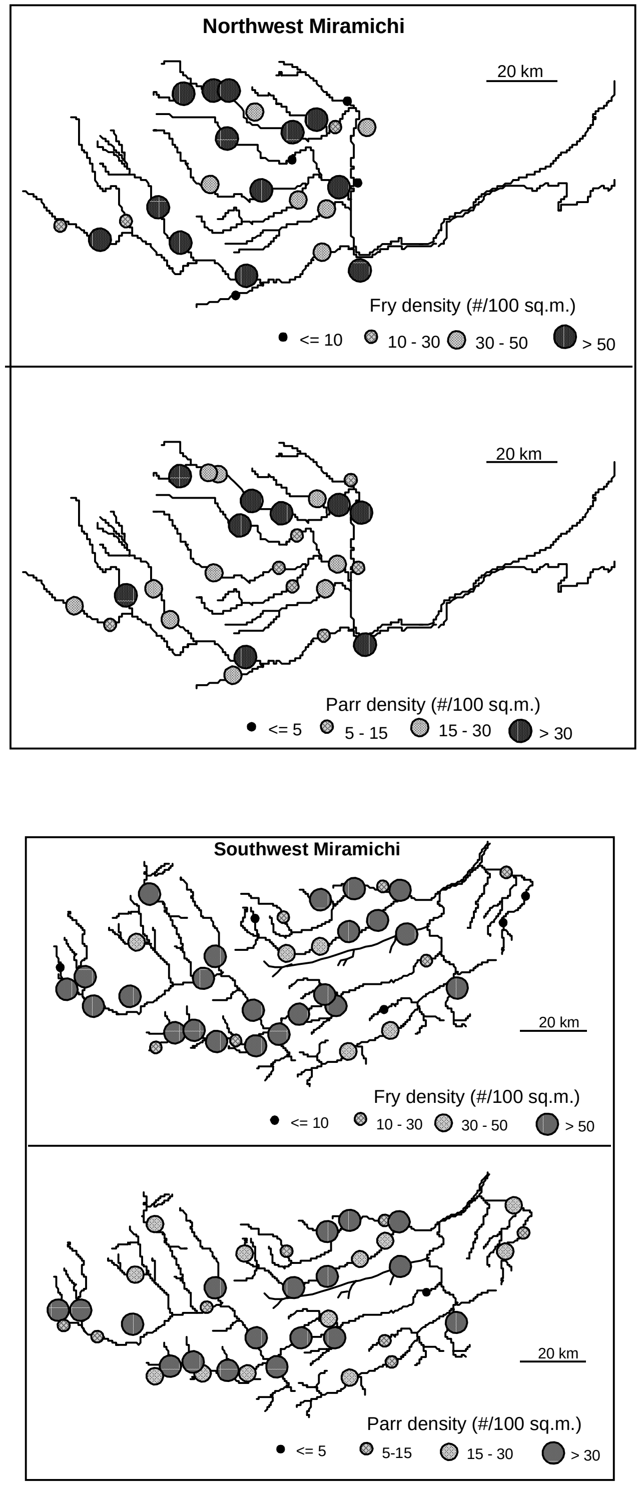


Figure 12. Observed fry and parr densities in the Northwest Miramichi (upper) and Southwest Miramichi sites sampled in 1998.

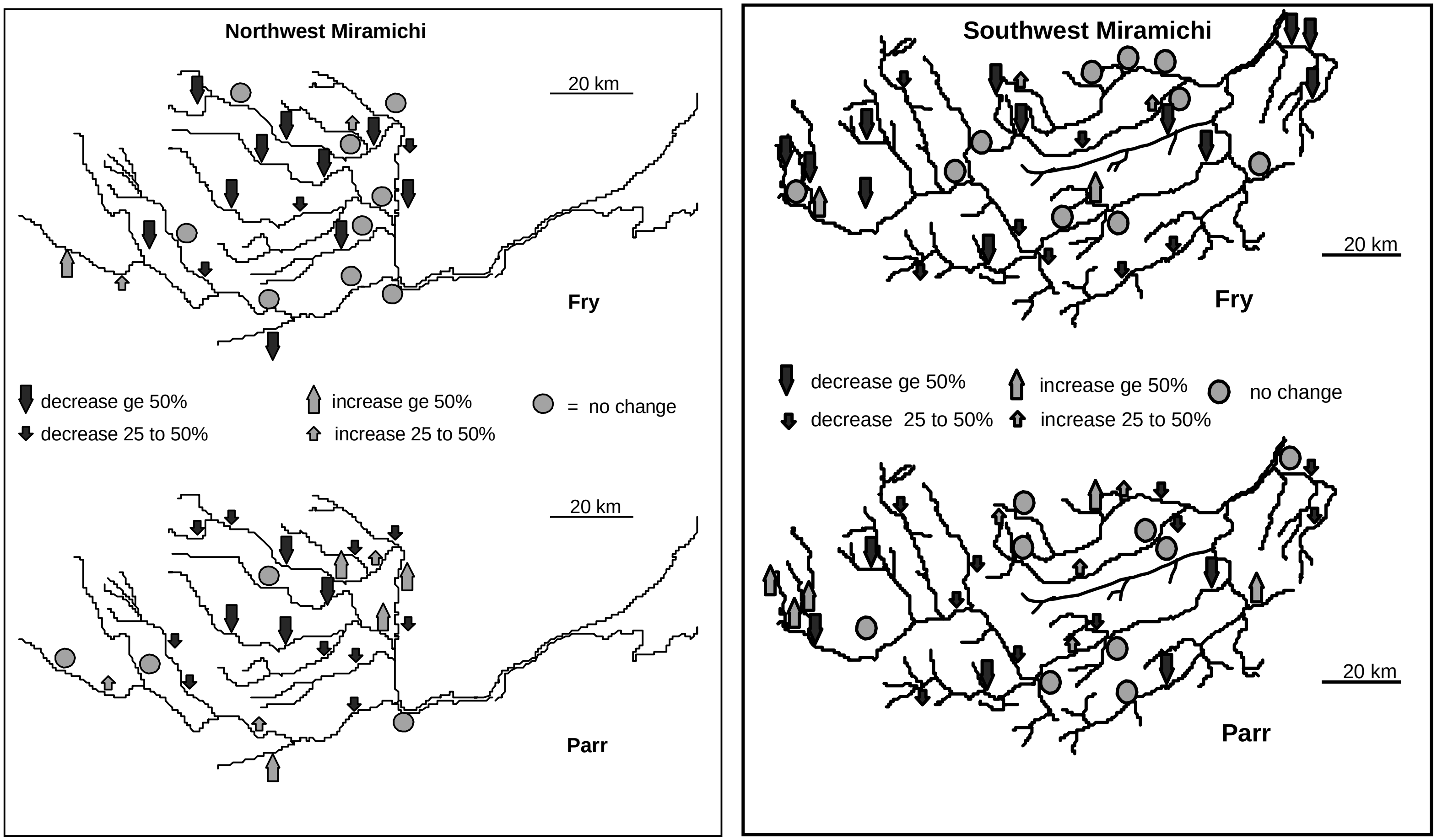


Figure 13. Change in abundance in 1998 of fry (upper panels) and parr (lower panels) relative to average abundance during 1993 to 1997.

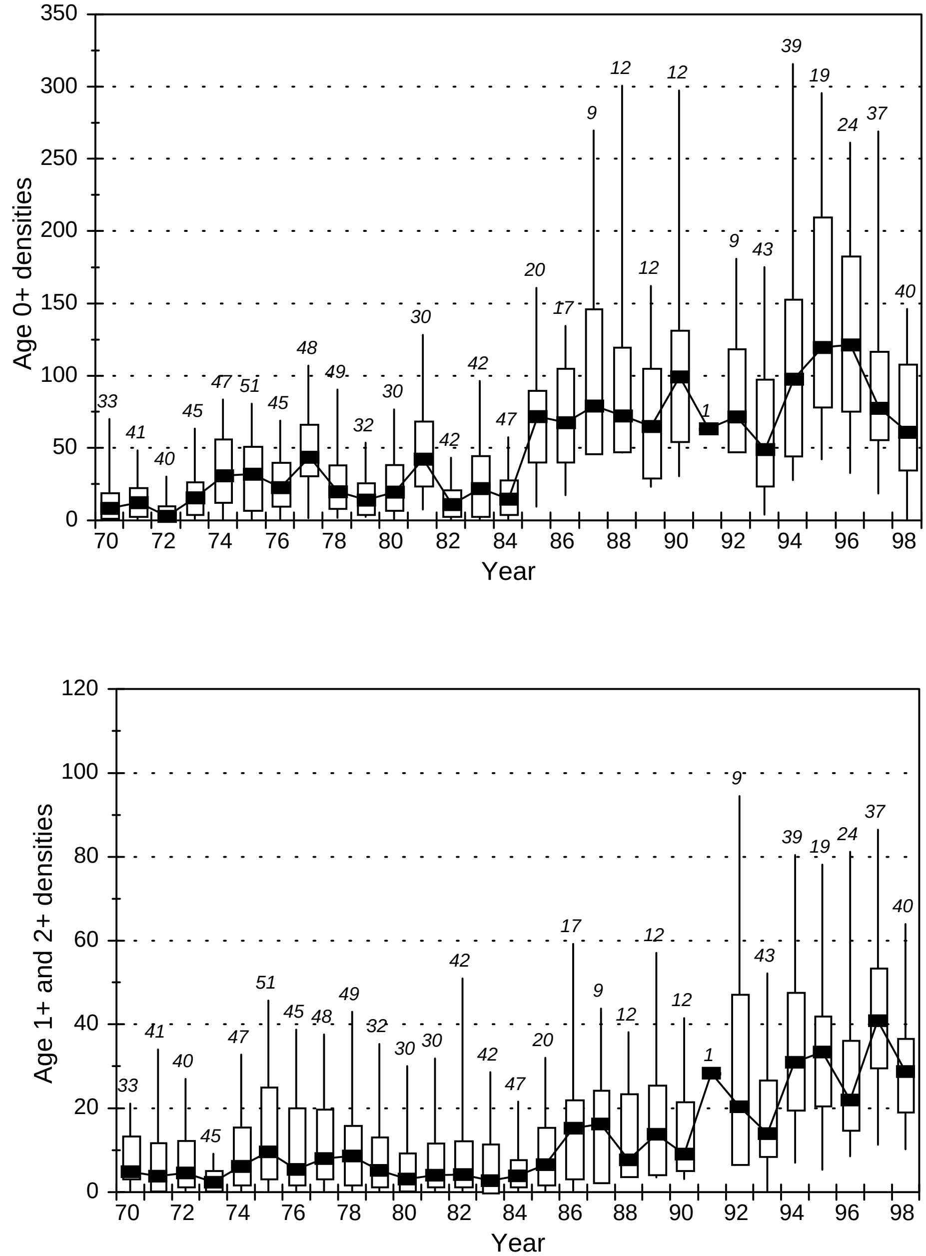


Figure 14. Atlantic salmon fry (upper) and parr (lower) densities at all sampled sites in the Southwest Miramichi, 1970 to 1998. Box plots are interpreted as follows: vertical line = 5th to 95th percentile range, box = 25th to 75th percentile range, square = median value. Number above the vertical line is the number of sites sampled.

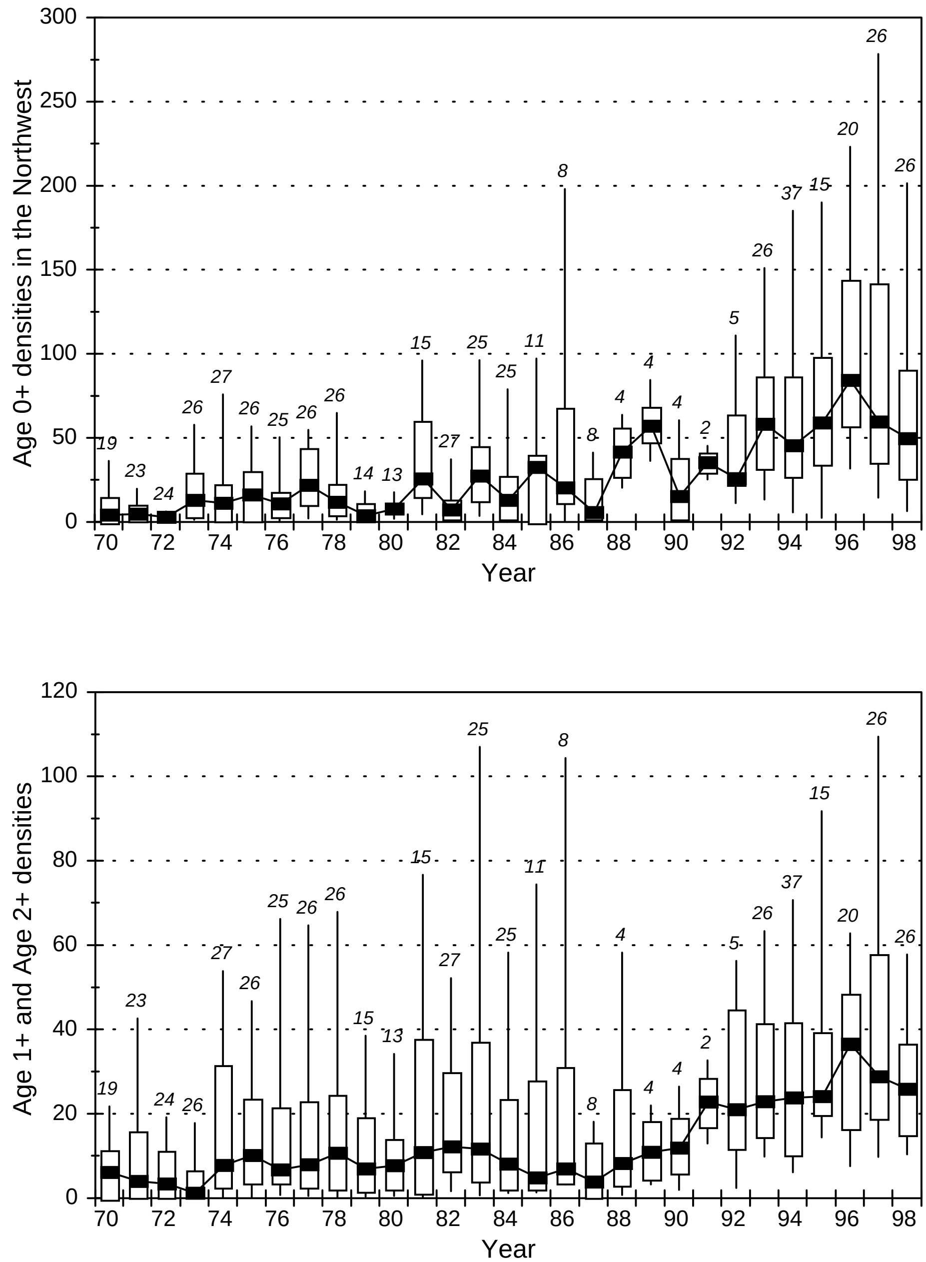


Figure 15. Atlantic salmon fry (upper) and parr (lower) densities at all sampled sites in the Northwest Miramichi, 1970 to 1998. Box plots are interpreted as in Figure 19.

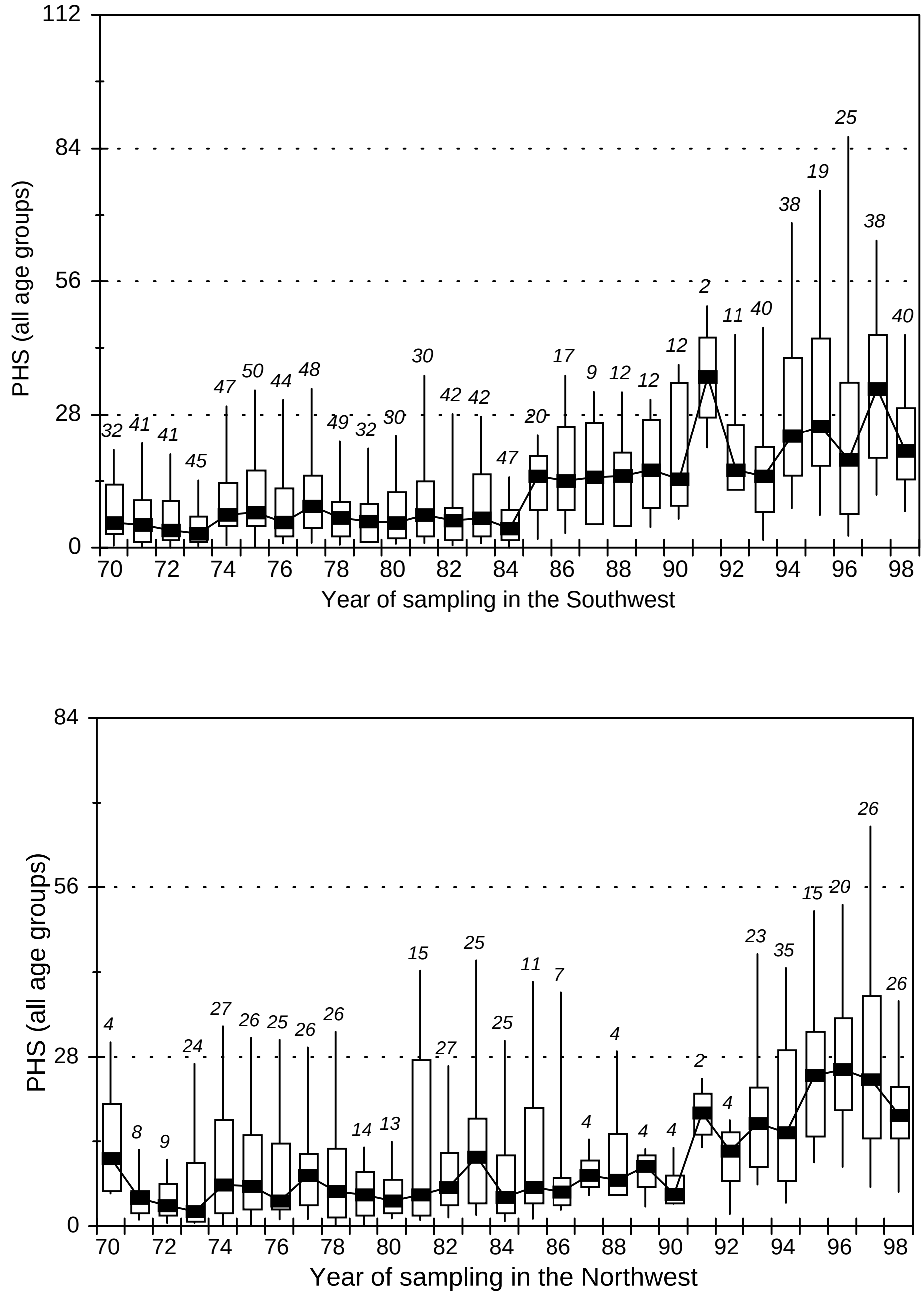


Figure 16. Percent habitat saturation (PHS) index of juvenile Atlantic salmon at all sampled sites in the Southwest Miramichi (upper) and four index sites in the Northwest Miramichi (lower) for 1970 to 1998. Box plots are interpreted as in Figure 19.

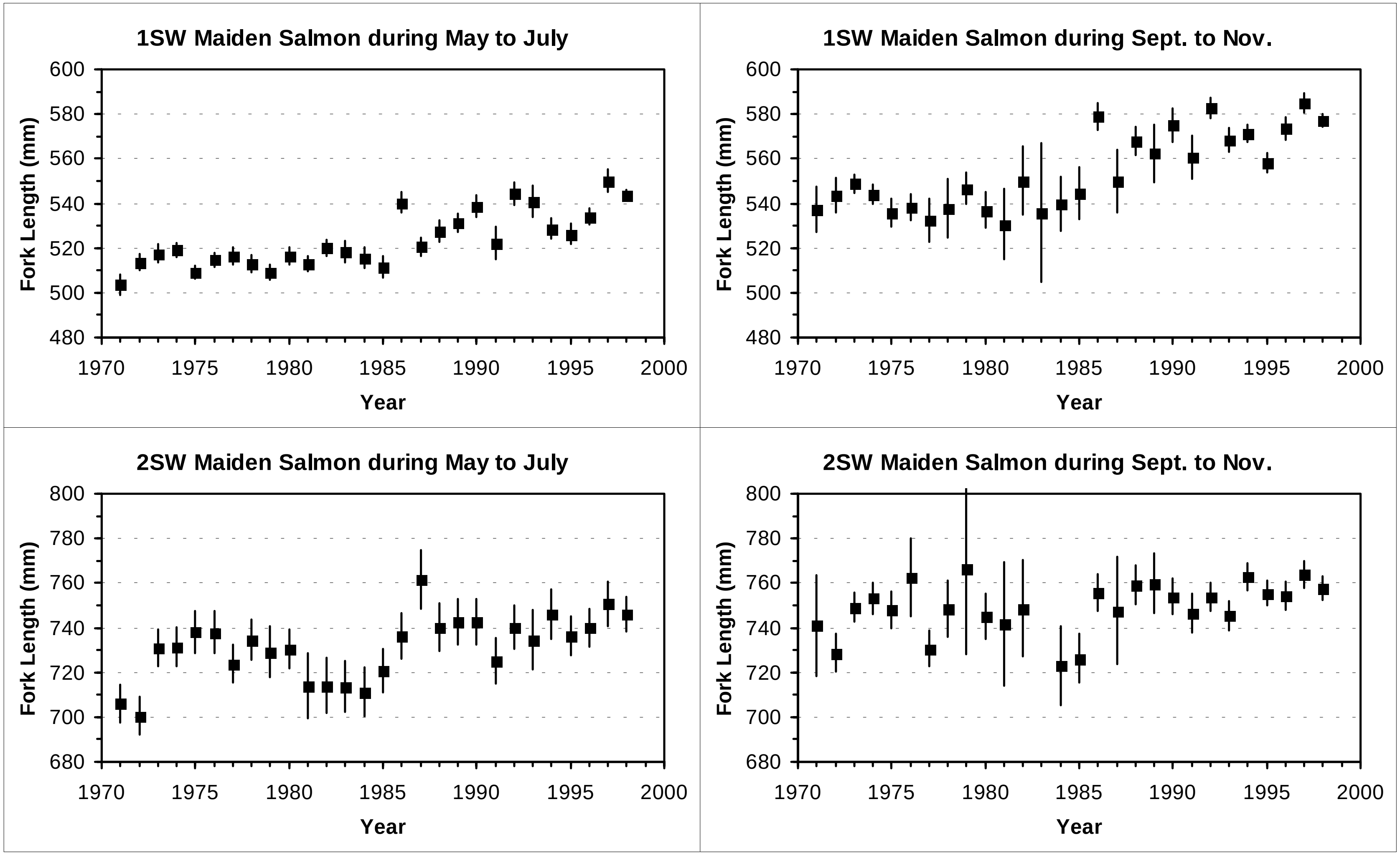


Figure 17. Fork length (mean ± 2 standard errors) of 1SW maiden salmon (upper panels) and 2SW maiden salmon (lower panels) for the summer run (June and July - left panels) and the fall run (Sept. to Nov. - right panels) from the Miramichi River, 1971 to 1998.

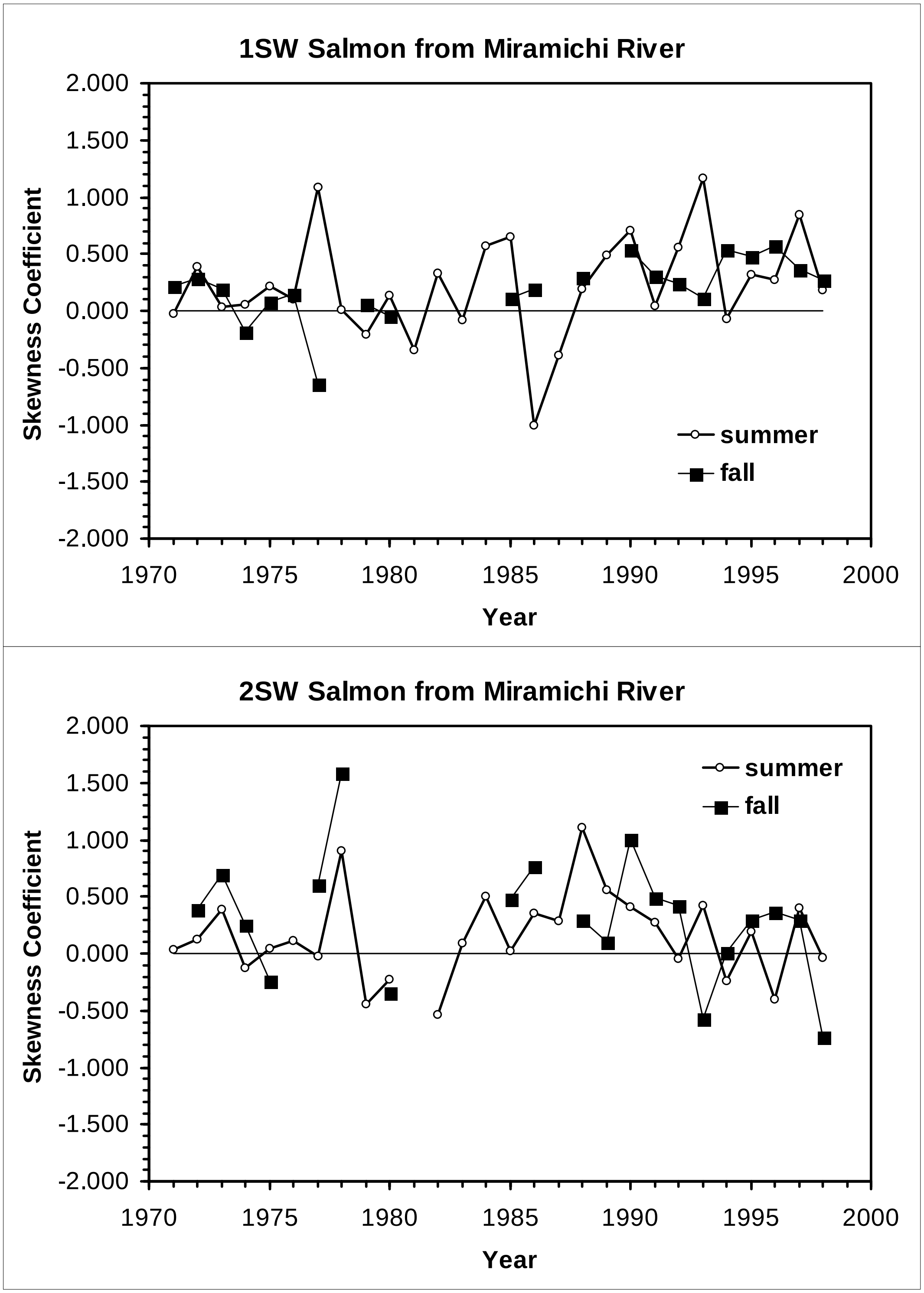


Figure 18. Skewness coefficient of fork length distribution of 1SW salmon (upper panel) and 2SW salmon (lower panel) sampled from estuary trapnets in the Miramichi River during the summer (May to June) and fall (Sept. to Nov.), 1971 to 1998. Shown are the age and season combinations where at least 30 samples were available.

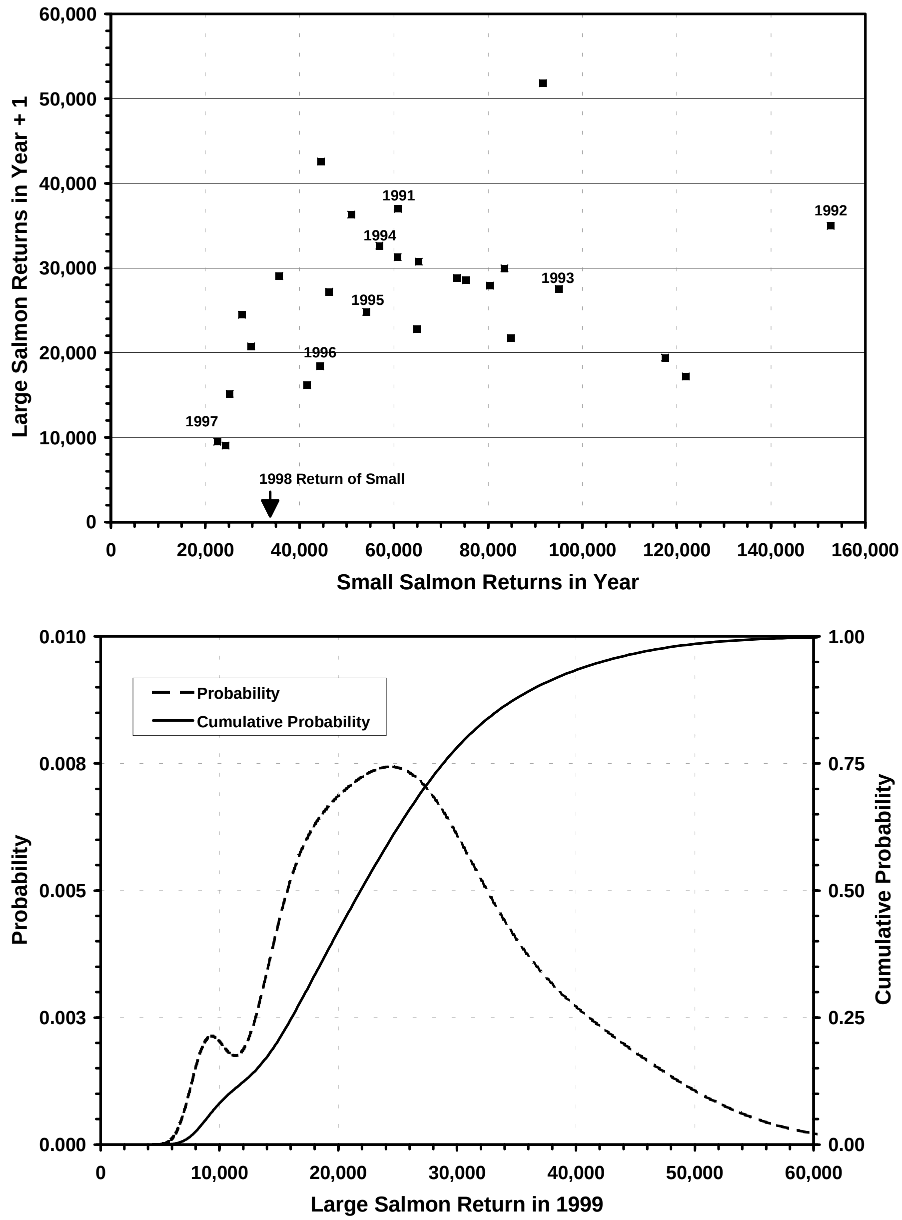
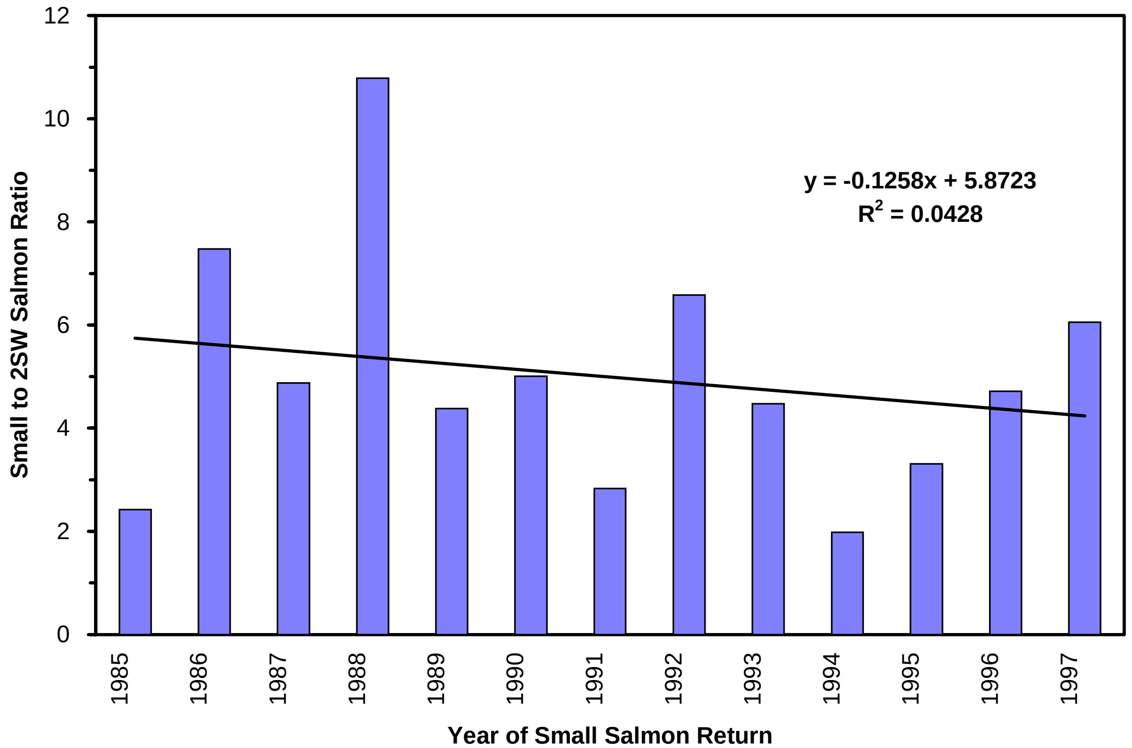


Figure 19. Preseason forecast model of the large salmon returns to the Miramichi River (upper) and the 1999 large salmon return forecast probability (bottom).



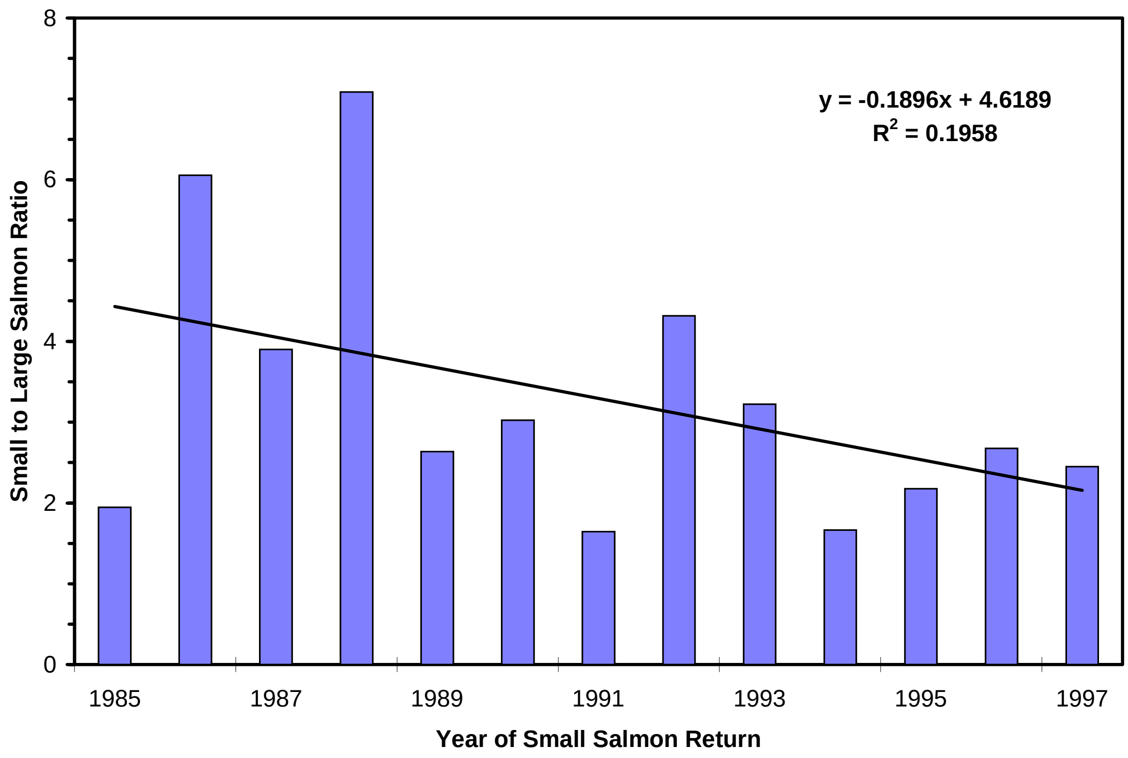


Figure 20. Small salmon to 2SW salmon ratio (upper panel) and to large salmon ratio (bottom panel) for the period 1985 to 1997. The median small salmon to 2SW ratio is 4.7 whereas the median small salmon to large salmon ratio is 2.7. Neither trend has a significant slope ($P > 0.10$).

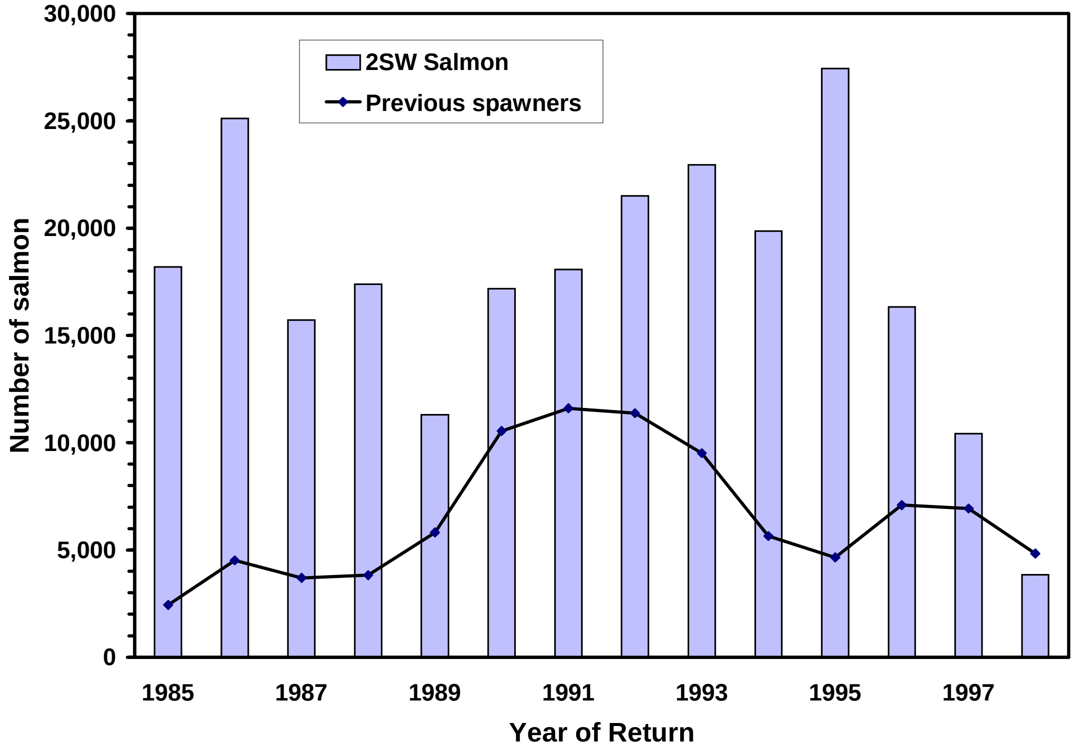


Figure 21. Estimates of abundance of 2SW maiden salmon and previous spawner salmon in the annual returns of large salmon to the Miramichi River for 1971 to 1998.

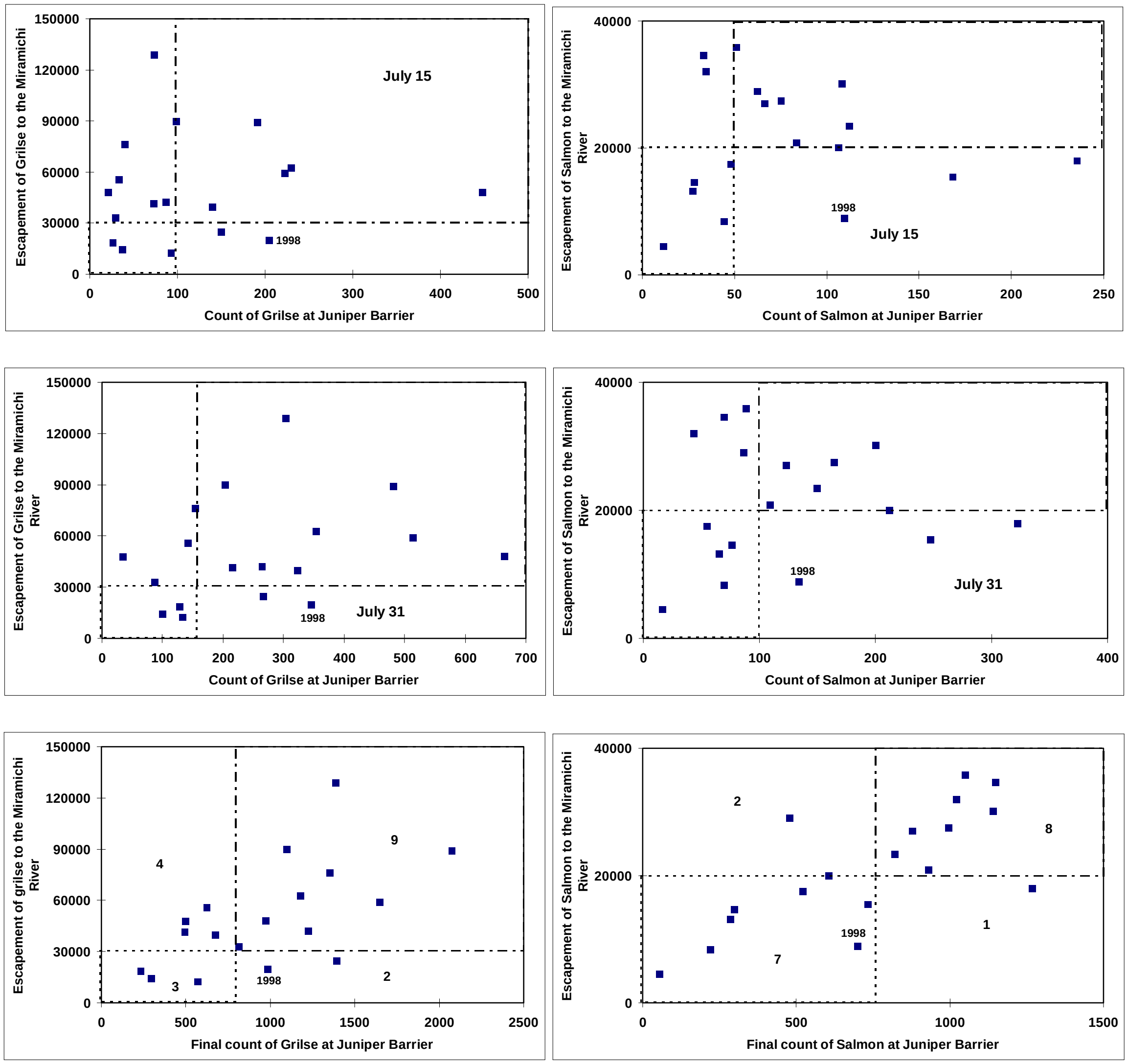


Figure 22. Counts of small salmon (left panels) and large salmon (right panels) to July 15 (upper panels), July 31 (middle panels) and end of year (lower panels) at the Juniper Barrier, main Southwest Miramichi relative to end of year escapement estimates to the Miramichi River, 1981 to 1998. Quadrat lines were defined using 1981 to 1997 data.

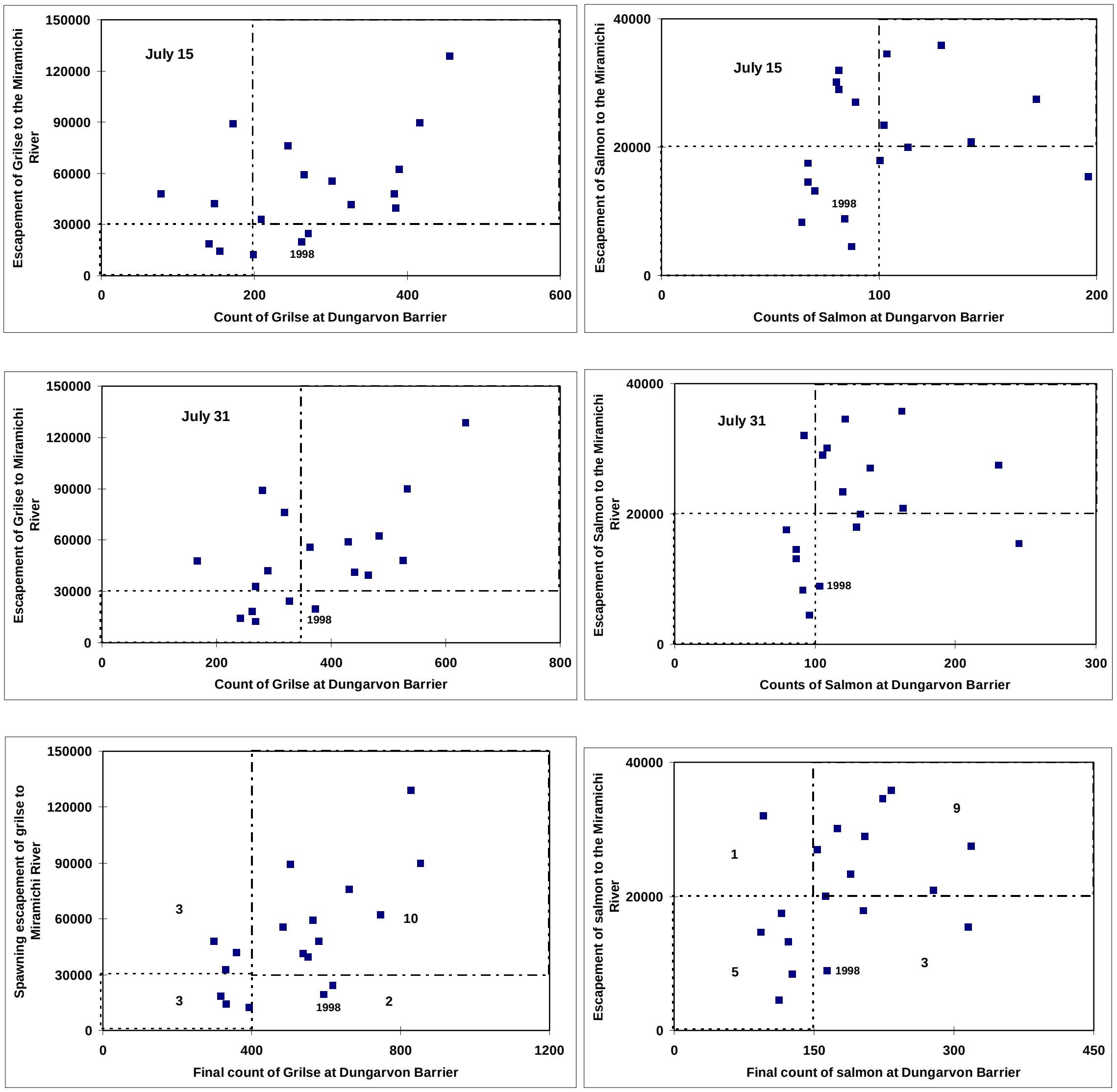


Figure 23. Counts of small salmon (left panels) and large salmon (right panels) to July 15 (upper panels), July 31 (middle panels) and end of year (lower panels) at the Dungarvon Barrier, Southwest Miramichi relative to end of year escapement estimates to the Miramichi River, 1981 to 1998. Quadrat lines were defined using 1981 to 1997 data.

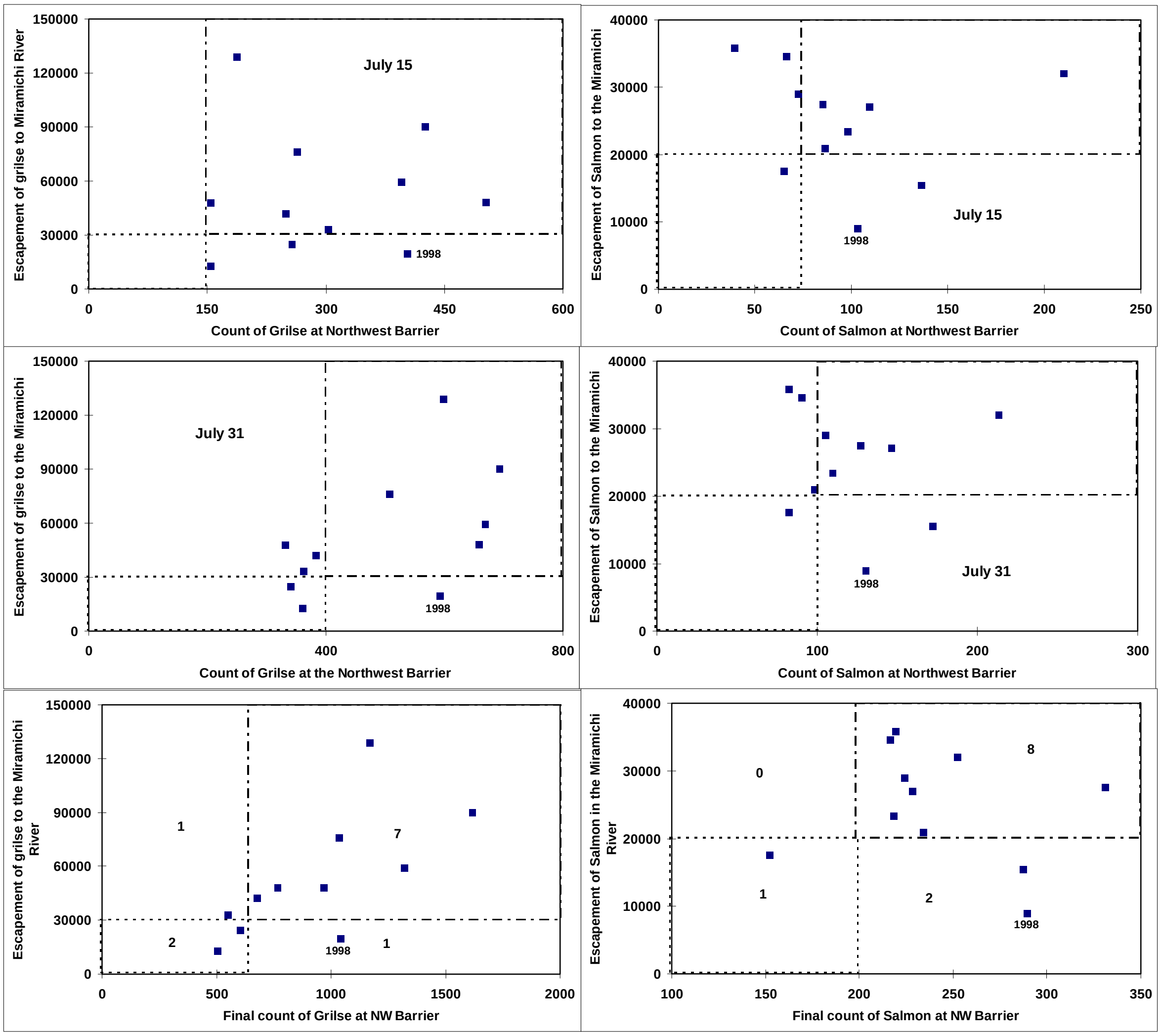


Figure 24. Counts of small salmon (left panels) and large salmon (right panels) to July 15 (upper panels), July 31 (middle panels) and end of year (lower panels) at the Northwest Barrier, Northwest Miramichi relative to end of year escapement estimates to the Miramichi River, 1988 to 1998. Quadrat lines were defined using 1988 to 1997 data.

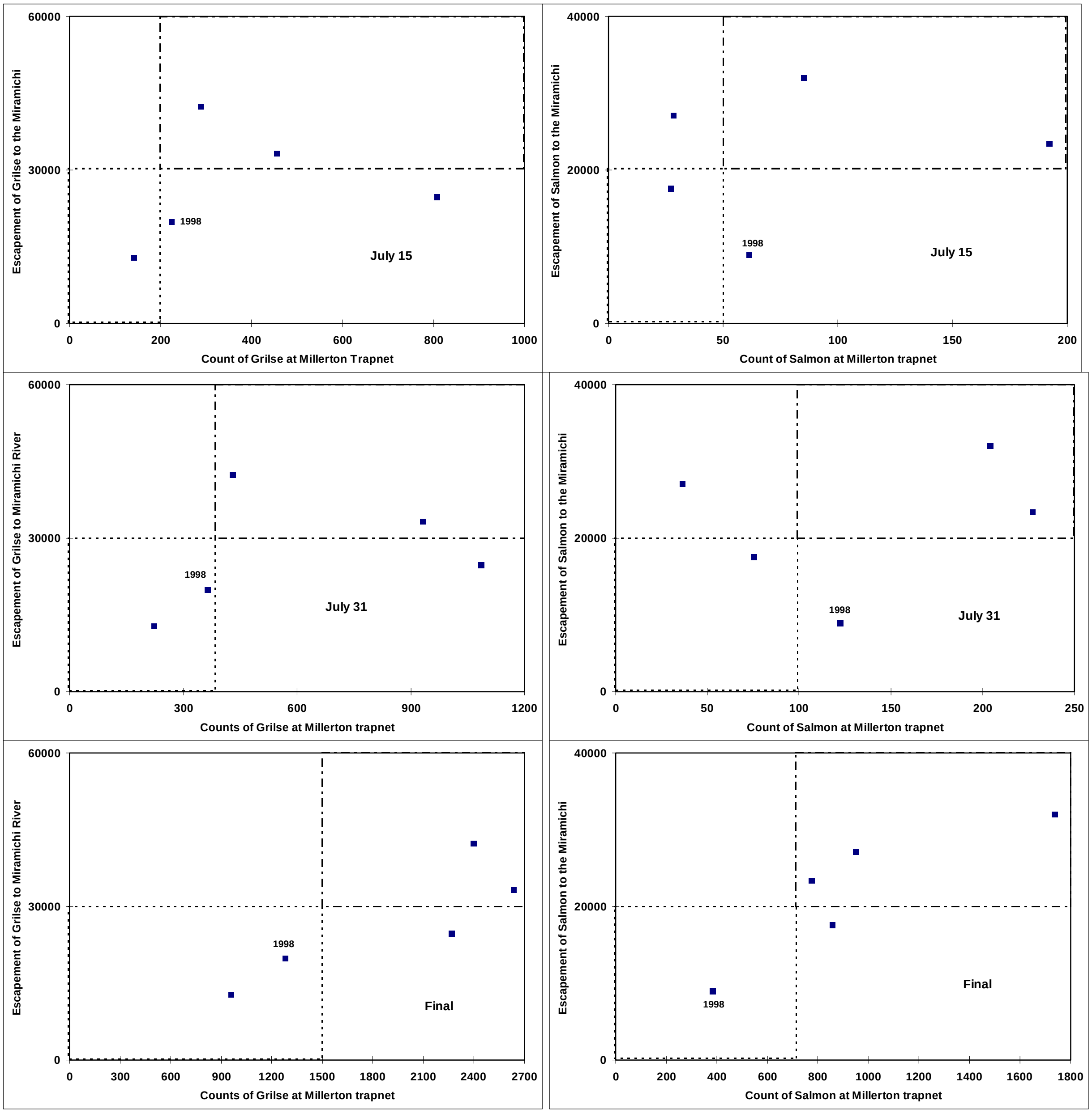
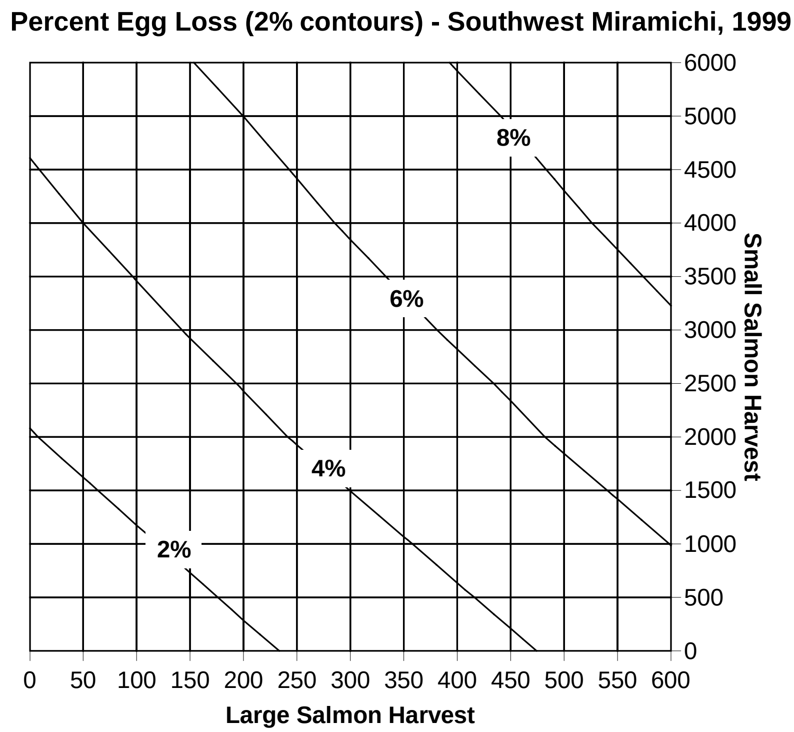


Figure 25. Counts of small salmon (left panels) and large salmon (right panels) to July 15 (upper panels), July 31 (middle panels) and end of year (lower panels) at the Millerton trapnet, Southwest Miramichi relative to end of year escapement estimates to the Miramichi River, 1994 to 1998. Quadrat lines were arbitrarily defined using 1994 to 1997 data.



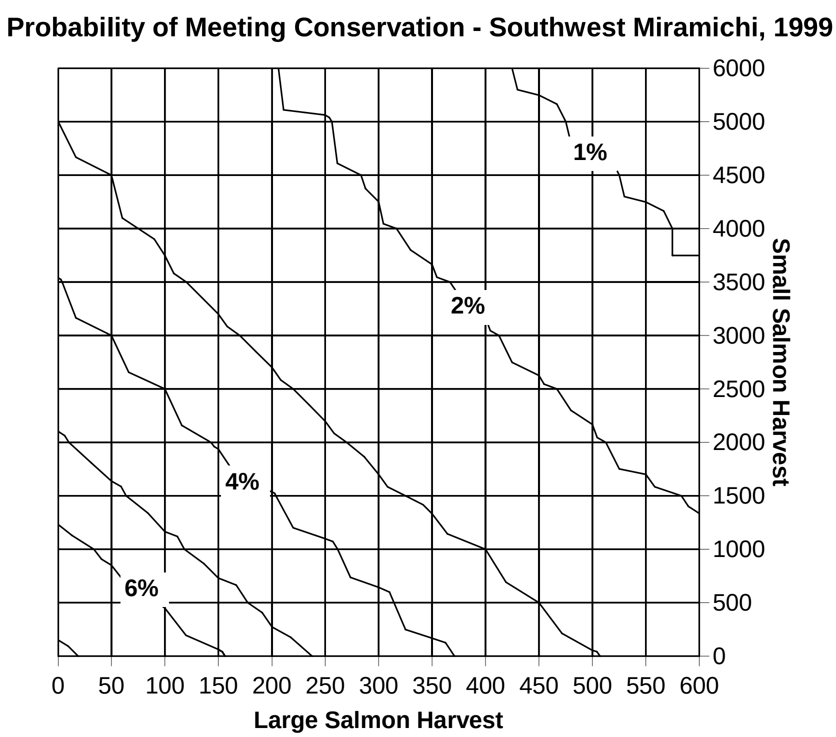


Figure 26. Expected egg loss (upper panel) as a percentage of eggs in the total returns of small and large salmon and the probability of meeting conservation (lower panel) relative to small and large salmon harvests in the Southwest Miramichi, 1999.

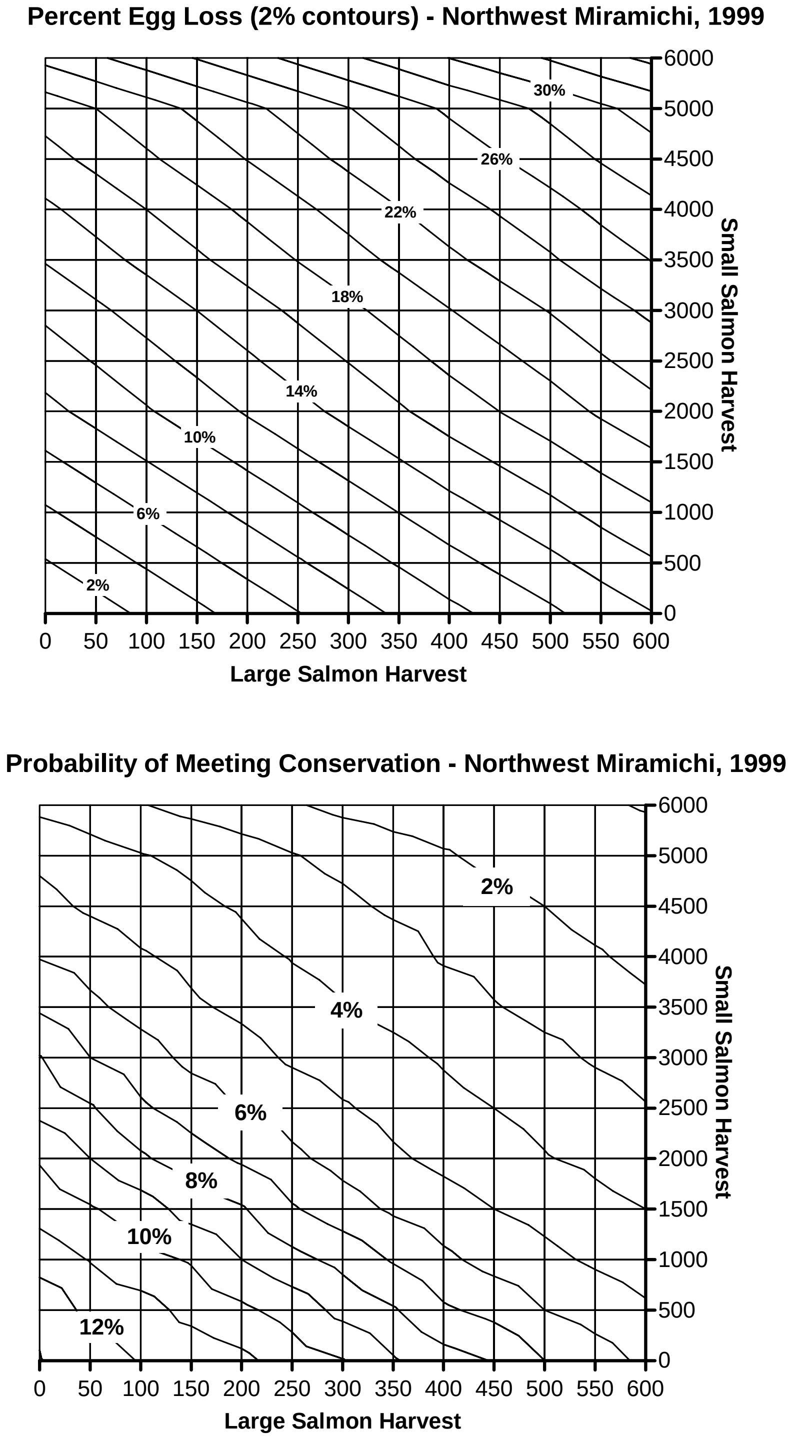


Figure 27. Expected egg loss (upper panel) as a percentage of eggs in the total returns of small and large salmon and the probability of meeting conservation (lower panel) relative to small and large salmon harvests in the Northwest Miramichi, 1999.

Appendix 1. Record of client consultation for the Atlantic salmon stock of the Miramichi River.

RECORD OF CLIENT CONSULTATION

1. SPECIES / STOCK:
- **Atlantic salmon - Miramichi River**

2. ARRANGEMENTS:
DATE: December 15, 1998
TIME: 9:00 to 16:00
LOCATION: REPAP Building, Newcastle (Miramichi City), New Brunswick

3. FORM OF CONSULTATION (Science Workshop, ZMAC, ETC..)
- **Science workshop**

4. PARTICIPANTS (Name and Affiliation)
- **Lorne Amos, NB Guides Association. Storeytown**
- **Amy Howe-Basco, Cains River Enhancement Association, Blackville**
- **William Basco, Wade's Fishing Lodge, Blackville**
- **Ivan Benwell, UNB, Fredericton**
- **Fred Butler, DFO Conservation and Protection, Blackville**
- **Don Boucher, Miramichi Headwaters, Wicklow**
- **Gérald Chaput, DFO Science, Moncton**
- **Faye Cowie, NB Aquatic Resources Data Warehouse, Doaktown**
- **Chris Connell, J.D. Irving Ltd., Fredericton**
- **Peter Cronin, Director of Fisheries, Dept. of Natural Resources and Energy (DNRE), Fredericton**
- **Jerry Doak, WW Doak Fishing Tackle, Doaktown**
- **Bill Donald, Chair, Miramichi Watershed Management Committee, Miramichi City**
- **Scott Douglas, Acadia University, Moncton**
- **Bernie Dubee, Regional Biologist, DNRE, Miramichi City**
- **Dave Dunn, DFO, Recreational Fisheries, Moncton**
- **Philip Fraser, NB Aboriginal Peoples Council, Fredericton**
- **Reginald Furlong, DFO Science, Miramichi City**
- **Mark Hambrook, Miramichi Fish Hatchery Inc., South Esk**
- **Peter Hardie, DFO Science, Moncton**
- **John Hayward, DFO Science, Miramichi City**
- **Léophane LeBlanc, Kouchibouguac National Park, Kouchibouguac**
- **Tim Lutzac, DFO Science, Aboriginal Fisheries Coordination, Moncton**
- **Ron MacKnight, Tabusintac Fish and Game Association, Tabusintac**
- **Rhonda McLaughlin, Rocky Brook / Bowater Canada, Boiestown**
- **Dave Moore, DFO Science, Moncton**
- **Lisa Perley, J.D. Irving Ltd., Fredericton**
- **Cyril Polchius, Big Cove Band, Big Cove**
- **Manley Price, Rocky Brook Camp / Avenor inc., Boiestown, New Brunswick**
- **Grant Ross, Miramichi Salmon Association, Boiestown**
- **Bill Scott, DFO Conservation and Protection, Miramichi City, New Brunswick**
- **Joe Shaesgreen, DFO Science, Miramichi City**

- **Norman Stewart, White Rapids Brook and Other Streams Enhancement Association, Lockstead**
- **Wilmot Tompkins, Juniper Lumber Co. Ltd.**
- **Stephen Tulle, DNRE, Miramichi City**
- **Vince Swazey, Miramichi Salmon Association, Boiestown, New Brunswick**
- **Bruce Whipple, Northumberland Salmon Protection Association, Miramichi City**
- **Fred Whoriskey, Atlantic Salmon Federation, St. Andrews**

5. NEW INFORMATION BROUGHT FORWARD (what? by who?)-*(Only a brief description is required)*

- **Crown Reserve angling catches and barrier fence counts (Benie Dube, DNRE NB)**
- **Update on Clearwater Brook project (ASF/Irving) - 1) enhance salmon assessments, 2)study optimizing salmon production. Clearwater Brook fence counts.**
- **New nursery area research initiative (habitat mapping, juveniles) on Taxis River, pool restoration initiative on Clearwater Brook, juvenile sampling for satellite stocking site definition by Rhonda McLaughlin and Manley Price, Bowater Canada**
- **continuation of MSA juvenile surveys for monitoring satellite stocking areas, development of a report card for reporting adipose-clipped fish, fall study defining beaver dams and access impacts on salmon spawning**

6. CONCERNS RAISED BY CLIENTS (include concerns, plus follow-up action/response made or committed). - (*Only a brief description is required)*

- **Concerns that the 1997 small salmon returns were underestimated because the black salmon fishery was good to very good in spring 1998. Conditions may have contributed to a good fishery rather than higher abundance.**

7. RECOMMENDATIONS: (*Only a brief description is required)*

a.) Pertaining to Assessment

- **Need to determine the consequences to the long-term sustainability of the resource of not meeting conservation requirements. This will guide management is assessing the consequences to the resource of risk adverse, risk neutral or risk prone strategies**

b.) Pertaining to next year's workplans

- **Continued assessment is required**
- **Estimates of smolt production from the Miramichi River (not just the Northwest Miramichi) would be a valuable addition to the assessment**
- **Low returns in 1998 are disappointing but not unexpected. Need to refine inseason approach for 1999**
-

Other Concerns:

-

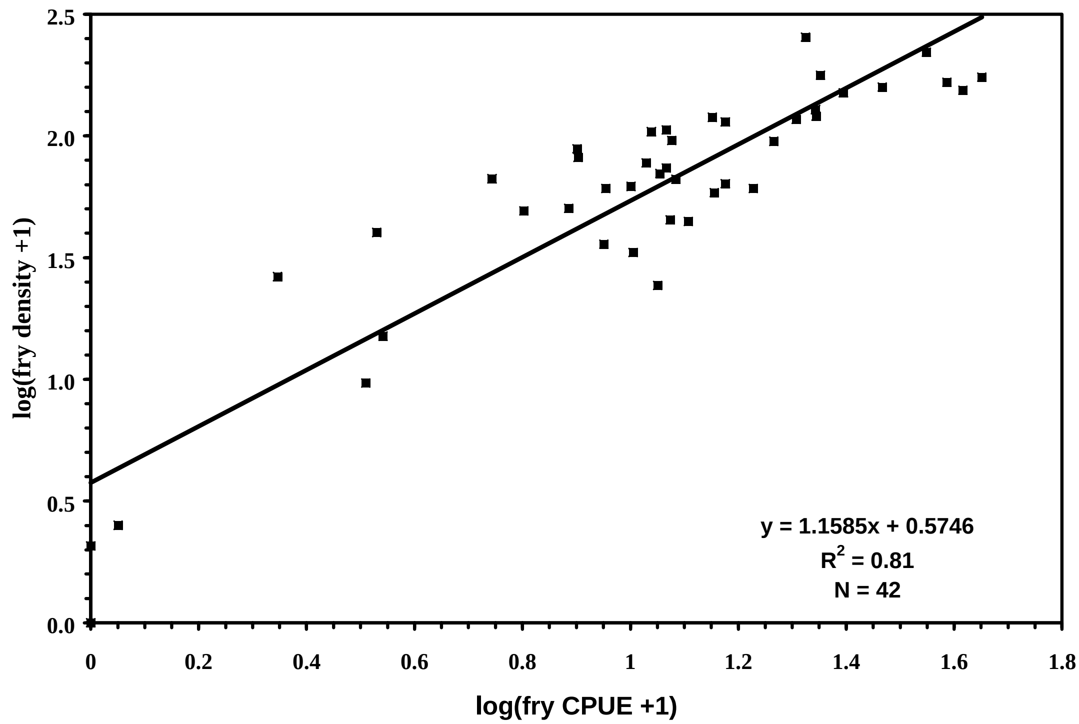
__Various__________________
NAME OF PRESENTER

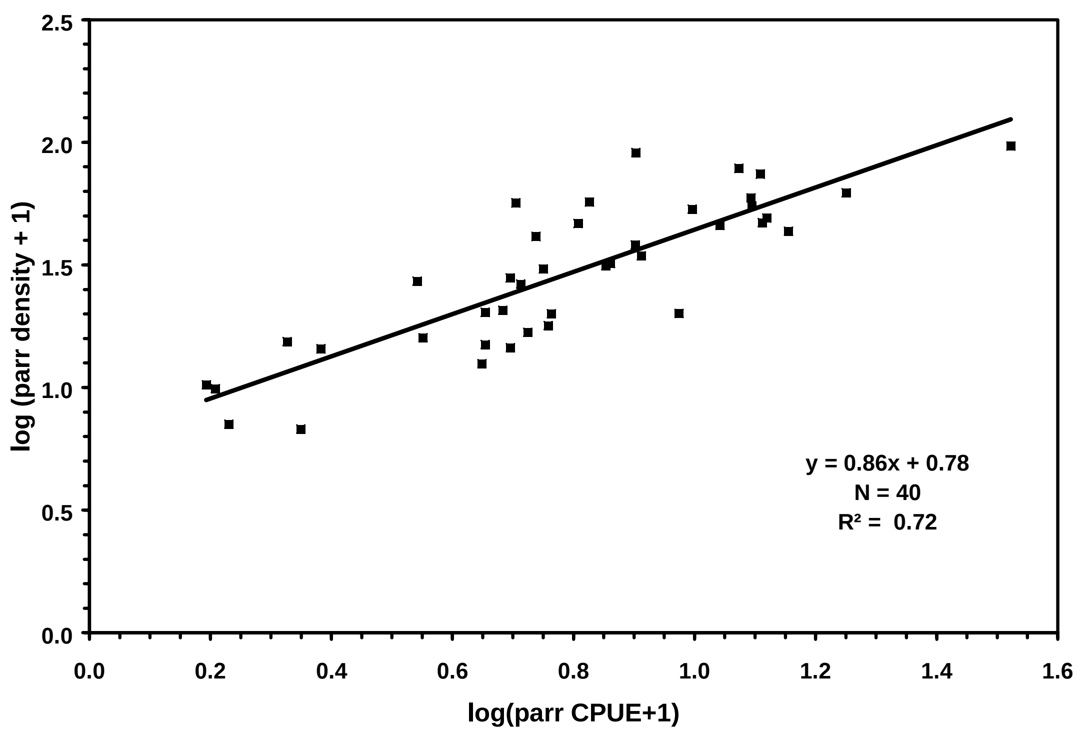
_Gérald Chaput____________________
NAME OF RAPPORTEUR

Appendix 2. Marking, recapture and fish sampling from Miramichi in 1998.

Contact authors for details.

Appendix 3. Juvenile survey CPUE to density calibration for the Miramichi River. CPUE is expressed as fish per 180 seconds of fishing effort, density expressed as fish per 100 m^2.





Appendix 4. Smolt estimate of the Northwest Miramichi in 1998.

DESCRIPTION OF FIELD OPERATIONS IN 1998

The smolt production estimates were be obtained by mark and recapture method. Attempts were made to capture smolts in the Northwest Miramichi at Big Hole Tract using a partial counting fence. Less than 100 smolts were captured over a five week period which was characterized by high flow conditions through most of the sampling period. We used an alternative method to calibrate the estuary trapnet by using hatchery smolts reared in McCormack Lake collaboratively by the Northumberland Salmon Protection Association and Heath Steele. Just over 5100 adipose-clipped smolts were marked with streamer tags on May 27 to 29 and released into Little River on May 28 to 30 in three separate batches. Smolts were marked just anterior to the dorsal fin with small, green minimally intrusive streamer tags. The tags were individually numbered to provide information on movement rates and behaviour.

Smolts were sampled in tidal waters, about 5 km below the confluence of the Little Southwest and Northwest Miramichi branches using a picket type smolt trapnet used previously on the Miramichi. The estuary trapnet commenced fishing for smolts on May 11 and was fished daily until June 15, 1998. On June 16, the smolt trapnet was removed and an adult trapnet was installed to begin sampling the ascending adult run into the Northwest Miramichi.

RESULTS

From May 11 to June 15, 1998, a total of 6,568 smolts (both wild and adipose-clipped) were captured in the estuary trapnet. Peak days of capture were May 16 to 17, May 22 and May 29 (Figure 4.1). Very few smolts were captured before May 16 and after May 31. Adipose-clipped smolts represented 5% of the catch (309 smolts). The majority of the adipose-clipped smolts were releases from the cage-rearing program in McCormack Lake. Adipose-clipped smolts not originating from McCormack Lake numbered 68 fish, or 1% of the smolt run (exlcuding Heath Steele smolts).

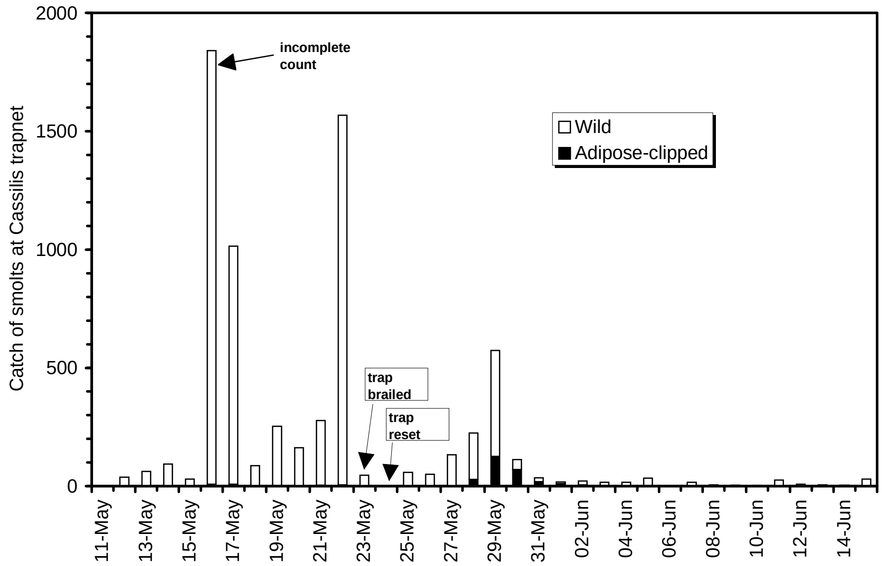


Figure A4.1. Daily catch of wild and adipose-clipped smolts at the Cassilis trapnet, Northwest Miramichi in 1998.

Wild smolts had an average fork length of 12.9 cm compared to the adipose-clipped smolts at an average fork length of 17.1 cm (Fig. 4.2). The wild smolt fork length in 1998 is less than observed in 1965 but very similar to the size of smolts from Catamaran Brook which averaged 12.1 to 13.4 cm fork length from 1991 to 1996 (Hardie et al. 1998).

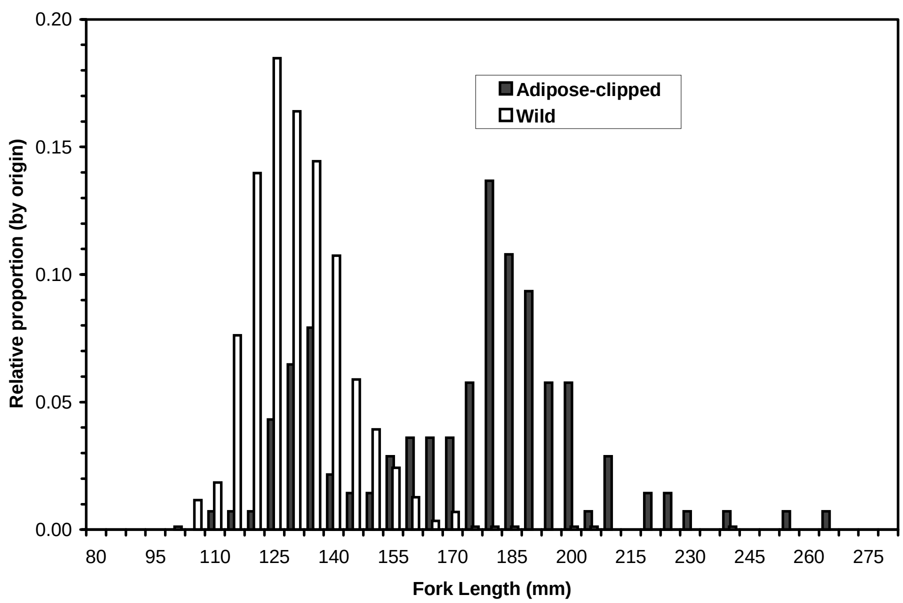


Figure A4.2. Fork length distributions of wild and adipose-clipped smolts sampled from the Cassilis trapnet, Northwest Miramichi in 1998. Proportion at size are relative to each group separately and unweighted to daily catch. For wild smolt, N = 866. For adipose-clipped smolts, N = 139.

About 5% of the smolts tagged at the lake cages at McCormack Lake died within 24 hours before release. The mortalities were the result of the tagging operations which included anesthetic bath, handling for tagging and recovery in pursed cages. The mortality was higher than expected and was probably acerbated by the lateness of the tagging operation and smolt release. Based on catches at the Cassilis trapnet, the majority of the smolt run was complete by the time the smolts were released. A total of 4,873 tagged smolts were released into Little River, tributary of the Northwest Miramichi upstream of Miner's bridge. From these almost 5,000 releases, 241 smolts were recaptured at the Cassilis trapnet. Movement of smolts was very rapid. In the three separate releases, from half to three-quarters of the total recaptures were observed within 24 hours of release, a distance of more than 50 kilometres downriver. The ratio of smolts recaptured relative to the number of smolts released indicates that the Cassilis trapnet sampled about 5% of the smolt run. If we assume the efficiency of the trapnet during the month of May of 5%, then the estimated smolt run from the Northwest Miramichi was about 130,000 smolts. This is probably an underestimate of the smolt run for two reasons:

1 - the trap catch count of more than 1,800 smolts on May 16 was not completed because darkness set in. The trap was reset without emptying the smolts from the trap. The trap crew felt that there was easily as many smolts left in the trap as had been counted.On the morning of May 17, the trap was fished and a total of 1,000 smolts were counted indicating that many of the smolts from the previous night had escaped.

2 - the trap was lifted on May 23 for almost 24 hours because of high water conditions. Some of the smolt run was likely missed during that event.

It is impossible to place an upper bound on the smolt run of 1998 but the most plausible values are in the order of 250,000 fish, not half to one million fish as might be expected based on relative juvenile densities and previous estimates of smolt production from the Miramichi.

CONCLUSIONS AND FUTURE INITIATIVES

There were a few attempts to estimate the smolt production from the Miramichi River in the 1950s and 1960s. During those years, smolt production from the Miramichi ranged between one and three million per year (Kerswill 1971). With the Northwest Miramichi representing about 1/3 of the production area, previous smolt production levels for the Northwest were in the order of 300 thousand to almost 1 million fish. The smolt production estimate in 1998 is substantially less than the levels estimated in the 1950s and 1960s.

The smolt trapping initiative in 1998 provided some critical experience in refining the study for 1999 and beyond. The trapnet was a very effective gear for sampling the smolts in the estuary. In 1999, it is proposed that the Cassilis trapnet be used for capturing smolts to be marked and a lower estuary trapnet near Newcastle be used for sampling the entire smolt run and recapturing marked smolts. Trapnets in the estuary can be fished under discharge conditions which preclude in-river capture gear such as fish fences. Marking of smolts using numbered streamer tags is also a critical component of the study to ensure that the efficiencies of the trapnet can be properly estimated, especially if the efficiencies vary over the season.

ACKNOWLEDGEMENTS

Numerous individuals and organizations contributed to the success of the program. The study would not have been possible without the interest and enthusiasm of the Northumberland Salmon Protection Association who sponsored the study through funding received from the New Brunswick Wildlife Trust. Moneys received from the trust were used to purchase the special, minimally intrusive streamer tags for marking smolts and to provide the critical labour for sampling the catches at the estuary trapnet. Local university students from the Miramichi area, Wendy Hoeksma, Trevor Cavanaugh, Jeri Traer, and Cheryl Morrison provided field assistance at the trapnets during the entire study period. Students were provided through funds from the New Brunswick Wildlife Council Trust Fund and the Federal Government's Summer Career Placement Program. Critical DFO Science staff included Dave Moore, John Hayward, Joe Sheasgreen, and Scott Douglas.

Appendix 5 . Detailed distribution records of salmonids from the Miramichi Salmonid Enhancement Centre in 1998.

LOCATION	dd	mm	yr	Mark	SPC.	STOCK	RIVER	Program	Stage	#FISH
Little River	28-30	5	98	3	A	NW Mir.	NW	Heath Steele	2+ Smolts	5,100
Renous R. below mouth of Dungarvon R.		5	98	3	A	Dungarvon	SW	Renous Ponds	2+ Smolts	12,500
Renous R. - McGraw Brook		5	98	3	A	Dungarvon	SW	Renous Ponds	2+ Smolts	12,500
North Branch Renous River		5	98	3	A	Dungarvon	SW	Renous Ponds	2+ Smolts	12,500
Mouth of Dungarvon River		5	98	3	A	Dungarvon	SW	Renous Ponds	2+ Smolts	2,500
Russell Swim Bdg.; Dungarvon R.	2	6	98	2	J	Dungarvon	SW	Hatchery	0+ Parr	7,857
Iron Bdg., Holtville; Dungarvon R.	2	6	98	2	J	Dungarvon	SW	Hatchery	0+ Parr	7,857
Throughout Buctouche River	9	6	98		J	Buctouche		Hatchery	0+ Parr	23,600
Black & White Pool	10	6	98	2	J	NW Mir.	NW	Hatchery	0+ Parr	3,940
Bridge Pool	10	6	98	2	J	NW Mir.	NW	Hatchery	0+ Parr	3,940
From Furlong Bdg to Russell Swim Bdg.	17	6	98	2	J	Dunagrvon	SW	Hatchery	0+ Parr	65,000
LSW Miramichi		6	98	2	J	LSW Mir.	NW	Hatchery	0+ Parr	22,625
Gillman Brook; Stanley	28	9	98	3	J	Juniper	SW	Satellite	0+ Parr	8,000
Salmon Brook; Stanley	3	10	98	3	J	Juniper	SW	Satellite	0+ Parr	4,996
Deadman Brook; Stanley	3	10	98	3	J	Juniper	SW	Satellite	0+ Parr	4,958
Camp Adams, NW Miramichi	7	10	98	3	J	NW Mir.	NW	Satellite	0+ Parr	4,500
Tower Road, SW Mir.	11	10	98	3	J	Cains	SW	Satellite	0+ Parr	1,975
Black Brook, SW Mir.	11	10	98	3	J	Cains	SW	Satellite	0+ Parr	1,975
Falls Black Brook, SW Mir.	11	10	98	3	J	Cains	SW	Satellite	0+ Parr	1,975
East Branch 6 mile; Blissfield	12	10	98	3	J	Cains	SW	Satellite	0+ Parr	1,975
Main Branch 6 mile; Blissfield	12	10	98	3	J	Cains	SW	Satellite	0+ Parr	1,975
Main South West Miramichi, Ludlow	14	10	98	3	J	Juniper	SW	Satellite	0+ Parr	1,658
Main SW Miramichi, Mouth of Cains R.	14	10	98	3	J	Cains	SW	Satellite	0+ Parr	1,631
Mountain Channel Brook	14	10	98	3	J	Cains	SW	Satellite	0+ Parr	1,657
Cains R., East Branch 6 mile	14	10	98	3	J	Cains	SW	Satellite	0+ Parr	1,658
Salmon Brook; Blackville	14	10	98	3	J	Cains	SW	Satellite	0+ Parr	1,656
White Rapids Brook; Blackville	14	10	98	3	J	Cains	SW	Satellite	0+ Parr	1,657
Buttermilk & Salmon Brook; Cains River	14&15	10	98	3	J	Cains	SW	Satellite	0+ Parr	4,977
Beckets Brook; Blackville	15	10	98	3	J	Cains	SW	Satellite	0+ Parr	1,657
Slate Island Brook; Stanley	17	10	98	3	J	Juniper	SW	Satellite	0+ Parr	4,794
Harris Brook; Ludlow	18	10	98	3	J	Juniper	SW	Satellite	0+ Parr	1,630
Mamies Brook; Ludlow	18	10	98	3	J	Juniper	SW	Satellite	0+ Parr	1,631
Harris Brook; Ludlow	18	10	98	3	J	Juniper	SW	Satellite	0+ Parr	2,430
Mamies Brook; Ludlow	18	10	98	3	J	Juniper	SW	Satellite	0+ Parr	2,430
Big Teague, L. Teague, Elliot Brk, S. Br. MSW	19	10	98	3	J	Juniper	SW	Satellite	0+ Parr	11,500
Big Teague, L. Teague, Elliot Brk, S. Br. MSW	19	10	98	2	S	SW Mir.	SW	Satellite	0+	12,500
Travis Brook, South Br. Sevogle	22	10	98	3	J	Sevogle	NW	Satellite	0+ Parr	6,870
Fullerton Brooko; Sisters Brook	27	10	98	3	J	Rocky Brook	SW	Satellite	0+ Parr	1,540
Henneman Forks; Sisters Brook	27	10	98	3	J	Rocky Brook	SW	Satellite	0+ Parr	1,541
Pond Brook, Clearwater Brook	27	10	98	3	J	Clearwater	SW	Satellite	0+ Parr	4,672
Hurd Brook; Rocky Brook	27	10	98	3	J	Rocky Brook	SW	Satellite	0+ Parr	4,622
L.L. Road; Rocky Brook	4	11	98	3	J	Rocky Brook	SW	Satellite	0+ Parr	7,000
Sisters Brook	4	11	98	3	J	Rocky Brook	SW	Satellite	0+ Parr	2,000
NW Mir.; Red Bank wharf, Cassilis	10&17	11	98	3	S	NW Mir.	NW	Hatchery	0+	74,350
Bridge @ Grand Lake Rd.	12	11	98	3	J	Cains	SW	Hatchery	0+ Parr	1,204
French Fort Cove, Miramichi R.	19	11	98	2	S	NW Mir.	MIR.	Hatchery	0+	5,000
White Rapids Brook/Smiths Lake	25	11	98	2	S	NW Mir.	SW	Hatchery	0+	5,000
NW Mir.; Stewart Brook - Johnson Bdg.	18 - 26	11	98	2	S	NW Mir.	NW	Hatchery	0+	201,045
Clearwater; Stanley			98	3	S	SW Mir.	SW	Satellite	0+	
Total										580,558

Codes: SPC: A - Smolts; J - Non-smolts; S - Brook trout

Mrk - 3; adipose clip; - 2; no mark