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STOCK STATUS OF ATLANTIC SALMON (*Salmo salar*) IN THE MIRAMICHI RIVER, 1996

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ABSTRACT

Atlantic salmon (*Salmo salar*) in the Miramichi River, New Brunswick, were harvested by two user groups in 1996; First Nations and recreational fishers. The Aboriginal food fishery catches in 1996 represented an increase of 37% for small and 33% for large salmon relative to the previous five years. Just over half of the large salmon (54%) harvests and 75% of the small salmon harvests were taken prior to Sept. 1 in 1996. Recreational fishery catches for 1996 were not collected. The Crown Reserve catches suggested that angling catches were similar to the 1990 to 1994 average catch. For the Southwest Miramichi, 30241 small salmon and 15734 large salmon were estimated to have returned in 1996. After accounting for all removals, egg depositions in the Southwest Miramichi by both small and large salmon were 114% of the conservation requirement. For the Northwest Miramichi, 18884 small salmon and 7957 large salmon were estimated to have returned. Egg depositions by small and large salmon in the Northwest in 1996 were 132% of conservation requirement. Egg depositions have exceeded the conservation requirements in each branch during the last five years. The 1997 forecast for large salmon returning to the Miramichi is 29933 with a 72% probability of meeting spawning 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 is for continued and increased abundance of salmon.

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 1996, les captures de grands saumons dans les pêches autochtones ont augmentés de 33% par rapport à la moyenne des années antérieures tandis que les captures de madeleineaux (<63 cm longueur à la fourche) ont augmenté de 37%. Près de la moitié des grands saumons (54%) et 75% des madeleineaux récoltés par les autochtones provenaient de la remontée d'été (avant le 1er septembre). Les statistiques de captures de madeleineaux et de grands saumons dans la pêche récréative n'ont pas étés receuillis en 1996. Mais la tendance des captures observées dans les eaux de réserves de couronne indiquaient que les captures en 1996 étaient similaires à la moyenne des années 1990 à 1994. La montaison de saumon dans la rivière Miramichi sud-ouest s'est situé à 30 241 madeleineaux et 15 734 grands saumons. Les géniteurs auraient contribué à une ponte d'oeufs équivalente à 114% des besoins de la conservation pour la rivière Miramichi sud-ouest. Dans la Miramichi nord-est, la montaison a été estimée à environ 18 884 madeleineaux et 7 957 grands saumons. Les géniteurs de cette montaison auraient contribué une ponte d'oeufs équivalente à 132% des besoins de la conservation. Durant les cinq dernières années, les pontes d'oeufs ont été supérieures aux besoins pour les deux affluents principales de la Miramichi, le sud-ouest et le nord-est. La prévision de la remontée de grands saumons pour 1997 est 29 933 poissons. Il est toutefois probable, à 72%, que la remontée soit égale ou 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 à celles observées récemment.

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 . Until 1991, the assessments dealt exclusively with returns and escapement to the entire river (Randall and Chadwick MS1983a, b; Randall and Schofield MS1987, MS1988; Randall et al. MS1985, MS1986, MS1989, MS1990; Moore et al. MS1991, MS1992). Since 1992, assessments of the Northwest and Southwest branches have been prepared (Courtenay et al. MS1993; Chaput et al. MS1994b, MS1995, MS1996).

There is considered to be two runs of Atlantic salmon in the Miramichi River (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. Two size groups of salmon return to the river to spawn. The small salmon category consists of salmon of fork length less than 63 cm 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 of fork length greater than or equal to 63 cm. 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. 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 further still into early and late run. We estimate egg depositions for each run in each branch by incorporating the variability in run composition (sex ratio and size of fish which determines the fecundity). 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.

Outstanding issues from the previous assessment include:

1. a review of fecundity data from the Miramichi Salmonid Enhancement Centre (South Esk) to determine if the length-to-fecundity relationship currently used is valid,

2. a presentation and analysis of the age composition over time with particular reference to the changes in management measures which have taken place.

New features for 1996 include:

1. conservation requirements for the Miramichi are stratified into sub-areas of the Northwest and Southwest Miramichi branches,
2. risks to meeting conservation requirements relative to harvest options in 1997 are presented by combining the uncertainty in the expected returns of large salmon in 1997 and the variability in the biological characteristics of salmon returning annually.

Input from industry, user groups and other government agencies was obtained during a science assessment workshop held in Miramichi City (NB) on January 7, 1997 (minutes in Appendix 1). Peer review notes are available under separate cover (Anon. 1997).

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 1996; 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 1996, the Eel Ground First Nation fished two food fishery trapnets in the Northwest Miramichi and two food trapnets in the Southwest Miramichi. New in 1996 was the operation of a partial counting fence at Big Hole Tract for the selective harvest of small and large salmon (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 no significant changes in recreational fishery regulations in 1996 relative to previous years (Moore et al. MS1995) (Table 2). Individual recreational quotas remained in effect: daily limits of 2 small salmon kept (<63cm fork length) and a maximum of 8 kept for the year, hook and release only of all large salmon (>= 63 cm fork length). In contrast to 1995, there were no river closures in 1996 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. An additional change to the Crown Reserve management in 1996 was the splitting of the Depot Stretch into two parts resulting in an additional two rod-days of effort available in 1996 relative to previous years. Crown Reserve stretches were also made available to anglers up to September 15 whereas in previous years angling on these stretches closed August 31.

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. Small salmon harvests were divided 53% from the Northwest Miramichi and 47% 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 1996 were 317 large salmon and 1233 small salmon. A total of 1074 small salmon were harvested from the Southwest Miramichi. The Burnt Church First Nation reported harvests of 55 large salmon and five small salmon. The harvests reported in Table 3 are exclusive of those taken off waters specified in the Aboriginal Communal Fishing licenses.

Gillnets accounted for 26% of the large salmon harvest from the Miramichi and 15% of the large salmon harvests from the Northwest branch. Gillnets in the Northwest Miramichi accounted for 11% of the small salmon harvest from the Northwest. The Eel Ground First Nation released all the large salmon from the food fishery trapnets (930 salmon) and 54% of the small salmon catch (1709 of 3148 small salmon). The Red Bank First Nation released 14% of the large salmon catch (43 of 308 large salmon) and 21% of the small salmon catch (201 of 944 small salmon). The food fisheries mainly targeted the early run for small salmon (75% of harvests were taken prior to September 1) but just over half of the large salmon were harvested from the early-run (54%). The Aboriginal food fishery harvests in 1996 represented an increase of 37% for small salmon and an increase of 33% for large salmon relative to the previous 5-year mean (Table 4).

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.

The final FISHSYS catch values for 1995 are presented (Table 5, Fig. 2). For 1996, the FISHSYS survey was not conducted therefore no catch estimates for 1996 are available.

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 fluctuate 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 1996 was among the highest since 1984 and the fourth highest ever (Fig. 3; Table 5). Catches of small salmon were 4% higher than the 1990 to 1994 mean. Large salmon catches were 13% higher than the 1990-1994 mean.

Quarryville Pool Creel Survey

A creel survey was conducted at Quarryville Pool during the period June 17 to October 15, 1996. Quarryville Pool is the first pool on the Southwest Miramichi, located at the confluence of the Renous River and the Southwest Miramichi (Fig. 1). The objectives of the survey were to quantify the variation in catches and effort over the season and to estimate the proportion of the angled catch which was adipose-clipped (fish of satellite rearing or semi-natural pond rearing origin). Angling activity for the entire pool could be easily monitored from a vantage point on the northeast bank. Angling activity was generally monitored from 6:00 AM to 10:00 PM every day of the week. Catches and effort were summarized by week. Catches from days with incomplete observations or days not sampled were estimated from the average catch per effort (catch per part of day sampled: AM (6:00 to 14:00) PM (14:00 to 22:00)). The angling effort (hours of fishing activity) was estimated by counting the active rods in the pool every fifteen minutes. Small salmon kept, small salmon released and large salmon released were obtained by direct observation of activity in the entire pool. Part of the small salmon catch, those small salmon landed on the same side of the river as the creel clerk, was sampled for the presence of a carlin tag and the presence of the adipose fin (presence indicating an origin other than satellite-rearing or semi-natural pond stocking).

The estimated catch of small salmon and large salmon by week for 1996 compared to similar surveys in 1993 and 1995 are summarized in Figure 4. Angling catch in 1996 was better early in the season for both small and large salmon. Fall angling catch for small salmon in 1996 was better than in 1995 but much poorer than in 1993. For large salmon, fall angling catch was worse in 1996 than in 1993 and 1995. Estimated catches at Quarryville Pool for the years surveyed were:

	1996	1995	1993
Small salmon (kept and released)	379	212	674
Large salmon (released)	73	95	116

All of the small salmon sampled had an adipose fin.

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 1996, recreational exploitation of tagged small salmon was greatest for fish marked in June and July. This pattern was similar to that observed in 1992. Exploitation has generally been heaviest on the early run fish and decreases progressively for September and October tag groups.

Percent of tags returned 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%

Illegal removals/seizures

A total of 10 nets were seized in the waters of the Northwest Miramichi in 1996. Only a few nets were removed from the Southwest Miramichi (B. Scott, DFO Conservation and Protection Branch, pers. comm.). The total number of fish in the seized nets was 11 small salmon and 3 large salmon from the Northwest Miramichi. From the Southwest Miramichi, three small salmon and one large salmon were seized. The small number of seizures in 1996 in part are the result of reduced effort on the river by enforcement staff but could also be related to the more significant penalties being imposed by the courts.

Broodstock collections

In 1996, a total of 71 large salmon and 66 small salmon were collected and spawned at the Miramichi Salmonid Enhancement Centre (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 largest single removal was from the Dungarvon River for subsequent production of smolts at the semi-natural rearing ponds on the Renous River. The collections in 1996 were similar to those of 1995.

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:

	Habitat area (m^2)	Eggs required	Fish equivalents	
			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). The proportion female and the fecundity were selected at random from the observed values between 1971 and 1996 (selected by year, not individually) (Fig. 5). 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 (Fig. 6). 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 (Fig. 6).

RESEARCH DATA

Data collected in 1996 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). The food/science trapnets operated by Eel Ground First Nation (two in each branch) 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. 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.

The Eel Ground food/science trapnets and leaders were constructed of 5 cm knotted stretched mesh, identical to those used in 1994 and 1995. The Millerton trapnet was constructed of 5.5 cm stretched mesh, knotless twine and the leader was constructed of 12.5 cm knotted stretched mesh. The leaders at the Red Bank trapnets were constructed of 12.5 cm knotted stretched mesh twine.

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 1996 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.

Voluntary returns of tags from the angling fishery were used to describe the emigration of tagged fish outside the branch where they were originally marked (Appendix 2).

Juvenile Surveys in the Miramichi River

Electrofishing surveys were conducted at 46 sites (21 in the Northwest Miramichi and 25 in the Southwest Miramichi) between August 27 and September 17, 1996. Thirteen of these sites have been sampled every year since 1970. A combination of open (42 in total) and closed (4 in total) sites was used. 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 50 sites between 1993 and 1996 are given in Appendix 3. Percent habitat satuation (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). At several sites, whole weights to the nearest 0.1 g were obtained from mortalities. Large eels were counted but not measured. Fish were anesthetized, using sodium bicarbonate salts, before measuring.

ESTIMATION OF STOCK PARAMETERS

Estimation of Returns

The objectives of the assessment were to estimate the returns to each branch for early and late-run periods. The returns to the Miramichi River were estimated from the sum of the returns to each branch. There are two approaches to estimating returns to each branch:

1 - calculate returns to each branch separately by adjusting the tags available for recapture based on the emigration rate estimates described below, or

2 - use spatially stratified estimators to estimate returns to each branch, and the total, simultaneously.

The tag and recapture matrices differ between the two methods (Table 8). In the first approach, fish tagged at Millerton in the Southwest Miramichi and recaptured at the Red Bank (Northwest Miramichi) trapnets can be used. These additional recoveries (23 small salmon and 3 large salmon, Appendix 2) represent 32% of the small salmon recaptures and 18% of the large salmon recaptures at Red Bank. These data would be ignored in method 2 because the Millerton trapnet would be treated exclusively as a recapture trapnet. Method 2 is attractive because it directly calculates the emigration rates. These emigration rates, based on trapnet recoveries, do not necessarily correspond to the rates obtained using angling recoveries.

Only marks placed up to and including Oct. 15 are considered to be available for recapture.Tagging in the Southwest finished on Oct. 14 while in the Northwest, the last day of tagging was Oct. 18. The recapture trapnets in the Northwest Miramichi and the Millerton trapnet on the Southwest Miramichi fished until Oct. 18. 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. 18.

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 1996, salmon with tagging scars were recorded at the tagging trapnets in the Northwest and Southwest but none at the recapture traps. 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 does occur because in the fall of 1996, one salmon was caught at the trapnets with an artificial fly embedded in its jaw (two such fish were observed in 1995). Since all fish at the trapnets are examined for tags and tagging scars, recaptures were considered known without error.

2 - In the 1994 tag retention experiment, none of the tagged broodstock fish held for about 60 days had shed their tags in the hatchery tank. This result was similar to the 1992 experiment on small salmon (Courtenay et al. MS1993). Similar experiments conducted for the Margaree River assessment indicated that tag shedding for large salmon was in the order of 1% per day (Chaput et al. MS1994a). 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). Mortalities of tagged fish (1 large salmon and 2 small salmon) were recorded in the river in 1996 (Appendix 2). 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).

3 - Tagged fish frequently migrated out of the branch in which they were tagged (Appendix 2). The emigration rate of marked fish out of the branch where they were tagged was calculated using recaptures from angling (Chaput et al. MS1995). If we assume that the reporting rate of tags from the angling fisheries in the Northwest and Southwest branches are identical (but unknown), and that the return rate (RR) of tags through the mail is a function of the exploitation rate factored by the tag reporting rate, then we can estimate the rate of emigration out of the branch where they were tagged using the following two equations:

$$\frac{NWTR_{NW}}{RR_{NW}} + \frac{NWTR_{SW}}{RR_{SW}} = \text{Total Tags}_{NW}$$

$$\frac{SWTR_{NW}}{RR_{NW}} + \frac{SWTR_{SW}}{RR_{SW}} = \text{Total Tags}_{SW}$$

where $NWTR_{NW}$ = Northwest tags returned from Northwest Miramichi angling (known),
$NWTR_{SW}$ = Northwest tags returned from Southwest Miramichi angling (known),
RR_{NW} = return rate of tags angled in the Northwest Miramichi (unknown),
RR_{SW} = return rate of tags angled in the Southwest Miramichi (unknown),
Total $Tags_{NW}$ = total tagged fish released in the Northwest Miramichi (known),...

Angling tag returns of both small and large salmon up to Oct. 15 were used to estimate the emigration rates (Table 9) because:

1 - we need to estimate emigration rates for both size groups,
2 - large salmon emigration rates could not be estimated because of insufficient returns of large salmon tags,
3 - sample sizes were insufficient in early and late periods to provide emigration rate estimates.

The point estimates and the resampling estimates for small and large salmon emigration in 1995 were:

	Emigration rate to other branch		
Origin	Point Estimate	Resampling median	90% C.I.
Southwest			
Lower	0.231	0.196	0.033 to 0.613
Millerton	0.235	0.230	0.131 to 0.418
Northwest	0.297	0.289	0.162 to 0.544

The uncertainty around the estimation of returns consists of two or three 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 of the emigration rate was estimated by resampling within the rows of the observed matrix of angling returns, the rows representing the tag returns from either the Northwest or Southwest Miramichi with tagging origin as the columns. Prior probabilities of tag origin were set at the observed proportions in the tag returns from angling.

3 - 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.

For the spatially-stratified approach which did not use the emigration rate component, only tag loss and the stochastic variation in recaptures (1 & 3) were considered.

Returns by size, season and branch were obtained using a resampling technique as follows:
Step 1: select a tag loss/tag mortality factor, estimate emigration rate, 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 (2000 replications were performed)
Step 4: summarize distribution of returns from step 3.

Performance and appropriateness of models

The estimation of the returns to the Miramichi are complicated by several factors:
1 - estimation of returns to separate branches
2 - movement of tagged fish between branches
3 - potentially different marking and recapture proportions in each branch
4 - potentially differing efficencies by season

There are two stratified estimators available: the Schaefer model (Ricker 1975) and the Darroch model (Arnason et al. 1995). Recent studies have indicated that the Schaefer model is unbiased if there are either constant tagging rates or constant recovery rates (in temporal stratification, this would mean either constant tagging proportion or constant recapture probabilities in early and late runs) (Arnason et al. 1995). Under these conditions, the authors indicated that the pooled Peterson estimator is also unbiased and more precise (because it uses the aggregated recaptures). The Darroch model does not require the rigid assumptions of the pooled Peterson and Schaefer model. It will be less biased but also less precise than the pooled Peterson when the probability of capture or recapture varies but the unbiasedness outweighs the loss of precision (Arnason et al. 1995). The Schaeffer model is attractive because it always gives apparently plausible results. The Darroch model on the other hand will not arrive at a solution when there is insufficient information in the data (for example, recaptures in strata frequently 0 or less than 5). This should not be construed as model failure but rather data failure. Hilborn and Walters (1992; p. 309) warn against the stock assessment approach where obtaining any answer as long as it appears to make sense is preferrable to being unable to estimate the parameters of interest.

In previous assessments, returns to each branch by early and late-run periods were obtained using the Schaefer model after estimation of the emigration rates (adjusting the tags available for recapture in each branch using the estimates of emigration rates from angling recoveries). Since every mark and recapture experiment has its unique features, we have attempted to address the performance of the Petersen, Schaeffer and Darroch models under the specific conditions which apply to the Miramichi.

The movements of salmon into the Miramichi were simulated under the following conditions:
1 - the relative size of the runs to the two branches are different with the Southwest run twice as large as the Northwest run (this is based on the relative habitat areas of the two branches)
2 - emigration of tagged fish occurs between the two branches
3 - variable efficencies of tagging and recapture nets between branches and between early and late-runs to the river.

Details of the simulations and results are in Appendix 4. Estimates of the emigration rate between branches are unbiased when calculated using the method described above. Since 1994, the emigration rates from the Northwest have been higher than from the Southwest.

	Emigration rate		
	1996	1995	1994
Northwest trapnets	33%	36%	37%
Southwest trapnets	20%	26%	13% (Enclosure + Millerton)
Southwest Millerton	21%	8%	

Under this condition (emigration from the smaller tributary greater than emigration from the larger tributary), the estimates of the returns to the Miramichi were unbiased for all three models (Appendix 4). Estimates of returns to each branch were biased and the direction of bias depended upon the emigration rate conditions and the efficiencies of the marking and recapture trapnets. For the Miramichi, emigration rate is greater from the small branch. For this condition, regardless of the tagging and recapture efficiencies in the individual branches, the returns to the small branch are overestimated and the returns to the large branch are underestimated. The overestimation (in terms of percent difference) was more important for the small branch than was the underestimation in the large branch (a 10% overestimation in the small branch translates to about a 5% underestimation of returns from the large branch under the conditions in the simulations).

In summary, the simulations indicate that if the Schaeffer model is used, the Northwest returns will be overestimated and the Southwest returns will be underestimated. The returns estimates to the Miramichi should be unbiased.

Temporal stratification

There were higher proportions of late tags recovered at the recapture trapnets than early tags for both small and large salmon (Table 10). The differences were significant ($P < 0.05$) for both size groups (Chi-square test of independence, d.f. = 1). This suggests that the recapture gears were more efficient at recovering late-run tagged fish.

An alternative hypothesis is that the survival rate to the recapture gear of early-run tagged fish was lower than that of late-run fish. Although mortality rates could not be directly estimated, we considered whether recovery rates were different between tagging locations. The control trapnet was the Southwest Millerton trap which was fished by experienced D.F.O. Science staff. The tagging trapnets in the Northwest and Southwest were fished by various experienced crews from the Eel Ground First Nation. We compared the recovery rate of fish tagged at the lower traps (Eel Ground tagging trapnets) to the recovery rate of fish tagged at the Southwest Millerton trapnet. Tags were recovered in the angling fisheries, at headwater barriers and counting fences and in broodstock seining expeditions. There were no significant differences (P 0.05) in recovery rates of small and large salmon tagged at the lower tagging traps relative to those tagged at the Southwest Millerton trapnet (Table 10). Only the large salmon from the early run tagged at the Southwest trapnets had a recovery rate which could be considered significantly different ($P = 0.05$) from the Southwest Millerton rate.

Because of the apparent different efficiencies for the early-run and late-run periods at the recapture traps, temporally stratified models (Schaeffer and Darroch) were used. The Petersen model assumes that efficiencies are similar over the two periods. When efficiencies are different, as appaears to be the case in 1996, the Petersen estimate will be negatively biased.

Returns to the Southwest Miramichi in 1996

An estimated 29200 small salmon returned to the Southwest Miramichi in 1996 with a 95% probability that the returns were more than 19000 fish (Table 11). By season, just under 22500 small salmon returned early and 6500 returned in the late run. Large salmon returns were estimated at 15734 fish with a 95% probability that the returns were at least 9500 fish (Table 11). Just over 7600 large salmon returned early and 7500 returned in the late run. Estimates using the pooled Peterson were lower than the Schaefer estimates whereas the Darroch model estimates were higher.

The large salmon returns to the Southwest Miramichi, estimated with the spatially stratified matrix, were not obtainable with the Darroch model (negative population values were obtained in more than 10% of the replications) whereas the Schaefer estimate for the Southwest was 11504 fish, 27% lower than the estimate using the emigration rate procedure (Table 11). Small salmon estimates from the Schaefer model were 34% lower than the corresponding estimates from the emigration rate procedure while the Darroch model estimated returns which were 53% lower than the Darroch derived values from the emigration rate procedure. The coefficients of variation (CV) of the Schaefer derived estimates were about 20%.

The overall efficiency of the Millerton recapture trap in 1996 was similar to 1994 and 1995 for small salmon but lower for large salmon than in 1994 and 1995. Lower efficiency in 1996 relative to the previous two years was expected because of high water levels which prohibited the fishing of the trapnet between July 13 and 18 . No washouts were encountered in the previous two years.

			Efficiency		
	Catch	Return	1996	1995	1994
Small salmon	2192	29167	7.5%	7.7%	7.9%
Large salmon	757	15734	4.8%	8.8%	6.9%

An alternate estimate of the efficiency of the Southwest Miramichi recapture trapnet was obtained from recoveries of fish tagged downstream of Millerton and recovered upstream of the trapnet. These recaptures of salmon in freshwater in the Southwest Miramichi included recoveries from angling, at barriers and fences, and from broodstock seining. The data for this estimate were:

M=79 Tags applied downstream of the Millerton trap and recaptured upstream in the Southwest Miramichi (29 large and 50 small). These fish had to pass by the Millerton trapnet.

R=4 A total of 4 of the 79 tags recovered upstream were initially intercepted at the Millerton trapnet and released (1 large and 3 small).

This provides an efficiency estimate for the Millerton trapnet for the entire season of 5.1% (4 / 79). A total of 757 large salmon were sampled at the Millerton trapnet which gives a return estimate to the Southwest of 14843 fish, identical to the estimate from the complete mark and recapture experiment. A similar calculation for small salmon (2192 sampled) yields an estimated return of 42980 fish, 47% higher than the Schaeffer estimate.

Returns to the Northwest Miramichi in 1996

About 18248 small salmon returned to the Northwest Miramichi in 1996 with a 95% probability that the returns were more than 12561 fish (Table 11). By season, just under 9000 small salmon returned early and 3158 returned in the late run. Large salmon returns were estimated at 7910 fish with a 95% probability that the returns were at least 4777 fish (Table 11). Early and late returns of large salmon were estimated at 3219 fish and 4541 fish, respectively. Estimates using the pooled Peterson were only 57% for large salmon and 71% for small salmon of the Schaefer derived values. The Darroch model estimates were 12% higher for large salmon and 19% higher for large salmon than the Schaefer derived values (Table 11).

With the spatially stratified matrix, the large salmon returns to the Northwest Miramichi were estimated at 5091 fish with the Schaefer model and 7402 fish with the Darroch model (Table 11). Compared to the emigration rate derived procedures, the Schaefer estimate was 36% lower and the Darroch estimate was 17% lower than the emigration rate derived estimates. For small salmon, the Darroch estimate from the spatially stratified matrix was 37% lower than the emigration rate derived value and the Schaefer estimate was 40% lower (Table 11). The CV's of the Schaefer derived estimates were also low for small salmon, about 10%.

As with the Southwest Millerton trapnet, the overall efficiency of the Red Bank recapture trapnets (2) was lower in 1996 relative to 1995. A lower efficiency in 1996 would have been expected as a result of the high water conditions in late July which prohibited fishing one of the trapnets for a period of 10 days and the other for 5 days between July 13 and 23.

			Efficiency		
	Catch	Return	1996	1995	1994
Small salmon	757	18248	4.1%	6.5%	6.7%
Large salmon	358	7910	4.5%	5.6%	3.9%

Returns to the Miramichi River in 1996

In 1996, 24078 large salmon and 42662 small salmon returned to the Miramichi River (Table 11). With the spatially stratified matrix, the large salmon returns to the Miramichi were estimated at just under 16594 fish with the Schaefer model and 15860 fish with the Darroch model (Table 11). The Darroch calculation for the Miramichi was not useful because of the very high coefficient of variation (CV). The spatially derived Schaefer estimate was 31% below the emigration rate estimate. For small salmon, the

Darroch and Schaefer model estimates were essentially identical, about 30000 fish but 30% lower than the emigration rate derived values. The precision was much better (CV's of about 9% compared to CV's of 18% to 20% from the emigration rate procedure). There was a 5% chance that returns of small salmon to the Miramichi were under 36000 fish (emigration rate derived method, Schaefer). Using the spatially stratified matrix approach, there was only a 5% chance that the returns of small salmon were greater than 35000.

We have chosen the emigration rate derived values for the estimation of returns in 1996 because the estimates obtained with the spatially stratified approach assume that fish recovered at the recapture trapnets are all destined to stay in that branch. From the 1994 tagging study (Chaput et al. MS1995) and the recoveries of fish tagged at the Millerton trapnet in the Red Bank trapnets in 1996, we know that this is not true. The spatial stratified matrix approach also assumes that the efficiency of the recapture trapnets is constant over time. It has been shown in a previous section that the chance of constant efficiency over the season of the recapture trapnets is very small (less than 5% for large and less than 1% for small salmon). A temporally stratified method would account for the differences in efficiency.

Estimation of Egg Depositions in 1996

The estimated egg depositions in 1996 are obtained from the estimates of the escapement of small and large salmon and the biological characteristics of the salmon in 1996.

Escapement in 1996

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

The total harvests and removals of salmon from the Miramichi River in 1996 were 19565 small salmon and 702 large salmon (Table 12). Total removals in the Northwest Branch were 7182 small salmon and 391 large salmon whereas Southwest Branch removals were 12378 small salmon and 256 large salmon.

The point estimates of escapements of small and large salmon in each branch by season are summarized in Table 13. Just under 19000 small salmon and 8000 large salmon returned to the Northwest Miramichi in 1996. Escapements of small salmon and large salmon were just under 12000 and 7600 fish respectively (Table 13). In the Southwest Miramichi, just over 30000 small salmon and about 16000 large salmon returned in 1996 of which 18000 small salmon and about 15500 large salmon were estimated to have escaped the fisheries (Table 13). Overall for the Miramichi in 1996, about 44000 small salmon and 24000 large salmon returned in 1996 with escapements of 25000 small salmon and 23400 large salmon.

Biological Characteristics of Salmon in 1996

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.

Sex ratios

The percent female in the small salmon component was significantly higher in the early run than in the late run for both Southwest and Northwest samples (Table 14). The sex ratios of small salmon were similar in the two branches for late run (6.1% female) but there was a significantly higher percent female in the small salmon from the early run in the Northwest (32%) compared to the early run in the Southwest Miramichi (19%) (Table 14). Large salmon were the majority female in both the Northwest and Southwest branches (Table 15). The early run salmon had a higher percent female component (87%) than the late run (80%) but the differences were only significant for the Northwest Miramichi Red Bank samples. The proportion female (81%) observed in 1996 was lower than the the 89% female component observed in 1995 but similar to that observed in 1994 (80%) (Chaput et al. MS1996). Broodstock seining samples generally supported the sex ratios observed at the trapnets (Table 16). There was a very high female proportion observed in the small salmon samples from the Little Southwest Miramichi. Such high female proportions (in the order of 60%) were also observed in the Little Southwest in 1994 and 1995 (Chaput et al. MS1995, MS1996). This suggested that only very early run fish (June and July) had managed to reach the upper stretches in 1995 but water conditions in 1996 would not have impeded the upstream migration of later migrants. The consistently high female ratio in that stretch of the river observed over the last three years suggests that the upper Little Southwest stock may be of different age structure than most of the other areas, i.e. it may be primarily a 1SW salmon stock (such stocks tend to have a high female proportion). Rocky Brook and Clearwater Brook in the Southwest Miramichi are also early-run stocks and the proportion female in these tributaries is more similar to the Miramichi River overall, less than 30% female in the early run (Table 16).

Size and age

The early runs in both the Northwest and Southwest Miramichi were dominated by small salmon (Table 11, Fig. 7, 8). In the Northwest Miramichi, small salmon represented 70% of the returns compared to 64% of the returns to the Southwest. In the late run, large salmon were more abundant in both the Northwest and Southwest branches (55% of all fish). Small salmon in the fall run were slightly longer than in the early run but the average fork length of the large salmon decreased slightly (Table 17). Based on an age-length key, previous spawners made up 36% of the large salmon in the Northwest and 30% in the Southwest Miramichi with previous spawners more abundant in the late run (Table 17). For 1995, a similar age-length analysis indicated that previous spawners comprised about 20% of the returns. Age determinations of the 1995 samples indicated that previous spawners represented 13% of the large salmon returns in the Southwest and Northwest rivers. The age-length distribution provides only a first approximation of the proportion previous spawners in the large salmon category.

Egg depositions in 1996

In the Northwest and Southwest branches in 1996, more eggs were contributed by early-run fish (Table 18). Large salmon contributed the largest proportion of the eggs in both the early (71% to 83%) and late runs (over 97%) in each branch. Early run small salmon contributed more than 10 times the eggs as late run small salmon. In the Miramichi River overall, large salmon contributed 91% of the total egg depositions (Fig. 9, Table 18).

Revised fecundities

The fecundity-length relationship for salmon from the Miramichi River was derived from samples collected primarily from commercial harvests in the estuary in the early 1980's (Randall 1989). These are considered to be egg counts from immature ovaries (green eggs). Another fecundity-length data set collected from fished spawned at the Miramichi Salmonid Enhancement Centre was examined. The egg counts are obtained from individual females after stripping of the eggs by hatchery personnel. Length and weight data were also collected from inidividual fish. The majority of these fish are considered to be early-run.

The log-log fit was extremely good ($R^2 = 0.81$) (Fig. 10). There are some important differences between this data set and the one analyzed by Randall (1989). The small salmon fecundities from Randall (1989) are about 37% higher than the fecundities from the hatchery data set. For large salmon, there is an important difference in slope (Fig. 10). For salmon less than 85 cm, the predicted fecundities from Randall are greater than those from the hatchery but the reverse is true for salmon greater than 85 cm fork length. The maiden salmon fecundities from Randall (1989) are overestimated but the previous spawner fecundities are underestimated (Fig. 10).

Some of the possible explanations for these differences include;

1 - atresia of eggs from the green stage to the fully mature stage. O'Connell and Dempson (1997) have reported that in some salmon stocks in Newfoundland, atresia (resorbtion or non-maturation of egg follicles) is a common phenomenon which varies annually and may reach as high as 35% in some years.

2 - the data set analyzed by Randall (1989)consists of ovaries collected from fish in the estuary, therefore comprising early and late run fish. There is evidence from other studies that early-run salmon have fewer but larger eggs than late-run salmon (Anon. 1994). The hatchery data consists almost exclusively of early-run females.

The consequences of using the fecundity-length relationship from the hatchery data set on the estimated egg depositions in 1996 are shown in Table 18. Overall, egg depositions would be reduced by 13%. Small salmon egg contributions would change the most, a decline of 25%. Large salmon egg contributions would decrease by less than 10%.

The data sets require more analysis and it would be important to verify whether fecundities between early and late run salmon are different or if differences are the result of factors such as atresia or incomplete maturation of ovaries.

STATUS OF STOCK

The point estimate of the total egg deposition to the Miramichi by large salmon was 103% of conservation requirements with a 53% probability of having met or exceeded the conservation requirement. Egg depositions by both small and large salmon were 113% of requirement, with a 69% probability of having met or exceeded the conservation requirement (Fig. 11). Egg depositions to the Miramichi River have been met or exceeded every year since 1985 (Fig. 12). Conservation requirements (2.4 eggs per m^2) have been met by large salmon alone every year since 1990. Large salmon egg depositions equalled or exceeded the conservation level in only four years between 1971 and 1989. The relative contribution of small salmon to the total egg depositions in the Miramichi in 1995 was 12%. 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. 12).

Returns and escapements of small salmon to the Miramichi peaked in 1992 and have declined since (Table 19, Fig. 13). The return in 1996 of 44377 small salmon is 47% below and 33% below the previous 5-year and historical (1971 to 1995) average returns to the river. The escapement of small salmon was 63% below the 5-year average and 49% below the historical average. The large salmon returns since the closure of the commercial fisheries in 1984, peaked in 1992. The return in 1996 of 24,180 large salmon is the lowest since 1990 and was 24% below and 10% below the previous 5-year and historical averages respectively. The large salmon escapement was 26% below but 15% above the 5-year and historical averages (Fig. 13, Table 19). Since 1992 (the first year of the insular Newfoundland commercial salmon fishery moratorium), large salmon returns have averaged 31400 fish which is 36% higher than the average return between 1984 and 1991 (23000) (Fig. 12). The average small salmon returns are similar (+2% change).

A total of 90.0 million eggs, 102% of conservation requirements, were deposited by large salmon in the Southwest Miramichi in 1996 (Table 18). There was a 49% probability that the egg depositions by large salmon in the Southwest Miramichi exceeded the conservation requirement (Fig. 11). Egg depositions by both small and large salmon were 114% of conservation requirements, with a 84% probability of having met or exceeded the conservation requirements. Egg depositions have exceeded the conservation requirements every year since 1992.

In the Northwest Miramichi, 47.2 million eggs were contributed by large salmon (115% of conservation requirements) (Table 18). There was a 66% probability that the conservation egg reuirements were exceeded by large salmon alone (Fig. 11). Egg depositions by small and large salmon were 132% of conservation requirements with a 80% probability of having met or exceeded the requirements. Egg depositions have exceeded the conservation requirements every year since 1992.

In the Southwest and Northwest branches, returns of small salmon have declined since 1992, returns of both small and large salmon in 1996 are the lowest estimated since 1992 (Table 20).

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 (Table 21). The fences are operated for varying periods each year but generally cover the entire migration period. The trend in the counts of large salmon in 1996 at the barrier fences of the Southwest Miramichi were similar to the previous 5-year mean at both locations but the counts of small salmon were 25% to 33% higher (only the counts at the North Branch barrier were significantly higher than the previous 5-year mean counts) (Table 21). Counts of small and large salmon at the Dungarvon Barrier in 1996 were double the low counts of fish in 1995.

Returns of large salmon at the Northwest Barrier were unchanged from the previous 5-year average (Table 21). Small salmon counts were the second lowest (after 1995) recorded since the beginning of operations in 1988, 28% below the previous 5-year average. The counts of small and large salmon at Catamaran Brook, a mainly fall-run tributary, were among the lowest since 1990 (Table 22).

Overall trends in returns/escapements since 1992

The returns to each branch as estimated from the mark and recapture experiments and the counts at the headwater barriers and the counting fences provide a concise summary of trends in each branch.

Northwest Miramichi	Small	Large
NW Barrier	1995 = 1996 = 1994 < 1993 < 1992	1993 = 1996 = 1992 < 1994 < 1995
Catamaran	1994 < 1996 < 1993 < 1995 < 1992	1994 < 1996 < 1993 < 1992 < 1995
DFO trapnets	1996 = 1994 = 1995 < 1992 < 1993	1996 < 1992 < 1993 < 1994 < 1995

For large salmon, returns were highest in 1995 at all facilities with 1996 being the lowest or equal to the lowest. For small salmon, 1996 was the lowest or second lowest at all the facilities whereas 1992 was the highest or second highest returns year.

Southwest Miramichi	Small	Large
Juniper	1995 < 1994 < 1993 = 1992 = 1996	1996 < 1994 < 1995 < 1992 < 1993
Dungarvon	1995 = 1994 < 1996 < 1993 < 1992	1995 < 1994 < 1996 < 1993 = 1992
DFO trapnets	1996 = 1995 = 1994 < 1993 < 1992	1994 < 1996 < 1995 < 1993 < 1992

For large salmon, 1996 is among the lowest returns at all three facilities with 1992 and 1993 being the highest. For small salmon, the trend is confused for 1996 (highest, middle and lowest) but 1992 was the highest return year. Two groups of years can be distinguished, 1992 and 1993 were the highest while 1994 to 1996 are lower return years.

In terms of 1996, we conclude that the returns of both large salmon and small salmon were the lowest observed or estimated since 1992.

ECOLOGICAL CONSIDERATIONS

Seasonal and Environmental Conditions

The Southwest Miramichi River discharge in 1996 was similar to the 1995 levels from mid-May until mid-June but levels from then until the first week of October were higher than those of 1995. The effects of hurricane Bertha were felt in mid-July when discharge peaked at more than 650 m^3sec^{-1} and remained above 100 m^3sec^{-1} into early August. Such discharges are usually observed in the spring during May. The Northwest Miramichi discharge profile in 1996 was similar to that of 1995 with the exception of the mid-July to mid-August period when discharges were higher in 1996 (Fig. 14). Otherwise, discharges from mid-August to early October were similar in the two years. The Little Southwest Miramichi had similar discharge profiles in 1995 and 1996 during June but discharges were higher in 1996 for the remainder of the year.

In 1996, the daily average surface water temperatures in the tidal waters of the Northwest never exceeded 23°C (Fig. 15). Water temperatures at the headwater barrier in the Northwest Miramichi were generally 5° to 10°C cooler than at the tidal water trapnet but at Big Hole Tract, the water had warmed considerably and temperatures were generally similar to or slightly cooler (2 to 3°C) than the tidal waters. Water temperatures were generally cooler in 1996 than in 1995 during June through August but fall water temperatures were similar to 1995 temperatures (Fig. 15). Water temperatures at Big Hole Tract in 1996 were cooler in August; during 1995, water temperatures exceeded 26°C in early August. Water temperatures at the Dungarvon Barrier (Southwest Miramichi) were also cooler during the summer of 1996 relative to the previous year's summer temperatures.

At the Millerton trapnet in the Southwest Miramichi, small and large salmon were more abundant early in the season in 1996 relative to 1995 (Fig. 16). The median small salmon count in 1996 was observed on August 11 while in 1995, the median count occurred on September 15. The cumulative count of large salmon was initially higher in 1996 than in 1995 (25% of the large salmon were counted by July 27, 1996 compared to September 11, 1995) but in both years, 60% of the annual counts occurred after September 20 (Fig. 16).

The movements of salmon through the Southwest Miramichi barrier in 1996 occurred throughout the summer but the largest numbers of fish moved through the barrier after mid-September (Fig. 17). Minimal numbers of fish had moved through the barrier in 1995 before the first week of October. Movements of fish at the Dungarvon River barrier were more evenly distributed through time in 1996 than was observed in 1995 (Fig. 17). More than 90% of the large salmon had been counted through by July 31, 1995 but less than 60% of the large salmon had been counted through on the same date in 1996. At the Northwest Miramichi Barrier, small salmon movements were similar in 1995 and 1996 but large salmon moved primarily during June (40% of total counts) and October (40% of total) in 1996 (Fig. 17). The movements of large salmon in 1995 were very early with more than 75% of the fish counted through by July 1.

Spawner Distribution and Habitat Utilization

In 1995, spawning occurred throughout the Northwest and Southwest Miramichi with the exception of 3 sites, two on the Northwest Miramichi and one on the Southwest Miramichi (Fig. 18):

1- as in 1994 salmon did not spawn at the Catamaran Brook site (Site 46) in 1995 because a beaver dam blocked access to that part of the stream (R. Cunjak, pers. comm.)

2 - the North Branch of Mullin Stream is inaccessible to anadromous salmon (B. Dube, pers. comm.).

3 - the South Branch of the Renous River. The substrate in the area of this site is 75% bedrock so spawning was not possible. However, the parr density was 25 per 100 m^2 indicating that parr, which are capable of migrating several kilometers from their natal site, utilize the habitat.

Fry densities were greater than 50 fish per 100 m^2 at 81% of the sites in the Northwest Miramichi (Fig. 18). At sites with fry, densities in the Northwest averaged 115 fry per 100 m^2. Parr densities were above 30 fish per 100 m^2 at 11 of 21 sites (52%) and averaged 34 fish per 100 m^2 overall (Fig. 18).

In the Southwest Miramichi spawning had occurred in the vicinity of 25 of the 26 (92%) sites (Fig. 18). Fry densities averaged 130 fish per 100 m^2 at sites with fry. Parr densities were greater than 30 fish per 100 m^2 at 7 of 26 sites (27%) and averaged 26.3 fish per 100 m^2 overall.

Spawning has been monitored using this method since 1993 (Chaput et al MS 1994, 1995, 1996) and results have indicated that spawning has been successful each year in all parts of the Miramichi accessible to anadromous Atlantic salmon.

Salmon juveniles are territorial and territory size has been shown to be correlated with the size of the fish (Grant and Kramer 1990). 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 PHS values in the Northwest ranged between 8. 2 and 55.2 (mean = 27.9). PHS values at Little Southwest Miramichi sites averaged 25.3, slightly less than the 29.5 value for the remaining Northwest sites. In the Southwest, PHS values were above 28 at 11 of the 26 sites, averaging 30.1 overall (range 8.2 to 84.1).

FORECAST/PROSPECTS

Short Term

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 1996 return of small salmon to the Miramichi of about 45000 fish, the 1997 forecast for large salmon returning to the Miramichi is 29,933 with a 72% probability of meeting spawning requirements (23,600 large salmon). This model has been used to forecast returns since 1992:

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		

Since 1991 large salmon returns have averaged just over 31,000 fish but the annual returns have been on a general decline since 1992. In two monitored rivers of Québec in the Gulf of St. Lawrence, sea survivals of smolts peaked for the 1989 smolt migration and have since declined with the lowest sea survivals to both small and large salmon returns observed for the 1993 and 1994 smolt migrations (Anon. 1996). Similarly low sea survival of Miramichi origin smolts would explain the decline in large salmon returns to the Miramichi since 1992. Crude survival estimates of smolts from Catamaran Brook do not show a similar declining trend in sea survival (Table 22). The estimates may not be applicable because of the confounding effects of parr migrations out of the brook as well as the potential for removals of Catamaran Brook fish in native and recreational fisheries.

Since 1992, the large salmon returns to the Miramichi have been estimated at about two-thirds Southwest and one-third Northwest Miramichi. This would indicate that the returns to the Northwest Miramichi in 1997 would be about 10,000 large salmon and returns to the Southwest would be about 20,000 large salmon.

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. 20). Moore et al. (1995) provided evidence that the changes in age composition of the salmon returning to the Miramichi River and the increased abundance of previous spawners was due to reduced fishing exploitation resulting from closures of commercial fisheries as well as hook and release measures in the recreational fisheries. The increased egg depositions since 1984 are in large part the result of higher contributions by previous spawners because the 2SW maiden abundance has essentially remained unchanged (Fig. 20). 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). Previous spawners which were destined to return to the Miramichi in 1997 have been intercepted in the Greenland fishery in the fall of 1996; two Carlin tags from salmon tagged in the Miramichi in 1995 were returned to us in 1996. The Greenland fishery had previously been suspended in 1994 and 1995. Only one other tagged previous spawner has been intercepted in the Greenland fishery since 1990; a grilse tagged in 1993 was recaptured in 1994.

There is no forecast model for small salmon but based on the smolt counts at Catamaran Brook in 1996 and the observed temporal trend in smolt counts in year i, small salmon returns to the Northwest in year i+1, the small salmon returns in 1997 are not expected to be any better and probably lower than the returns observed in the last three years.

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. Almost 40,000 2+ smolts were released to the Northwest Miramichi in 1996 (Table 23). Very few smolts (5700 fish) were stocked to the Southwest Miramichi in 1996 because the Dungarvon stock from the Renous semi-natural rearing ponds did not conform to fish health standards (tested positive for bacterial kidney disease) and were destroyed. Stocking of other life stages in 1996 was similar to previous years. Returns of small and large salmon from stocking in previous years are not expected to make up more than 1% of the total returns in 1997, a level consistent with the observed contribution of adipose-clipped salmon in previous years. Detailed descriptions of releases by date, location and life stage are available in Appendix 5.

Long Term

Fry densities at 9 index sites in the Southwest Miramichi and 4 in the Northwest Miramichi in 1996 were the highest on record (Fig. 21 and 22). Parr densities were decreased in both the branches of the river in 1996 but were still among the highest observed since 1971(Fig. 21 and 22). PHS values have increased since the 1970's (Fig. 23) corresponding to an increase in juvenile poduction resulting from higher egg depositions and/or higher survival in the river. Increased abundance of juveniles is evident throughout the Miramichi River. Densities of fry and parr in eight sections of the Miramichi illustrate the substantial improvement in juvenile abundance between 1970 to 1983 and 1984 to 1996 (Fig. 24). The improvements in juvenile abundance have occurred in all the areas with about four-fold increases in fry abundance in the Northwest Miramichi, the Little Southwest Miramichi, the Dungarvon River and the Cains River. At least in the freshwater portion of the life cycle, the abundance of the cohorts is increasing in both the Northwest and Southwest Miramichi and the long-term prospect for the Atlantic salmon stock of the Miramichi is for continued and increased abundance of salmon.

Large salmon returns have averaged 31,400 fish between 1992 and 1996, a 36% increase from the average return between 1984 and 1991 (23,000) (Fig. 13). Given an average life cycle of 5 to 6 years (migration to migration) for large salmon, the returns to the Miramichi in 1996 to 2001 will be the progeny of the 1990 to 1995 escapements. Between 1971 and 1989, large salmon escapements equalled or exceeded 30,000 spawners 3 times and the returns of large salmon 6 years later from these escapements ranged from 28000 to 37000 fish (Table 19, Fig. 13). Returns of small and large salmon since 1992 however have declined. It appears that Atlantic salmon from the Miramichi may also be experiencing reduced sea survival in recent years, as has been noted for other Gulf of St. Lawrence stocks. Returns of large salmon have remained above the conservation requirements in part because of an abundance of previous spawners which may not be affected by the same sea survival constraints as smolts. As well, the smolt output from the Miramichi must be higher than the levels of the 1970's to mid 1980's (as inferred from the increased abundance of juveniles) and these are compensating for the declining sea survival.

MANAGEMENT CONSIDERATIONS

Was conservation met in 1996?

The conservation requirements for the Southwest Miramichi, Northwest Miramichi and Miramichi River system were exceeded in 1996 at the point estimate of egg depositions. There was a reasonably high probability (31%) however that conservation requirements were not met in the Miramichi River. There is a higher exploitation rate on the early run small and large salmon but the overall exploitation rate on large salmon in 1996 was low; less than 5% in the Northwest Miramichi and less than 2% in the Southwest Miramichi with overall exploitation rate for the Miramichi River of 3%. Small salmon are more heavily exploited; 38% of the total returns in the Northwest, 41% from the Southwest Miramichi and 44% from the Miramichi River.

Will the returns of large salmon in 1997 exceed the conservation requirements for the Miramichi River?

The expected return of large salmon in 1997 is in the order of 29,000 fish. There is a very good chance (72%) that the returns in 1997 will at least meet the fish-equivalent conservation level of 23,600 large salmon. The exploitation rates on large salmon over the last 5 years should not threaten the resource. Since the 1997 forecast is for returns during the whole year, the exploitation of both small and large salmon should be prudently distributed across the entire migration. In the Northwest and Southwest Miramichi rivers, this would represent about 20% of potential harvests of large salmon taking place prior to Sept. 1 and 80% of harvests after Aug. 31. For small salmon, more fish return early, 40% up to and including Aug. 31 and 60% after Aug. 31.

What are the risks of not acheiving the conservation egg depositions in 1997 if harvesting of large salmon occurs in 1997?

The egg depositions from salmon in 1997 depend upon the actual number of salmon escaping to spawn, the proportion female and the fecundity of the females in the escapement. The proportion female and the average fecundity (based on average length of large salmon) varies annually. Returns of large salmon in 1997 are expected to be between 13114 fish and 51274 fish (95% confidence interval; Fig. 19). Any evaluation of risk for management scenarios requires three components:

1 - Long-term decision rule: in the case of Atlantic salmon, the management strategy is to potentially harvest all fish surplus to the conservation level.

2 - Undesirable event: for a management strategy to have risk, an undesirable event has to be defined. In the case of Atlantic salmon, the undesirable event is that the egg depositions from the escapement will be below the conservation requirement. There is no gradient of undesirability relative to the level of egg deposition below conservation; an underescapement of 1 egg is as undesirable as an underescapement of

1 million eggs. This is a consequence of treating the conservation requirement as a threshold reference point rather than a target.

3 - Evaluate the chances of the undesirable event: to evaluate the risk of the undesirable event, uncertainties in the forecast, variability in the proportion female and fecundity all have to be considered. In addition, the likelihood of achieving at least the conservation egg requirements in all the production areas of the river must be included. For the Miramichi, it is proposed that six production areas be used as identified in the "Conservation Requirement Section".

In the past, Atlantic salmon in the Miramichi have been managed in a risk neutral approach. The point estimate of expected returns was compared to the spawning requirements for the Miramichi River and harvesting was adjusted accordingly. Risk was not quantified because the uncertainty of the forecasts, the conservation requirements and the harvest options were never integrated in a manner which would provide a measure of the risk of not meeting conservation requirements. Such a risk assessment (theoretical) would take the form shown in Fig. 25. Under the risk neutral approach, point estimates of forecasts and conservation requirements are used and the associated risk of not meeting conservation requirements is 50%. Risk prone managers may consider a 75% risk of not meeting conservation requirements acceptable. In that case, the precision of the information used to assess harvest options becomes important. For the uncertain stock assessment, the risk curve would indicate that the corresponding harvest level is 12200 whereas under a more precise stock assessment (better data and models) the corresponding harvest level is 6500 fish (Fig. 25). For the risk averse management approach, a 25% risk of the undesirable event would correspond to no harvests for the uncertain stock assessment and 4300 fish for the precise stock assessment. A harvest level of 4300 fish under the uncertain stock assessment would amount to a 46% risk of not meeting conservation requirements.

For the Miramichi River situation, the risks of not meeting the conservation egg requirements in 1997 under possible harvest scenarios are summarized in Table 24. In the absence of any large salmon losses due to fisheries (no First Nations harvest of large salmon, no hook and release losses in the recreational fishery), there is a 23% risk that the large salmon escapement will not be sufficient to meet the conservation egg requirements for the Miramichi. With a management plan in 1997 identical to that of 1996, the risk of not meeting conservation requirements rises to 28% (Table 24). Any number of management scenarios can be considered.

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

The broodstock collections in 1996 amounted to about 0.1 million eggs from the Northwest and 0.4 million eggs from the Southwest. These represent less than 0.3% of the in-river egg depositions in both the Northwest and Southwest.

The contribution of adipose-clipped fish to the returns and subsequent egg depositions in the Miramichi is negligible (Table 25). In 1996, small salmon sampled at the trapnets in the Southwest Miramichi were predominantly (>99.6%) wild in both the early and late runs. Large salmon returns were also essentially all wild origin (>99.4%). In the Northwest Miramichi, both small salmon and large salmon were predominantly of wild origin (>99.4%) (Table 25).

In the tributaries which received adipose-clipped stocking in recent years (for example smolt stocking in Little River, satellite rearing stocking in Rocky Brook), returns of adipose-clipped fish comprised a slightly higher percentage of the total returns but never more than 16% (Table 25). The Dungarvon River received more than 20,000 smolts in 1995 but adipose-clipped small salmon represented than less 0.5% of the small salmon sampled through the DNRE protection barrier.

What is the state of the Little Southwest Miramichi relative to other parts of the river?

Concerns have been expressed regarding the status of the salmon resource of the Little Southwest Miramichi. Anglers have the impression that the salmon are less abundant now than in previous decades. During the 1970's and early 1980's, juvenile densities in the Little Southwest Miramichi were also lower than in all the other areas but since the changes in management in 1984, juvenile abundance has increased more than four fold (Fig. 24). In spite of this increase, juvenile densities are lower in the Little Southwest Miramichi than in other parts of the river. The causes of the lower abundance levels are unknown. An assessment of the returns and escapement of salmon to the Little Southwest could indicate whether insufficient spawning escapement or habitat conditions are the cause of the lower abundance. Juvenile abundance in the Little Southwest increased when escapement to the entire Miramichi River improved after the introduction of the 1984 management plan. However, the lower abundance of juveniles in the Little Southwest Miramichi at low spawning escapements and subsequently at high spawning escapements suggests that the habitat differences may account for the lower abundance of salmon in the Little Southwest relative to other parts of the Miramichi. The lower section of the Little Southwest Miramichi is wide and shallow and gravel bed scouring occurred during the winter of 1995/96 (R. Cunjak, DFO Science, pers. comm.). Water temperatures in the summer were recorded as high as 30°C in the summer of 1995 (Caissie 1996). The Little Southwest Miramichi salmon also have different characteristics. There is a high proportion female in the small salmon category which is not seen in other early-run stocks of the Miramichi River such as at Rocky Brook and Clearwater Brook. Given these differences and the constraint that a separate assessment of the Little Southwest is not feasible with the present resource allocation, a precautionary approach to the management of the fisheries of the Little Southwest Miramichi is advised.

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Table 1. Food fishery agreements on the Miramichi River for 1996.

Location	Allocation Small	Large	Gear	Time Period
Eel Ground First Nation				
Northwest	1880	195	trapnets[1], gill nets[2] and recreational[3]	May 1 to Aug. 31
	780	-	trapnets[1], gill nets[2] and recreational[3]	Sept. 1 to Oct. 31
	200	5	counting fence (Big Hole Tract)	April 1 to July 31
	40	-	counting fence (Big Hole Tract)	Aug. 1 to Oct. 31
Southwest	1320	-	trapnet[1] and recreational[3]	May 1 to Aug. 31
	780	-	trapnet[1] and recreational[3]	Sept. 1 to Oct. 31
Red Bank First Nation				
Little Southwest	1320	71	trapnet[4] and recreational[3]	June 1 to Aug. 31
	680	141	trapnet[4] and recreational[3]	Sept. 1 to Oct. 31
Northwest	1320	70	trapnet[4] and recreational[3]	June 1 to Aug. 31
	680	141	trapnet[4] and recreational[3]	Sept. 1 to Oct. 31
Burnt Church First Nation[6]				
Miramichi Bay	1300	80	gill nets[5] and angling	May 1 to July 31
	700	120	gill nets[5] and angling	Aug. 1 to Oct. 15

1 Maximum of two trapnets.

2 Maximum of 12 gill nets of maximum length 125 feet each, and to be removed after capture of the 195 large salmon.

3 Native recreational fishing gear

4 Maximum of 1 trapnet

5 Maximum of 25 gill nets; 15 nets of maximum length 300 feet each and 10 nets of maximum length 150 feet each.

6 Communal fishing license only.

Table 2. Salmon angling seasons for 1996.

General season: **April 15 to October 31**

Exceptions to the general season		
Opens	**Closes**	**Area**
April 15	Aug. 31	NW Miramichi River upstream from Little River Rocky Brook, tributary of Southwest Miramichi River
April 15	Sept. 15	All tributaries of Southwest Miramichi above Cains River except Rocky Brook Big Sevogle River above Square Forks Dungarvon River above the Furlong Bridge Little Southwest Miramichi above Catamaran Brook North and South brances of the Renous River above the forks Southwest Miramichi River upstream from the Deersdale Bridge, including the North and South branches
April 15	Sept. 30	Southwest Miramichi River upstream of the mouth of Burnt Land Brook to the Deersdale Bridge
April 15	Oct. 15	Bartholomew River Big Sevogle River downstream from Square Forks Cains River Dungarvon River downstrream from the Furlong Bridge Little Southwest Miramichi River below Catamaran Brook Northwest Miramichi River downstream from Little River Renous River downstream from the confluence of the Norht and South branches Southwest Miramichi River, from the confluence of Burntland Brook downstream to the mouth Southwest Miramichi River tributaries downstream from the confluence of the Cains River not described above
Oct. 1	Oct. 15	Hook and release only, Southwest Miramichi from the confluence of Burntland Brook upstream to the Deersdale Bridge
June 10	Sept. 15	Crown Reserve angling waters on the Little Southwest Miramichi (hook and release angling only in September), Sevogle, and Northwest Miramichi rivers.

Table 3. Catch and effort (net days) for native food fisheries on the Miramichi River in 1996 for early and late runs as reported by band councils.

	Burnt Church		Eel Ground							Red Bank			
	Gillnets		Gillnets			SW Trapnets	NW Trapnets	Big Hole counting fence		NW Trapnet		LSW Trapnet	
	Small	Large	Effort	Small	Large	Small	Small	Small	Large	Small	Large	Small	Large
Early run													
May 28-June 3						0	0	0	0	0	0	0	0
June 4-10	0	0	36	37	4	2	0	0	0	0	0	0	0
June 11-17	0	1	54	36	8	15	6	0	0	17	4	3	0
June 18-24	1	5	42	32	13	66	19	14	1	3	0	5	1
June 25-July 1	3	28	54	74	7	88	64	37	2	41	9	20	0
July 2-8	1	21	42	45	5	135	31	27	2	64	12	20	0
July 9-15	0	0	24	24	4	221	45	13	0	41	7	14	0
July 16 - 22	0	0	30	14	4	0	21	22	0	0	0	6	2
July 23-29	0	0	18	0	0	62	35	4	0	37	5	33	7
July 30-Aug. 5	0	0	12	0	0	96	16	0	0	18	9	5	4
Aug. 6-12	0	0	12	9	2	88	11	0	0	24	8	24	4
Aug. 13-19	0	0	0	0	0	70	10	0	0	5	2	7	3
Aug. 20-26	0	0	0	0	0	1	1	0	0	4	4	6	3
Aug. 27-Sept. 2	0	0	0	0	0	21	3	0	0	4	6	12	6
Subtotal	5	55	324	271	47	865	262	117	5	258	66	155	30
Late run													
Sept. 3-9	0	0	0	0	0	18	6	0	0	1	6	12	8
Sept. 10-16	0	0	0	0	0	43	5	5	0	2	0	4	1
Sept. 17-23	0	0	0	0	0	148	87	3	0	24	15	33	9
Sept. 24-30	0	0	0	0	0	0	5	0	0	30	6	101	31
Oct. 1-7	0	0	0	0	0	0	0	0	0	44	23	53	26
Oct. 8-14	0	0	0	0	0	0	0	0	0	8	7	18	37
Oct. 15-21	0	0	0	0	0	0	0	0	0	0	2	0	5
Subtotal	0	0	0	0	0	209	103	8	0	109	57	221	112
Total season	5	55	324	271	47	1074	365	125	5	367	123	376	142
% Early run	100%	100%	100%	100%	100%	81%	72%	94%	100%	70%	54%	41%	21%

Table 4. Recorded harvests of salmon in all fisheries (commercial, by-catch, recreational, and native) Miramichi River and Bay, 1951 to 1996. Kelts angled in year I are added to harvests in year I-1. The 1996 angling fishery data are not available. All numbers are in fish X 1000.

				Angling Fisheries										
	Commercial Fishery			Kelts (yr i+1)			Brights (yr i)				Native Fishery			All
Year	Small	Large	Total	Small	Large	Total	Small	Large	Total	All	Small	Large	Total	isheries
1951		27.6	27.6			12.0			9.6	21.6				49.2
1952		27.3	27.3			11.3			15.9	27.2				54.5
1953		24.4	24.4			10.1			18.2	28.3				52.7
1954		50.6	50.6			11.2			23.5	34.7				85.3
1955		15.3	15.3			8.9			14.7	23.6				38.9
1956		24.7	24.7			9.3			28.9	38.2				62.9
1957		29.9	29.9			8.4			19.5	27.9				57.8
1958		25.2	25.2			10.2			36.7	46.9				72.1
1959		37.3	37.3			9.5			10.3	19.8				57.1
1960		30.8	30.8			5.6			4.5	10.1				40.9
1961		30.0	30.0			9.5			11.0	20.5				50.5
1962		41.6	41.6			7.3			10.3	17.6				59.2
1963		40.7	40.7			5.2			50.9	56.1				96.8
1964		69.8	69.8			9.0			35.1	44.1				113.9
1965		69.5	69.5			16.0	38.7	3.9	42.6	58.6				128.1
1966		72.9	72.9			20.0	51.7	5.9	57.6	77.6				150.5
1967		102.2	102.2			14.1	41.8	4.1	45.9	60.0				162.2
1968		48.5	48.5			6.9	7.0	1.5	8.5	15.4				63.9
1969		41.3	41.3	3.7	1.6	5.3	24.3	3.8	28.1	33.4				74.7
1970		39.7	39.7	2.4	1.4	3.8	19.6	3.3	22.9	26.7				66.4
1971		18.3	18.3	1.5	0.5	2.0	13.7	1.8	15.5	17.5				35.8
1972		2.5	2.5	1.5	3.0	4.5	19.1	8.9	28.0	32.5				35.0
1973		0.9	0.9	1.5	3.0	4.5	13.9	6.0	19.9	24.4				25.3
1974		1.0	1.0	1.8	3.1	4.9	18.2	7.2	25.4	30.3				31.3
1975	0.4	0.7	1.1	2.3	1.4	3.7	15.6	6.3	21.9	25.6	0.4	0.2	0.6	27.3
1976	1.8	0.9	2.7	2.4	2.2	4.6	27.2	7.4	34.6	39.2	0.2	0.2	0.4	42.3
1977	0.4	6.9	7.3	1.4	2.1	3.5	13.6	11.6	25.2	28.7	0.5	0.4	0.9	36.9
1978	1.2	8.4	9.6	1.5	1.7	3.2	8.3	4.9	13.2	16.4	0.4	0.4	0.8	26.8
1979	5.5	1.7	7.2	2.2	1.5	3.7	14.5	2.7	17.2	20.9	0.1	0.2	0.3	28.4
1980	2.7	10.9	13.6	1.7	2.1	3.8	12.0	6.5	18.5	22.3				35.9
1981	1.6	7.8	9.4	2.7	1.4	4.1	22.7	3.2	25.9	30.0	1.0	0.5	1.5	40.9
1982	2.3	12.5	14.8	2.1	1.0	3.1	21.4	4.6	26.0	29.1	0.7	0.4	1.1	45.0
1983	1.6	17.1	18.7	0.9	0.7	1.6	8.4	2.2	10.6	12.2	0.4	0.2	0.6	32.5
1984	0.0	0.0	0.0	2.4	0.0	2.4	18.8	0.0	18.8	21.2	0.4	0.3	0.7	21.9
1985	0.0	0.0	0.0	2.5	0.0	2.5	18.4	0.0	18.4	20.9	0.5	0.3	0.8	21.7
1986	0.0	0.0	0.0	2.7	0.0	2.7	26.2	0.0	26.2	28.9	2.0	0.6	2.6	31.5
1987	0.0	0.0	0.0	4.2	0.0	4.2	20.8	0.0	20.8	25.0	1.3	0.9	2.2	27.2
1988	0.0	0.0	0.0	5.4	0.0	5.4	30.6	0.0	30.6	36.0	0.9	0.3	1.2	37.2
1989	0.0	0.0	0.0	3.9	0.0	3.9	24.4	0.0	24.4	28.3	1.1	0.5	1.6	29.9
1990	0.0	0.0	0.0	2.4	0.0	2.4	21.7	0.0	21.7	24.1	2.1	0.6	2.7	26.8
1991	0.0	0.0	0.0	2.3	0.0	2.3	11.3	0.0	11.3	13.6	1.1	0.5	1.6	15.2
1992	0.0	0.0	0.0	1.8	0.0	1.8	21.5	0.0	21.5	23.3	1.7	0.6	2.3	25.6
1993	0.0	0.0	0.0	0.9	0.0	0.9	15.3	0.0	15.3	16.2	0.6	0.2	0.8	17.0
1994	0.0	0.0	0.0	0.6	0.0	0.6	11.2	0.0	11.2	11.8	3.0	0.1	3.1	14.9
1995	0.0	0.0	0.0	-	-	-	5.6	0.0	5.6	-	3.0	0.2	3.2	-
1996	0.0	0.0	0.0	-	-	-	-	-	-	-	2.6	0.4	3.0	-
1991-95 Mean						13					1.9	0.3	2.2	
change = (96-mean)/mean											37%	33%	36%	

Note: Angling catches from 1951-68 are from DFO while catches from 1969-95 are from DNRE FISHSYS

Table 5. Recreational Atlantic salmon fishery statistics from the Miramichi River, 1996. Mean is for the years 1990 to 1994 (1995 is excluded because of important within-season closures). % change represents 1996 minus mean divided by mean. Detailed catches are in Moore et al. (MS1995) of which 1995 data have been finalized.

		Miramichi River	Northwest	Southwest	
Black salmon fishery					
Effort (rod days)	1996	N/A	N/A	N/A	
	1995	2058	613	1445	
	Mean	11374	2330	9044	
	% change				
Small salmon	1996	N/A	N/A	N/A	
	1995	550	154	396	
	Mean	2600	443	2157	
	% change				
Large salmon	1996	N/A	N/A	N/A	
	1995	945	275	671	
	Mean	4216	706	3511	
	% change				
Bright salmon fishery					
Effort (rod days)	1996	N/A	N/A	N/A	
	1995	33462	10930	22532	
	Mean	115561	36790	78771	
	% change				
Small salmon	1996	N/A	N/A	N/A	
	1995	5533	1705	3828	
	Mean	16893	5636	11258	
	% change				
Large salmon	1996	N/A	N/A	N/A	
	1995	3146	627	2519	
	Mean	8293	1998	6294	
	% change				
Northwest Miramichi crown reserve angling			Individual stretches		
		Total	Little Southwest	Sevogle	Northwest
Effort (rod days)	1996	2607	565	752	1290
	1995	1773	490	466	817
	Mean	2407	524	773	1109
	% change	+8%	+8%	-3%	+16%
Small salmon	1996	1301	151	267	883
	1995	523	136	122	265
	Mean	1256	165	332	760
	% change	+4%	-9%	-20%	+16%
Large salmon	1996	131	31	33	67
	1995	88	22	19	47
	Mean	116	30	34	53
	% change	+13%	+3%	-3%	+26%

Table 6. Summary of broodstock collections in 1996.

Stock Collected	Date Collected	Female		Male		Collection Site
		Large	Small	Large	Small	
Northwest Miramichi						
Little Southwest	Sept. 22	3	10	1	8	Smith Fork and Moose Landing
Northwest	Sept. 18	4	0	2	2	Barrier Pool
Sevogle	Sept. 12	0	0	0	3	Trash Heap Pool
	Sept. 20	1	4	0	2	Trash Heap Pool
Subtotal		8	14	3	15	
Southwest Miramichi						
Southwest	Sept. 21	1	0	0	0	Slate Island
	Sept. 21	7	0	1	3	South Branch at Juniper
Clearwater	Sept. 14	5	0	2	2	Avenor Bridge
	Oct. 10	1	0	2	1	Irving counting fence
	Oct. 12	2	0	0	0	Irving counting fence
	Oct. 15	2	0	0	2	Irving counting fence
Rocky Brook	Sept. 5	4	0	2	2	McGrath Pool
Cains	Sept. 10	1	0	0	4	Island Pool
	Oct. 1	2	0	1	0	Island Pool
Dungarvon	Sept. 25	25	0	2	23	Barrier Pool
Subtotal		50	0	10	37	
Total		58	14	13	52	

Table 7. Summary of trapnet operation dates, catch, and tags applied in the Miramichi River, 1996. Catch represents all fish sampled, including recaptures.

		Catch		Tagged	
Trapnets	Time Period	Small	Large	Small	Large
NW Miramichi					
Eel Ground Lower	June 12 to Oct. 18	892	260	551	220
Eel Ground Upper	June 12 to Oct. 7	386	123	240	106
Red Bank NW	June 11 to Oct. 18	417	132	0	0
Red Bank LSW	June 15 to Oct. 18	527	176	0	0
SW Miramichi					
Eel Ground Lower	June 12 to Oct. 14	1565	513	551	444
Eel Ground Upper	June 10 to July 14	305	34	112	32
Millerton	May 21 to Oct. 18	2323	796	2018	687

Table 8. Raw data matrices used in the estimation of returns of small salmon and large salmon to the Miramichi River in 1996. Recaptured in the Northwest refers to catches at Red Bank trapnets and Big Hole partial counting fence.

Using method based on prior estimation of emigration rates using angling recaptures.

Matrices for Estimating Large Salmon Returns to the Northwest Miramichi in 1996

	Recaptured in Northwest		Tags placed in 1996		
Tagged	Early	Late	NW	SW	SWMill
Early	3	4	158	210	240
Late	0	13	173	280	454
Unmarked catch	117	221			

Matrices for Estimating Large Salmon Returns to the Southwest Miramichi in 1996

	Recaptured at Millerton		Tags placed in 1996	
Tagged	Early	Late	NW	SW
Early	2	6	158	210
Late	0	21	173	280
Unmarked catch	246	482		

Matrices for Estimating Small Salmon Returns to the Northwest Miramichi in 1996

	Recaptured in Northwest		Tags placed in 1996		
Tagged	Early	Late	NW	SW	SWMill
Early	18	8	549	306	1121
Late	0	59	238	356	889
Unmarked catch	535	501			

Matrices for Estimating Small Salmon Returns to the Southwest Miramichi in 1996

	Recaptured at Millerton		Tags placed in 1996	
Tagged	Early	Late	NW	SW
Early	17	2	549	306
Late	0	54	238	356
Unmarked catch	1174	945		

Using spatial stratification without prior estimation of emigration rates (excludes tagging at Millerton)

Large Salmon in 1996

	Recaptures in		
Tagged in	NW	SW	Tags placed
NW	9	6	331
SW	7	23	490
Unmarked catch	288	728	

Small Salmon in 1996

	Recaptures in		
Tagged in	NW	SW	Tags placed
NW	45	17	787
SW	16	56	662
Unmarked catch	1036	2119	

Table 9. Tagging and recapture matrices used to estimate the emigration rate of tagged fish outside the branch where they were marked. Recaptures are exclusively returns from angling.

Small and Large Salmon Recoveries in Angling Fishery Combined

SW Lower versus NW Lower

From \ To	NW	SW	Tags Placed	Emigration Rate
NW	26	19	956	50.8%
SW	11	32	1017	19.6%

SW Millerton versus NW Lower

From \ To	NW	SW	Tags Placed	Emigration Rate
NW	26	19	956	29.1%
SW	20	135	2501	20.8%

SW Lower & Millerton versus NW Lower

From \ To	NW	SW	Tags Placed	Emigration Rate
NW	26	19	956	32.7%
SW	31	167	3518	21.8%

Example calculation for SW Lower vs NW Lower

1 - invert recapture matrix:

26	19	Inverted-->	0.0514	-0.0305
11	32		-0.0177	0.0417

2 - multiply by tag vector

956.05	-->>	18.09	= NW weighting for tag recoveries
1017		25.56	= SW weighting for tag recoveries

3 - estimate tag distribution in each branch by multiplying recapture matrix by respective weightings from step 2

(26 X 18.09)	(19 X 25.56)	-->>	470	486
(11 X 18.09)	(32 X 25.564)		199	818

4 - estimate emigration rate by dividing tags from branch A estimated to have moved to branch B relative to tags placed in branch A.

NW tags to SW branch =	(486 / 956) =	50.8%
SW tags to NW branch =	(199 / 1017) =	19.6%

Table 10. Independence tests (Chi-square) of mark and recapture assumptions regarding homogeneity of recovery rates by season and by marking location.

H_o: recovery rates of fish tagged in the early season (before Sept. 1) = recovery rates of fish tagged during the late season (Aug. 31). Recapture facilities are trapnets in the Northwest (Red Bank) and Southwest (Millerton) branches.

	Large Salmon		Small Salmon	
	Early	Late	Early	Late
Seen	13	30	44	103
Not seen	355	423	811	491
Proportion	3.5%	6.6%	5.1%	17.3%
Chi-square	3.9		57.2	
P-value	<0.05		<0.01	

H_o: recovery rates (angling, at barriers, counting fences and in broodstock seining) of fish tagged at Southwest Millerton trapnet (SWMILL) = recovery rates of fish tagged at Eel ground trapnets (SWFFT = Southwest taggging trapnets, NWFFT = Northwest taggging trapents).

Large Salmon

	Early period		Late period	
	SWFFT	SWMILL	SWFFT	SWMILL
Seen	4	13	9	12
Not seen	206	227	271	442
Proportion	1.9%	5.4%	3.2%	2.6%
Chi-square	3.8		0.2	
P-value	0.05		>0.1	

	Early period		Late period	
	NWFFT	SWMILL	NWFFT	SWMILL
Seen	5	13	3	12
Not seen	153	227	170	442
Proportion	3.2%	5.4%	1.7%	2.6%
Chi-square	1.1		0.4	
P-value	>0.1		>0.1	

Small Salmon

	Early period		Late period	
	SWFFT	SWMILL	SWFFT	SWMILL
Seen	30	131	15	45
Not seen	276	990	341	844
Proportion	9.8%	11.7%	4.2%	5.1%
Chi-square	0.9		0.4	
P-value	>0.1		>0.1	

	Early period		Late period	
	NWFFT	SWMILL	NWFFT	SWMILL
Seen	50	131	14	45
Not seen	499	990	224	844
Proportion	9.1%	11.7%	5.9%	5.1%
Chi-square	2.5		0.3	
P-value	>0.1		>0.1	

Table 11. Estimates of returns of small salmon and large salmon by season for the Northwest Miramichi, Southwest Miramichi, and Miramichi River in 1996. Estimates were obtained by resampling technique. Values in bold are the point estimates used for returns to recapture trapnets in 1996.

			Southwest				Northwest				Miramichi River			
Size	Season	Estimator	Median	5th perc.	5th perc.	CV	Median	5th perc.	5th perc.	CV	Median	5th perc.	5th perc.	CV
Using method based on prior estimation of emigration rates using angling recaptures														
Large	Early	Petersen	.	.	.	.	.	.	.	.	.	.	.	.
		Schaefer	7655	4018	17790	60%	3219	1750	6831	54%	11368	6927	21621	49%
		Darroch	16682	6418	44585	59%	4505	1180	15420	76%	22782	10258	50708	45%
	Late	Petersen	.	.	.	.	.	.	.	.	.	.	.	.
		Schaefer	7518	4718	11262	26%	4541	2754	7222	30%	12039	8670	16228	19%
		Darroch	5996	3771	9251	28%	4137	2417	7020	34%	10139	7187	13934	20%
	Total	Petersen	12182	7818	17963	25%	4489	4489	11525	29%	19495	14263	26100	18%
		Schaefer	**15734**	9454	27225	37%	**7910**	4777	13231	33%	**24078**	17341	32455	19%
		Darroch	23144	11775	51354	47%	8874	5039	19634	45%	33216	61188	19758	36%
Small	Early	Petersen	.	.	.	.	.	.	.	.	.	.	.	.
		Schaefer	22471	13987	36061	30%	13593	8980	21464	28%	32020	26598	51783	21%
		Darroch	25226	15391	42386	32%	18025	11382	30502	33%	38227	31042	65481	23%
	Late	Petersen	.	.	.	.	.	.	.	.	.	.	.	.
		Schaefer	6469	438	9037	22%	4606	3158	6775	24%	10017	8562	14396	16%
		Darroch	5838	3893	7971	22%	3537	2420	5258	25%	8432	7161	12121	16%
	Total	Petersen	20783	14427	28370	21%	13040	9256	18505	22%	30605	26276	43305	15%
		Schaefer	**29167**	19087	43801	26%	**18248**	12561	27349	25%	**42662**	35936	65004	18%
		Darroch	31224	20123	49142	28%	21749	14404	34540	29%	47270	39669	75892	20%
Using spatial stratification without prior estimation of emigration rates														
Large	Total	Petersen									16683	13406	21449	15%
		Schaefer	11504	9049	14963	16%	5091	3939	6859	18%	16594	13318	21438	15%
		Darroch	8163	-5510	16042	473%	7402	2843	21505	401%	15860	10218	22483	59%
Small	Total	Petersen							.		30705	26892	35166	8%
		Schaefer	19133	16543	22385	9%	10994	9450	12993	10%	30132	26400	34698	8%
		Darroch	14647	9230	20394	23%	13597	10247	18192	18%	28425	24453	33406	10%

Table 12. Removals of Atlantic salmon by size and season from the Northwest Miramichi, Southwest Miramichi and total Miramichi River system in 1996.

	Northwest Miramichi			Southwest Miramichi			Estuary	Miramichi River		
	Early	Late	Total	Early	Late	Total	Early	Early	Late	Total
Small salmon										
Food fisheries	1063	441	1504	865	209	1074	5	1933	650	2583
Angling[1]	4836	800	5636	7239	4019	11258	0	12125	4769	16894
Seizures[2]	11	0	11	3	0	3	0	14	0	14
Broodstock	29	0	29	37	0	37	0	66	0	66
Incidental mortalities[3]	2	0	2	6	0	6	0	8	0	8
Total	5941	1241	7182	8150	4228	12378	5	14146	5419	19565
Large salmon										
Food fisheries	148	169	317	0	0	0	55	203	169	372
Angling[4]	49	11	60	115	74	189	0	164	85	249
Seizures	3	0	3	1	0	1	0	4	0	4
Broodstock	11	0	11	60	0	60	0	71	0	71
Incidental mortalities[3]	0	0	0	5	1	6	0	5	1	6
Total	211	180	391	181	75	256	55	447	255	702

[1] Average catch of small salmon (1990-1994) from DNRE FISHSYS
[2] Reported by DFO Conservation and Protection Branch personnel
[3] Include trapnet mortalities, meshed fish mortalities, broodstock mortalities, and other observed mortalities
[4] Based on 3% of average catch of large salmon (1990-1994) from DNRE FISHSYS

Table 13. Estimated returns, removals, and escapements of small and large salmon by season to the Northwest Miramichi, Southwest Miramichi and Miramichi River in 1996.

		Returns to recapture trapnets	Harvest below recapture trapnets	Total returns	Total removals	Escapement
Northwest Miramichi						
Small	Early	13,593	533	14,126	5,941	8,185
	Late	4,606	103	4,709	1,241	3,468
	Total	18,248	636	18,884	7,182	11,702
Large	Early	3,219	47	3,266	211	3,055
	Late	4,541	0	4,541	180	4,361
	Total	7,910	47	7,957	391	7,566
Southwest Miramichi						
Small	Early	22,471	865	23,336	8,150	15,186
	Late	6,469	209	6,678	4,228	2,450
	Total	29,167	1,074	30,241	12,378	17,863
Large	Early	7,655	0	7,655	181	7,474
	Late	7,518	0	7,518	75	7,443
	Total	15,734	0	15,734	256	15,478
Miramichi River						
Small	Total	42,662	1,715	44,377	19,565	24,812
Large	Total	24,078	102	24,180	702	23,478

Table 14. Sex ratio (% female) of small salmon by trap, season, and river system for 1996.

	Early run	Late run	X^2	P-value	DF
NW Big Hole	34.3%	18.2%	1.2	0.28	1
NW Red Bankl	30.9%	5.6%	95.0	0.00	1
X^2	0.4	3.1	Average		
P-value	0.53	0.08	early	31.8%	
DF	1	1	late	5.9%	

	Early run	Late run	X^2	P-value	DF
SW Food Fishery	18.7%	8.5%	3.8	0.05	1
SW Millerton	N/A	6.2%	-	-	-
X^2	-	0.5	Average		
P-value	-	0.5	early	18.7%	
DF	-	1	late	6.3%	

	Early run	Late run	X^2	P-value	DF
NW Miramichi	31.8%	5.9%	108.3	0.00	1
SW Miramichi	18.7%	6.3%	59.9	0.00	1
X^2	17.1	0.1	Average		
P-value	0.00	0.7	early	22.6%	
DF	1	1	late	6.1%	

Table 15. Sex ratio (% female) of large salmon by trap, season, and river system in 1996.

	Early run	Late run	X^2	P-value	DF
NW Big Hole	80.0%	75.0%	0.0	0.86	1
NW Red Bankl	92.8%	83.7%	4.0	0.05	1
X^2	1.1	0.2	Average		
P-value	0.31	0.64	early	92.1%	
DF	1	1	late	83.7%	

	Early run	Late run	X^2	P-value	DF
SW Millerton	83.7%	77.9%	2.6	0.1	1

	Early run	Late run	X^2	P-value	DF
NW Miramichi	92.5%	83.7%	3.6	0.06	1
SW Miramichi	83.7%	77.9%	2.6	0.11	1
X^2	3.4	3.0	Average		
P-value	0.06	0.08	early	86.6%	
DF	1	1	late	79.5%	

Table 16. Sex ratios (% female) of small and large salmon observed during broodstock collections and at the Little River counting fence. All determinations based on external characteristics.

	Small salmon			Large salmon		
	Female	Male	% female	Female	Male	% female
Southwest Miramichi						
Rocky Brook, Coldstream Pool (Sept. 5, 1996)	16	40	29%	18	2	90%
Rocky Brook, Hurd and McGrath pools, (Sept. 5, 1996)	6	32	16%	10	2	83%
Clearwater Brook, Avenor Bridge (Sept. 14, 1996)	2	29	6%	37	2	95%
Dungarvon Barrier (Sept. 25, 1996)	166	248	40%	105	8	93%
Northwest Miramichi						
Sevogle, Trash Heap Pool, (Sept. 20, 1996)	9	5	64%	1	0	100%
Northwest Barrier, (Sept. 18, 1996)	26	40	39%	18	2	90%
Little Southwest, Smith Forks and Moose Landing (Sept. 22, 1996)	10	8	56%	3	1	75%
Little River, counting fence (Oct. 26-Nov. 10, 1996)	5	21	19%	7	4	64%

Table 17. 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 1996.

		Small salmon		Large salmon	
		Estimate	Std. Dev.	Estimate	Std. Dev.
Northwest Miramichi					
% Female	early	31.8		92.1	
	late	5.9		83.7	
	total	17.0		86.2	
Fork length (cm)	early	53.0	2.52	77.5	7.59
	late	56.9	2.76	79.1	7.24
	total	54.2	3.15	78.4	7.43
Fecundity[1]	early	977		6775	
	late	226		6337	
	total	562		6445	
% Previous spawners	early			32.0	
	late			39.2	
	total			35.9	
Southwest Miramichi					
% Female	early	18.7		83.7	
	late	6.3		77.9	
	total	11.0		79.3	
Fork length (cm)	early	53.7	2.46	76.9	6.19
	late	56.8	3.92	78.8	7.90
	total	55.1	3.56	78.1	7.42
Fecundity[1]	early	597		6093	
	late	242		5870	
	total	382		5899	
% Previous spawners	early			19.9	
	late			35.2	
	total			30.0	
Miramichi River					
% Female	early	23.8		86.6	
	late	6.2		79.5	
	total	13.2		81.3	
Fork length (cm)	early	53.5		77.2	
	late	56.9		78.8	
	total	54.9		78.2	
Fecundity[1]	early	753		6340	
	late	238		5990	
	total	452		6059	
% Previous spawners	early			24.6	
	late			36.3	
	total			31.9	

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 18. Egg deposition (millions of eggs) and percent of conservation requirement met for early, late and total spawners for the Northwest Miramichi, Southwest Miramichi and Miramichi River system in 1996. Figures in brackets are depsositions calculated using fecundity data from broodstock at Miramcihi Salmonid Enhancement Centre (see text for details).

	Small	Large	Total	Contribution by large	% of conservation requirement
Northwest Miramichi					
Early	8.5	20.9	29.4	71%	
	(6.3)	(19.0)	(25.4)	(75%)	
Late	0.8	25.6	26.4	97%	
	(0.6)	(23.8)	(24.4)	(98%)	
Total	7.0	47.2	54.2	87%	
	(5.1)	(43.2)	(48.6)	(90%)	
Conservation requirement			41.0	115%	132%
				(106%)	(119%)
Southwest Miramichi					
Early	9.8	46.4	56.2	83%	
	(7.0)	(41.4)	(48.7)	(86%)	
Late	0.7	43.6	44.3	98%	
	(0.4)	(40.5)	(41.0)	(99%)	
Total	10.5	90.0	100.5	90%	
	(7.5)	(81.9)	(89.6)	(92%)	
Conservation requirement			88.0	102%	114%
				(93%)	(102%)
Miramichi River					
Total	13.3	135.6	148.9	91%	
	(9.8)	(121.8)	(132.1)	(93%)	
Conservation requirement			132.0	103%	113%
				(93%)	(100%)

Table 19. Estimated returns and escapement to the Miramichi River (to Millbank 1971 to 1991; to Enclosure area 1992 to 1996) of small and large salmon. % change is 1996 minus mean relative to the mean.

	Small salmon		Large salmon	
Year	Returns	Escapement	Returns	Escapement
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	24,812	24,180	23,478
Mean				
1991 to 1995	83,918	65,960	32,424	31,792
1971 to 1995	66,595	47,312	27,506	20,489
1992 to 1996	80,620	61,268	31,270	30,669
1984 to 1991	79,292	57,422	23,008	22,035
% change in 1996 relative to				
1991 to 1995	-47.1%	-62.4%	-25.4%	-26.2%
1971 to 1995	-33.4%	-47.6%	-12.1%	14.6%

Table 20. Estimated returns of small and large salmon to the Southwest Miramichi and the Northwest Miramichi, 1992 to 1996.

	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
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

Table 21. Numbers of large and small salmon counted at barriers in three tributaries of the Miramichi River, 1981 to 1996.

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
1991-95	Mean	918	1047	1965		
Change (96-mean)/mean		-11%	+33%	+12%		
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
1991-95	Mean	182	493	675		
Change (96-mean)/mean		+3%	+25%	+19%		
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
1991-95	Mean	228	837	1065		
Change (96-mean)/mean		-5%	-28%	-23%		

Table 22. Counts of migrant parr, smolts, small salmon and large salmon at Catamaran Brook, Northwest Miramichi 1990 to 1995. Data courtesy of R. Cunjak (DFO Science, Moncton, NB). Migrant parr (ages ≥ 1) counts are for May to November. Survivals back to the fence as small and large salmon are based on smolt counts only.

	Downstream		Upstream		% Survival to	
Year	Migrant parr	Smolts	Small salmon	Large salmon	Small salmon	Large salmon
1990	851[1]	760	83[1]	28[1]	10.3%	8.6%
1991	1684	1165	78	49	10.9%	3.7%
1992	1229	2135	127	65	5.0%	1.2%
1993	1371	426	106	43	13.4%	16.9%
1994	1779	887	57	25	13.3%	4.4%
1995	1620	935	118	72	8.3%	
1996[2]	N/A	472	78	39		

[1] incomplete count because of damage to counting fence

[2] 1996 counts are preliminary

Table 23. Distribution of salmon juveniles in the Miramichi River in 1996. AC = adipose-clip, NM = unmarked.

River	Life stage	Mark	Number of fish stocked
Northwest Miramichi	2+ smolts	AC	39,742
	1+ smolts	AC	1,736
	1+ parr	AC	8,460
	0+ parr (June)	AC	15,381
	0+ parr (Sept.-Oct.)	AC	12,848
	Non-feeding fry	NM	37,008
Southwest Miramichi	2+ smolts	NM	2,890
	1+ smolts	AC	3,891
	0+ parr (June)	NM	50,115
	0+ parr (Sept.-Oct.)	AC	59,179
	Non-feeding fry	NM	42,793
Miramichi (total)	2+ smolts	AC	39,742
	2+ smolts	NM	2,890
	1+ smolts	AC	5,627
	1+ parr	AC	8,460
	0+ parr (June)	AC	15,381
	0+ parr (June	NM	50,115
	0+ parr (Sept.-Oct.)	AC	72,027
	Non-feeding fry	NM	79,801

Table 24. Risk of not achieving conservation requirements in 1997 for different harvesting scenarios. Harvest scenarios are for large salmon only.

	First Nations Harvests			Angling harvests		Risk of not acheiving conservation requirements in 1997		
Scenario	Estuary	Northwest	Southwest	Northwest	Southwest	Northwest	Southwest	Miramichi
1	0	0	0	0	0	22.10%	21.40%	23.20%
2	0	0	0	124	273	23.30%	22.60%	24.50%
3	200	623	0	0	0	27.40%	22.30%	27.40%
4	200	623	0	115	270	27.50%	23.40%	27.50%
5	400	1246	0	105	268	31.10%	24.70%	31.10%
6	333	1800	3600	98	220	37.17%	34.57%	37.45%

Scenario 1 : no fisheries in 1997

Scenario 2 : no First Nations harvests, angling harvests are incidental mortalities by hook and release

Scenario 3: only First Nations harvests as per 1996 plan, no angling fisheries

Scenario 4: First Nations harvests and angling fisheries as per 1996 plan

Scenario 5: doubling of 1996 plan harvests for First Nations, angling fisheries as per 1996 plan

Scenario 6: allocating all surplus MSW based on the mode of the forecasted returns and the point estimate for conservation requirements for the Miramichi (23600 MSW salmon). Note: First Nations harvests are distributed between Southwest and Northwest based on expected returns to each branch.

Table 25. Relative contribution of wild (non-adipose clipped) salmon to the returns in 1996.

	Small salmon			Large salmon		
	Wild	Adipose-clip	% wild	Wild	Adipose-clip	% wild
Southwest Miramichi (received 33000 smolts in 1994, 27000 smolts in 1995)						
Sampling at food fishery and Millerton trapnets						
June to Aug.	1658	7	99.6%	477	3	99.4%
Sept. to Oct.	1512	3	99.8%	844	1	99.9%
Total	3170	10	99.7%	1321	4	99.7%
Dungarvon River (received smolt stocking in 1994 and 1995)						
Seining at Furlong Bridge						
Sept. 9	36	0	100.0%	14	0	100.0%
Seining at Barrier Pool						
Sept. 25	412	2	99.5%	111	2	98.2%
Clearwater Brook (received satellite-reared fall fingerlings)						
Bridge Pool						
Sept. 14	31	0	100.0%	29	0	100.0%
Rocky Brook (received satellite-reared fall fingerlings annually since 1984)						
Seining at McGrath, Coldspring, and Hurd Brook pools						
Sept. 5	95	0	100.0%	32	2	94.1%
Northwest Miramichi (received 41000 smolts in 1994, 2700 smolts in 1995)						
Sampling at Eel Ground trapnets						
June to Aug.	661	2	99.7%	171	1	99.4%
Sept. to Oct.	310	1	99.7%	207	0	100.0%
Total	971	3	99.7%	378	1	99.7%
Sampling at Red Bank trapnets						
June to Aug.	215	2	99.1%	90	0	100.0%
Sept. to Oct.	160	0	100.0%	153	0	100.0%
Total	375	2	99.5%	243	0	100.0%
Northwest Barrier Pool (seining) (smolts in 1994 and 1995 stocked below barrier)						
Sept. 18	66	0	100.0%	20	0	100.0%
Sevogle River (Trash Heap Pool) (non-feeding fry stocking only)						
Oct. 12	14	0	100.0%	1	0	100.0%
Little River counting trap (1500 smolts released in 1994, 2700 smolts in 1995)						
Oct. 26 to Nov. 10	22	4	84.6%	11	0	100.0%
Little Southwest Miramichi (non-feeding fry stocking only)						
Seining at Smith Forks and Moose Landing						
Sept. 22	18	0	100.0%	4	0	100.0%

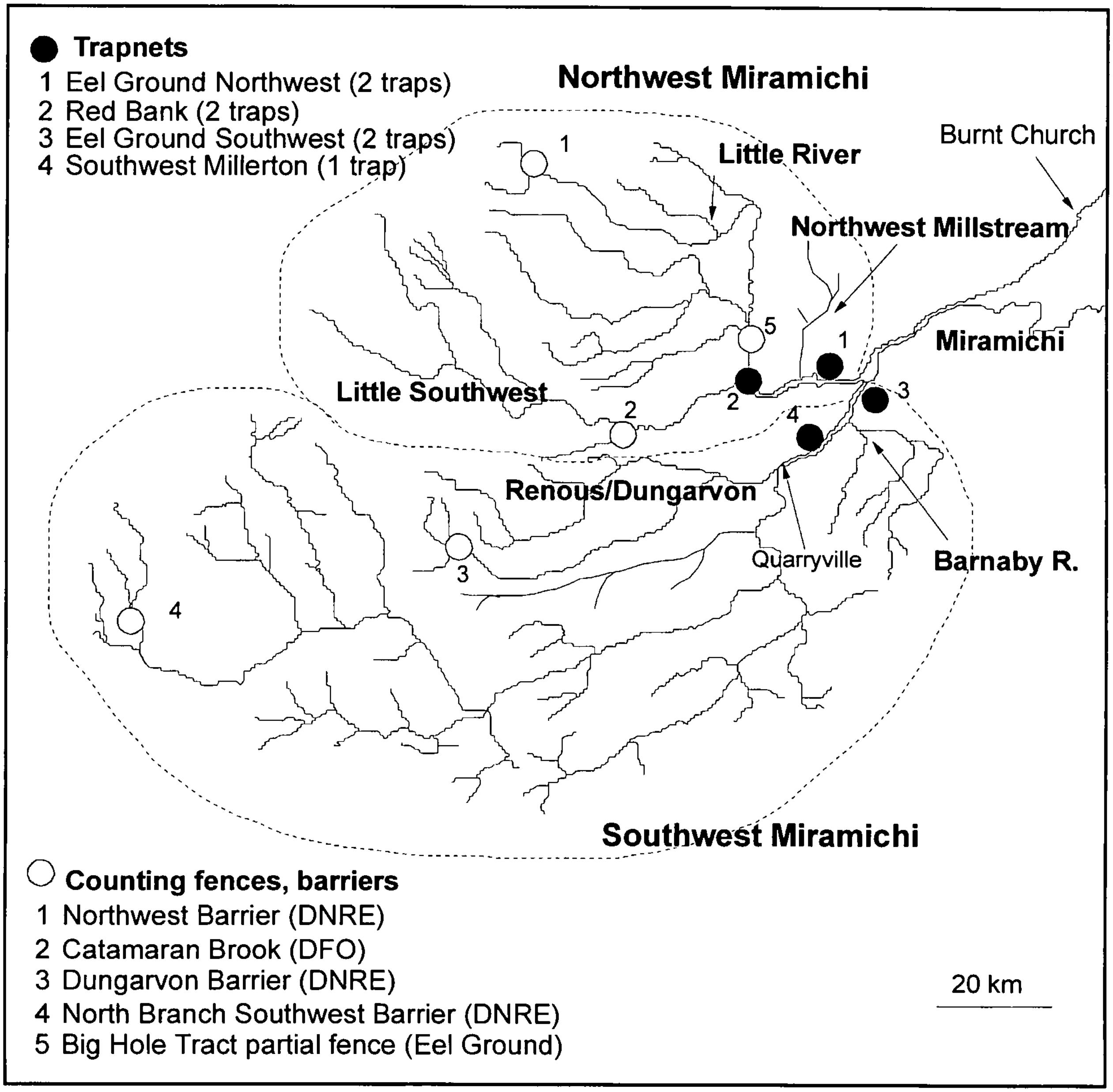


Figure 1. The Miramichi River indicating major branches, major tributaries and location of trapnets and counting fences operated in 1996.

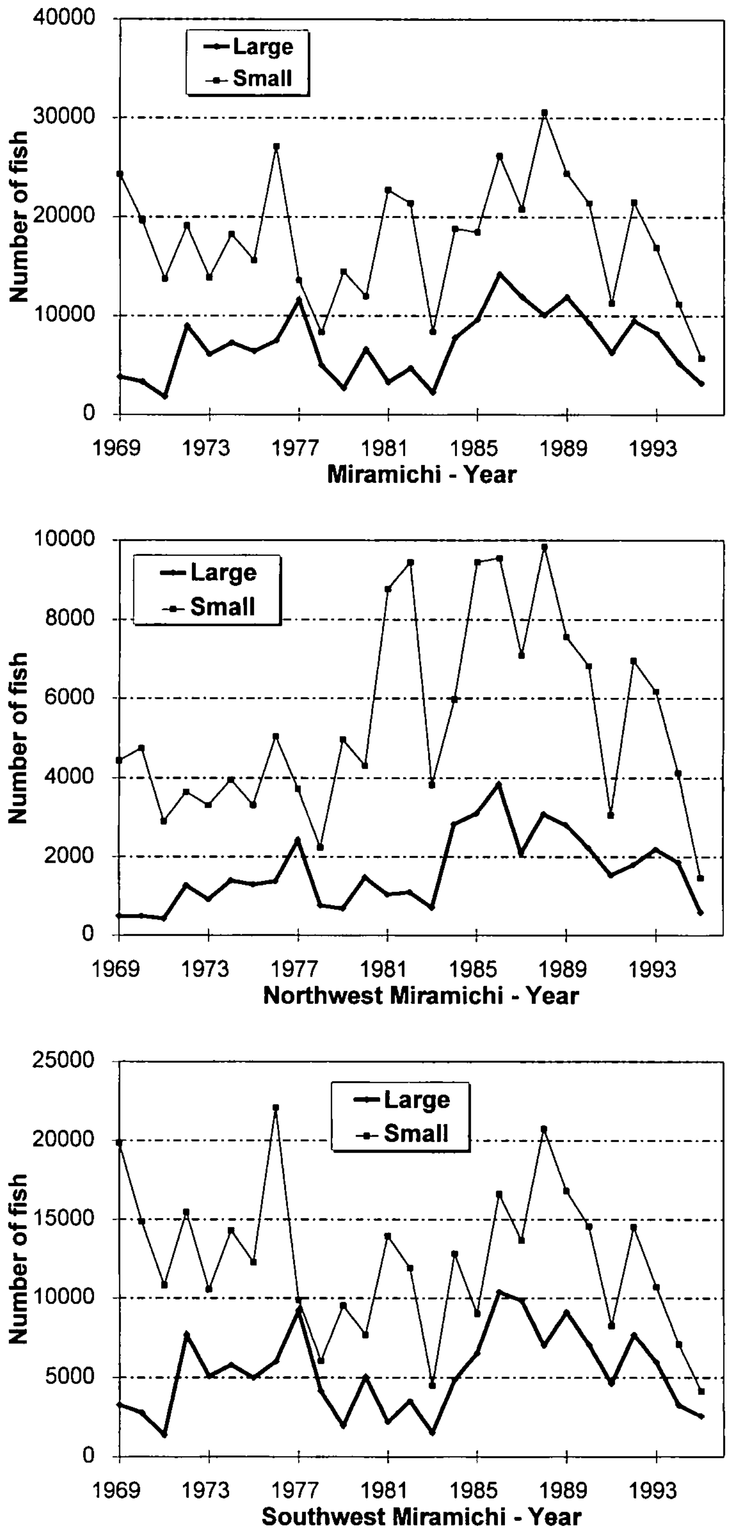


Figure 2. Trends in angling catches of small and large salmon from the Miramichi River (top), Northwest Mriamichi (middle) and Southwest Miramichi (bottom) rivers.

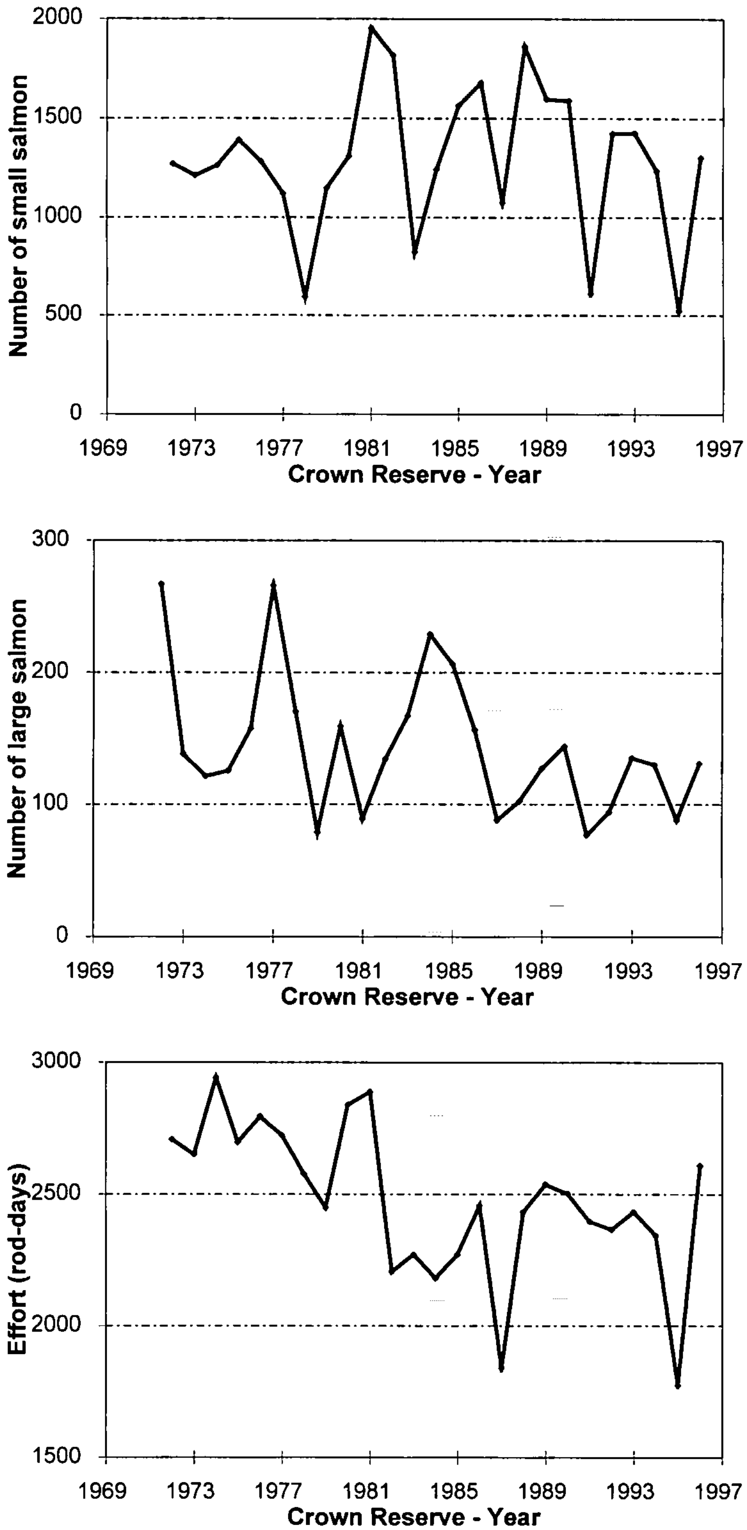


Figure 3. Trends in catches of small salmon (top), large salmon (middle), and angling effort (bottom) from the Crown Reserve waters of the Northwest Miramichi, 1972 to 1996.

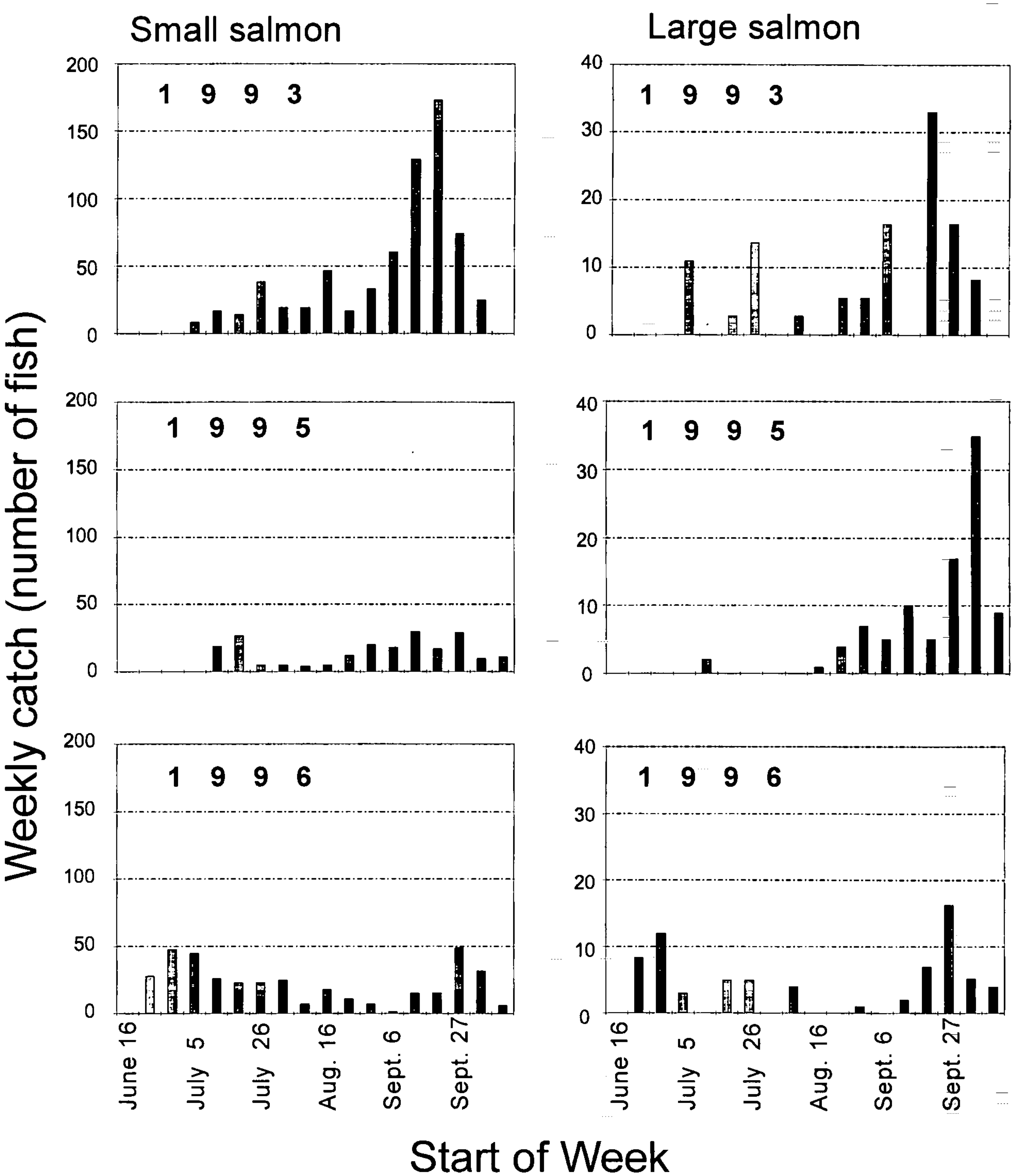
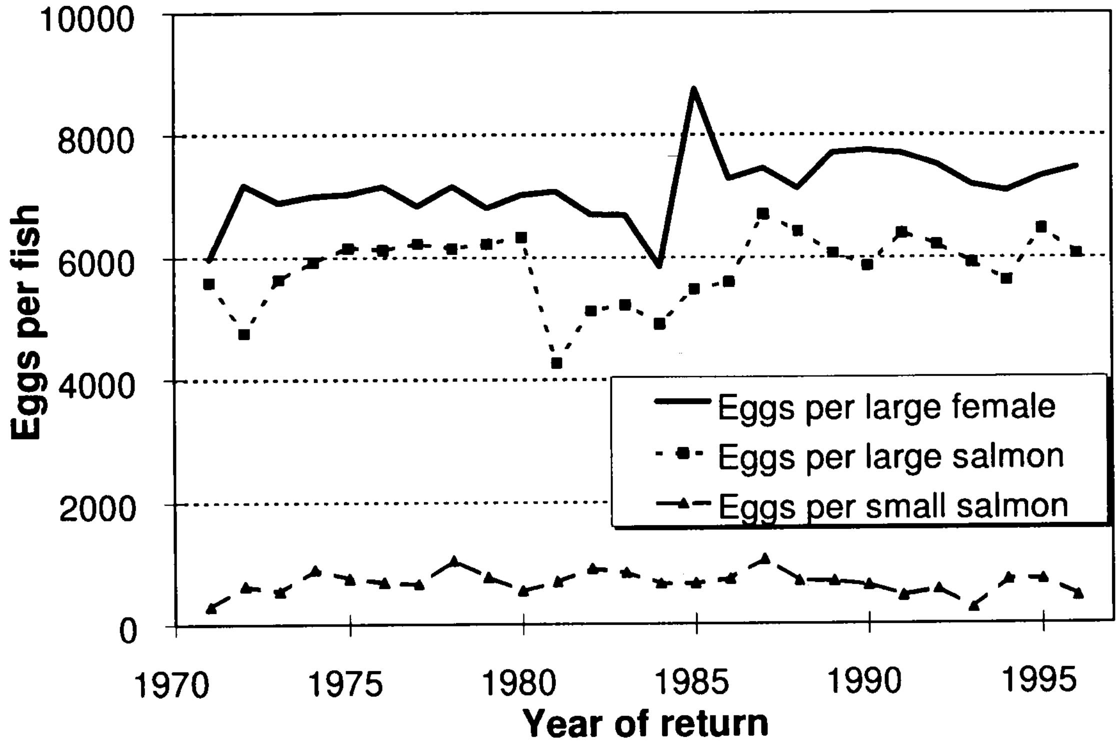


Figure 4. Catches of small salmon and large salmon by week at the Quarryville Pool as estimated by creel surveys in 1993, 1995 and 1996.



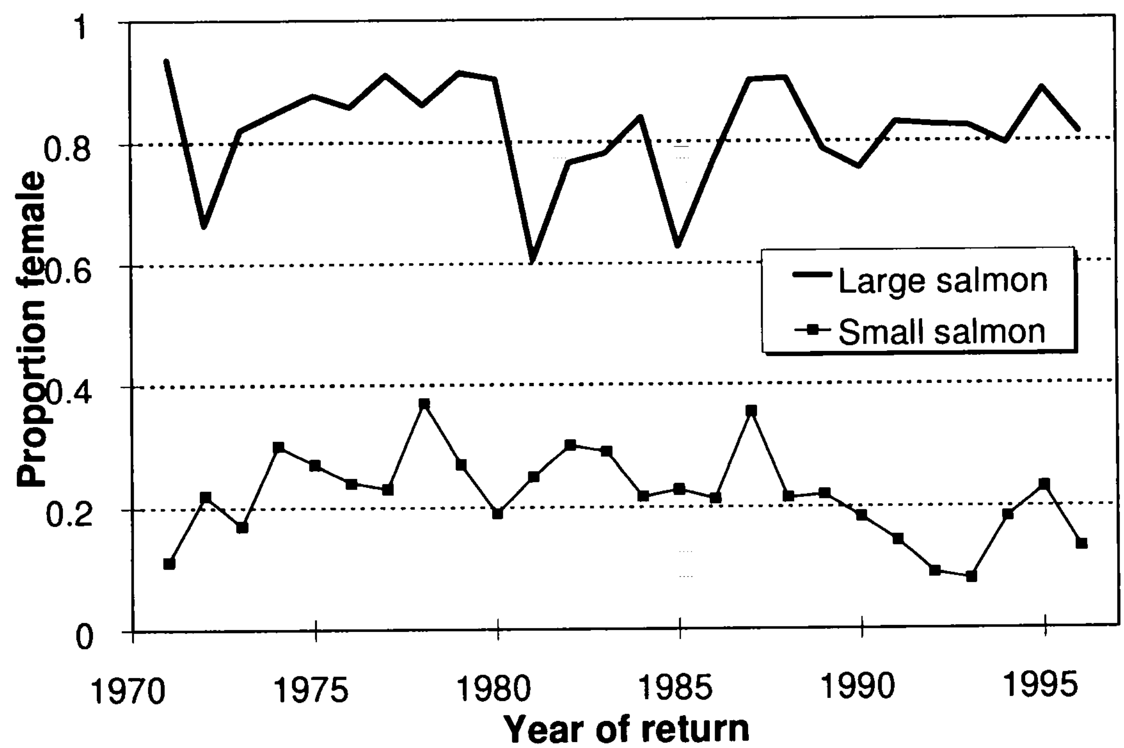


Figure 5. Annual variation in the fecundity (upper) and proportions female (lower) of small and large salmon from the Miramichi River, 1971 to 1996.

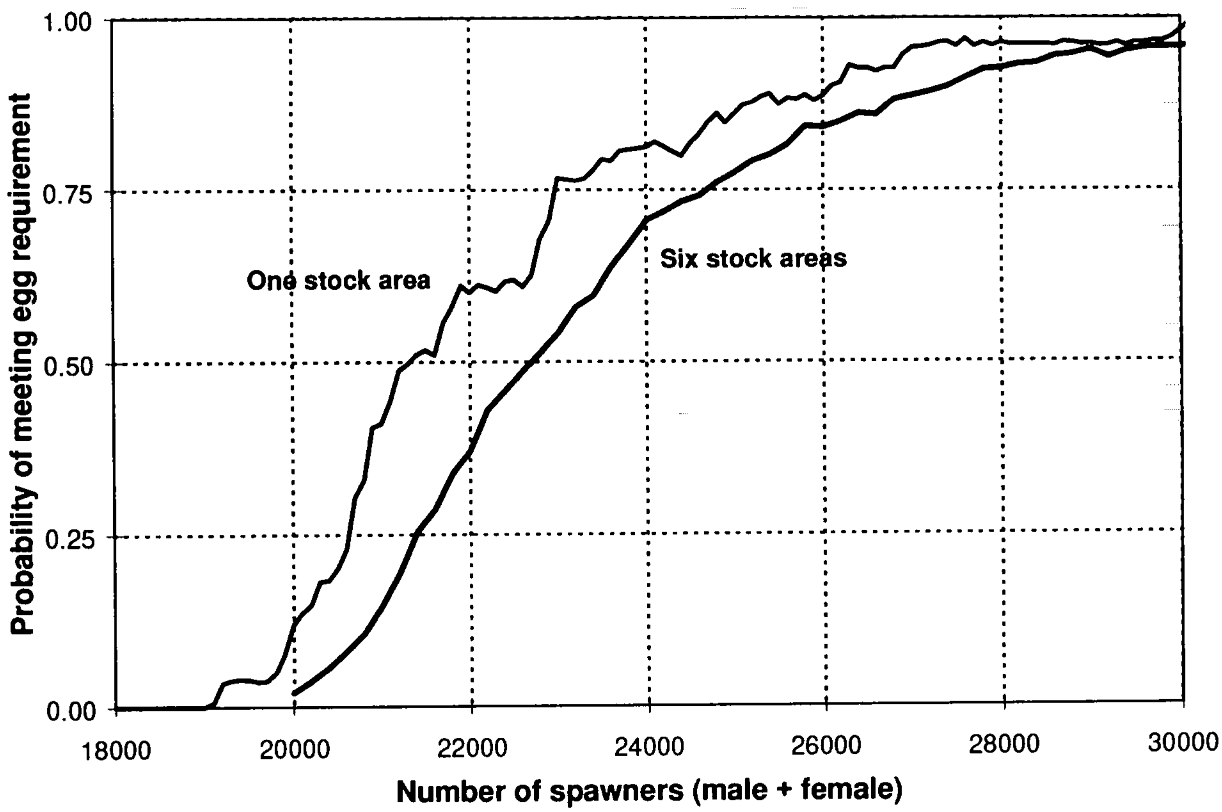
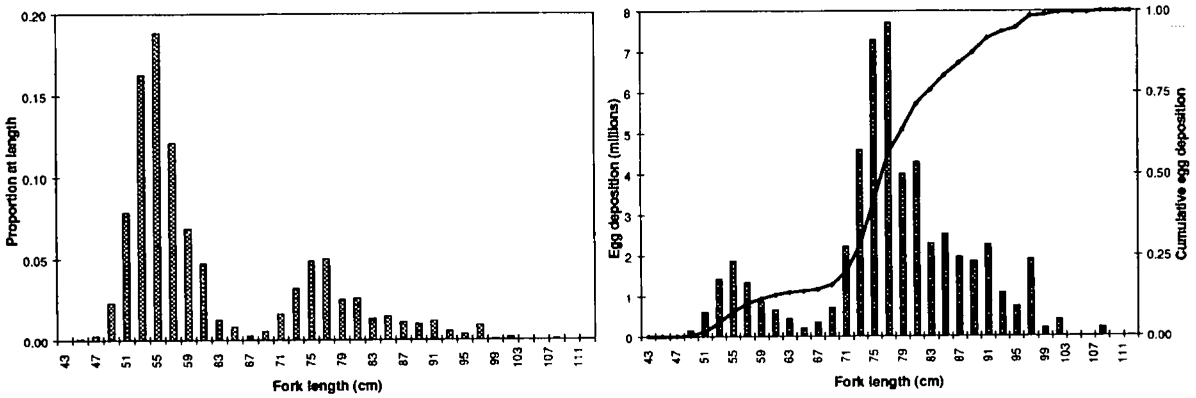
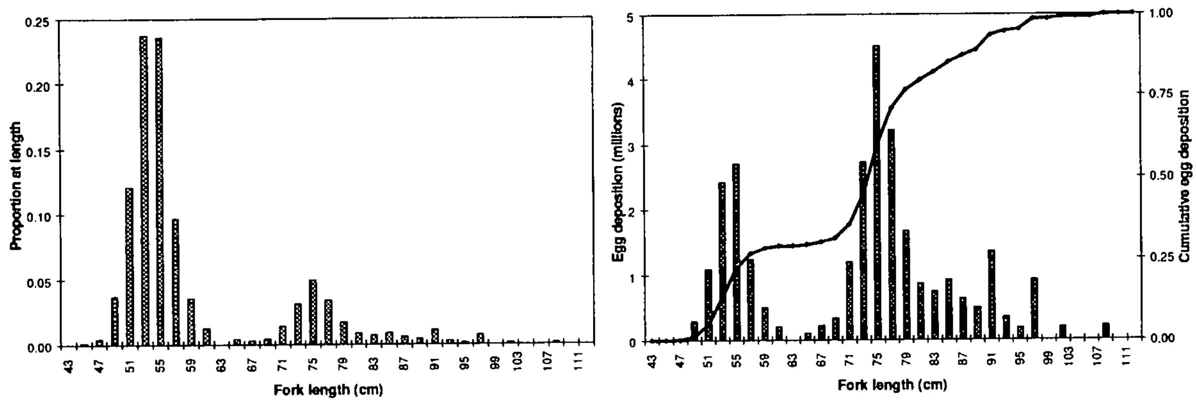


Figure 6. Probability of meeting or exceeding conservation egg requirements for the Miramichi River (1 stock) and simultaneously in six sub-areas (six stocks) of the Miramichi River relative to the number of large salmon (male and female) spawners.

Northwest Miramichi: total for the year



Northwest Miramichi: early run



Northwest Miramichi: late run

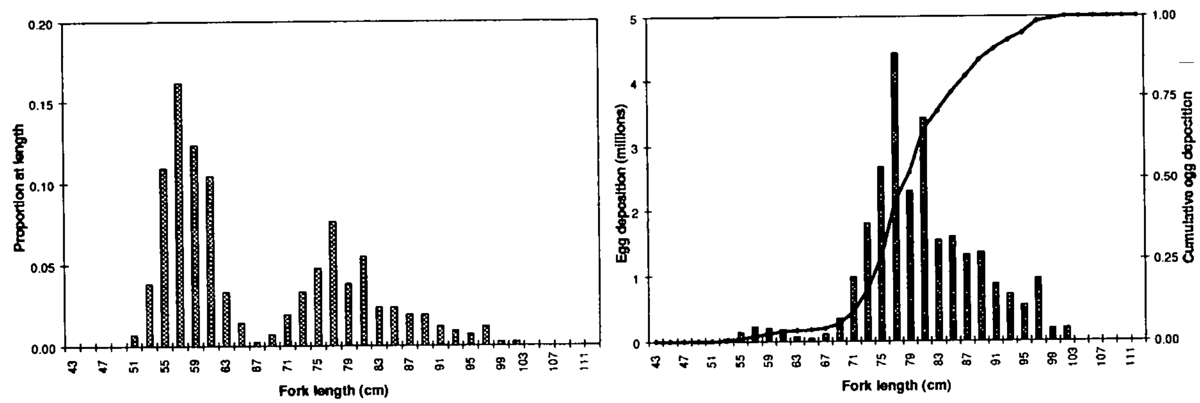
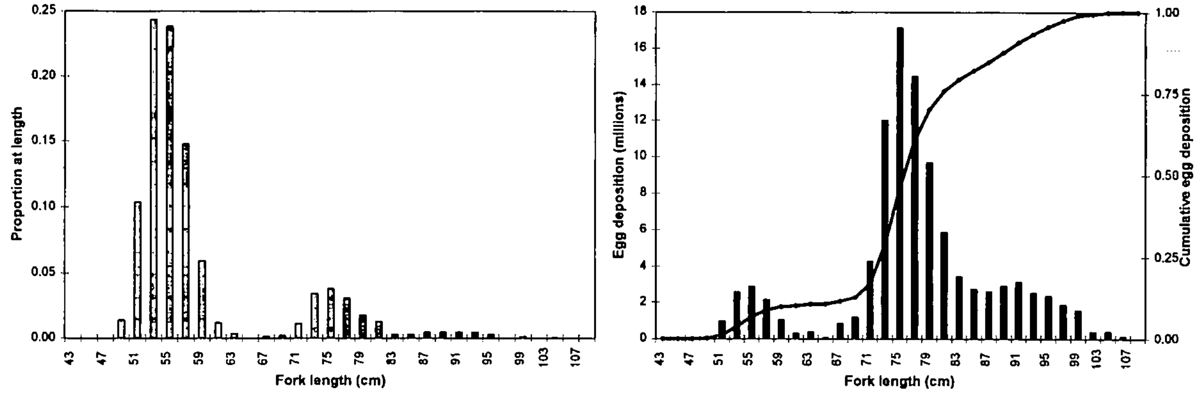
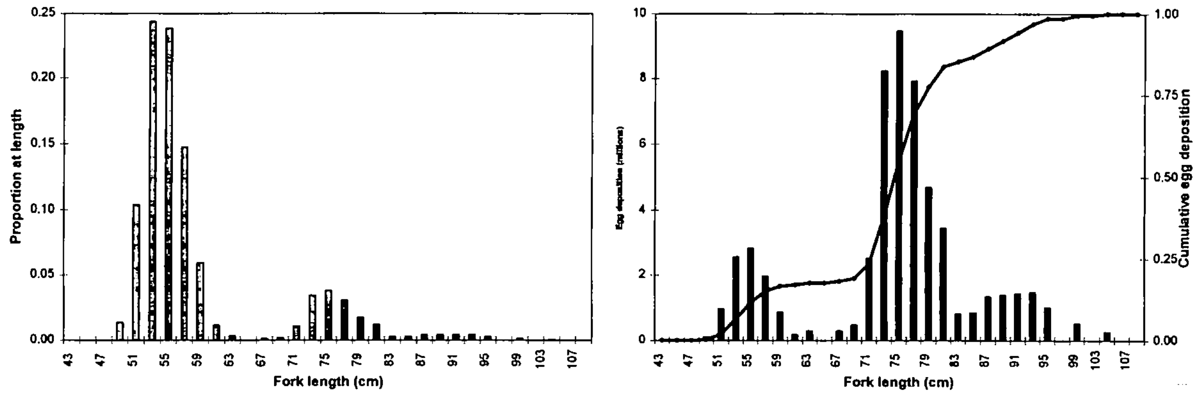


Figure 7. Proportion at length, egg deposition at length and cumulative egg deposition at length for total spawners, early run and late run spawners to the Northwest Miramichi during 1996.

Southwest Miramichi: total for the year



Southwest Miramichi: early run



Southwest Miramichi: late run

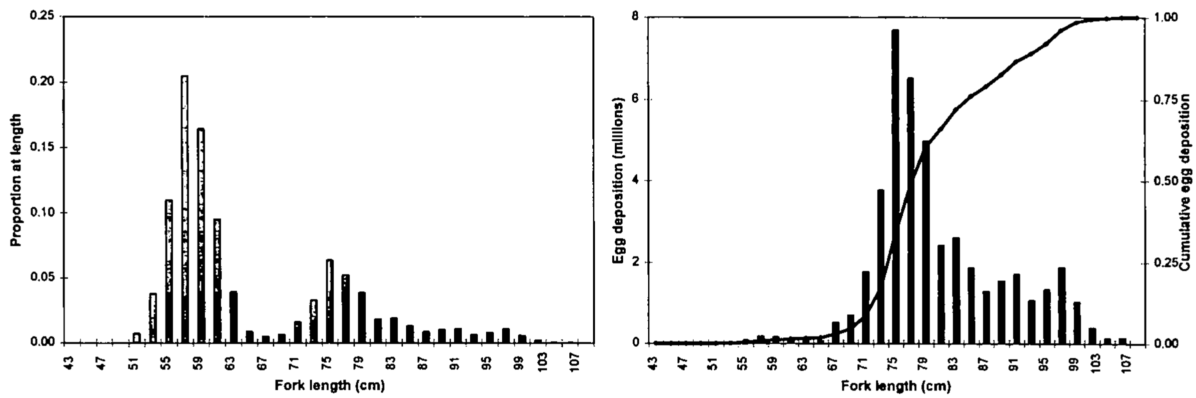


Figure 8. Proportion at length, egg deposition at length and cumulative egg deposition at length for total spawners, early run and late run spawners to the Southwest Miramichi during 1996.

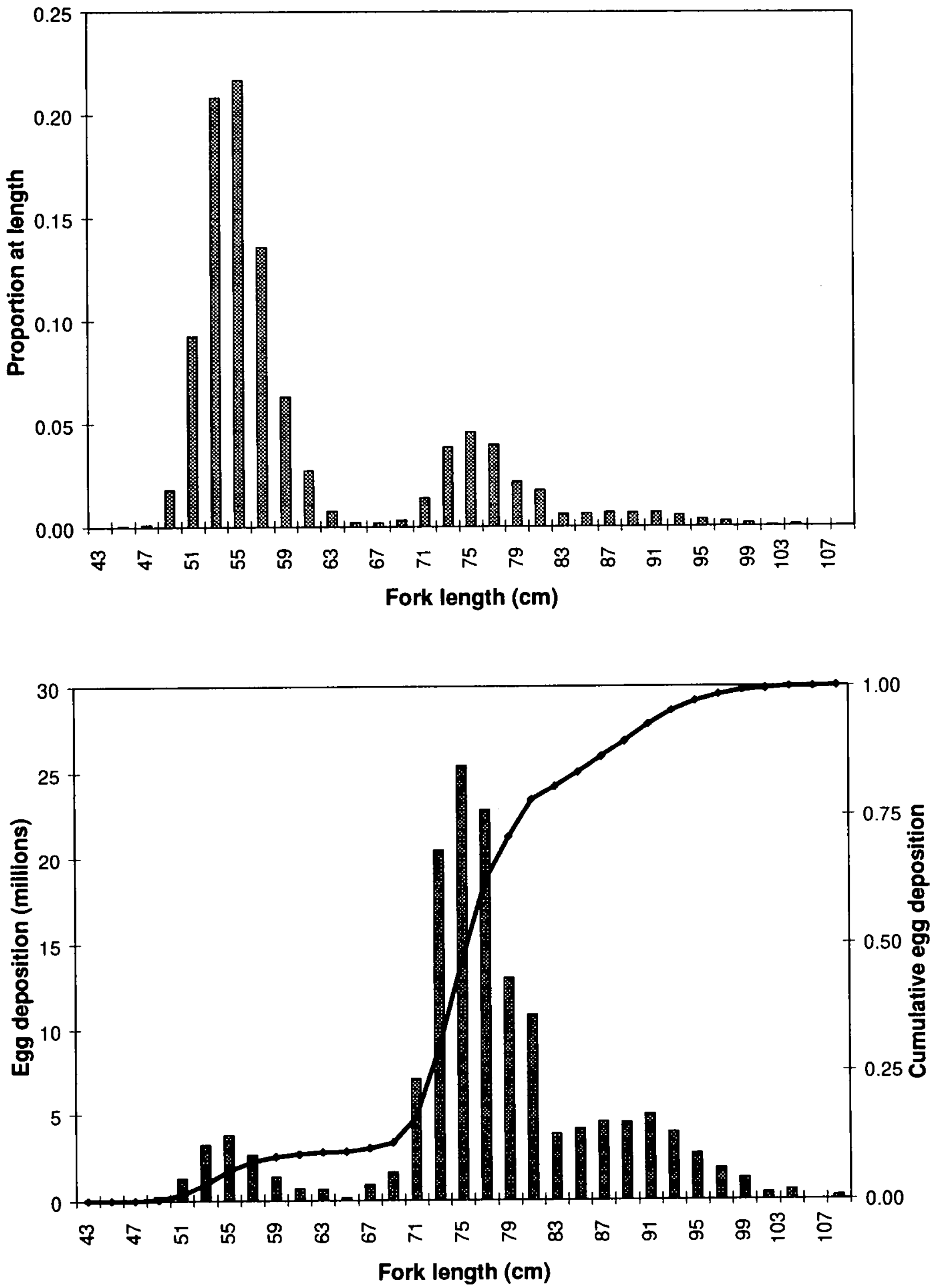


Figure 9. Proportion at length, egg deposition at length and cumulative egg deposition at length for the total spawners of the Miramichi River during 1996.

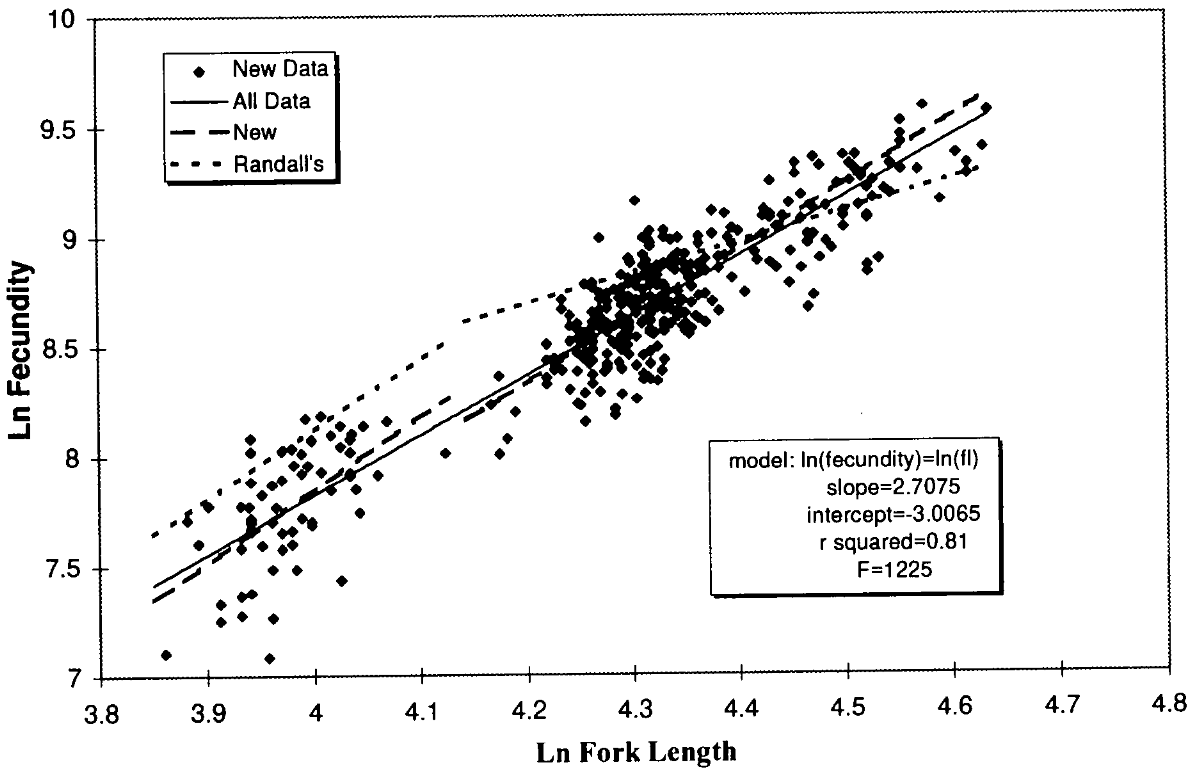
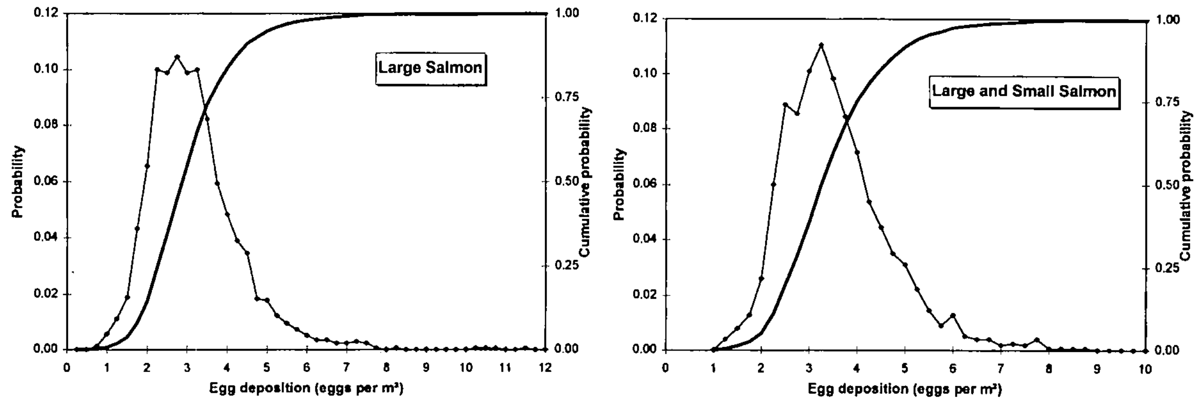
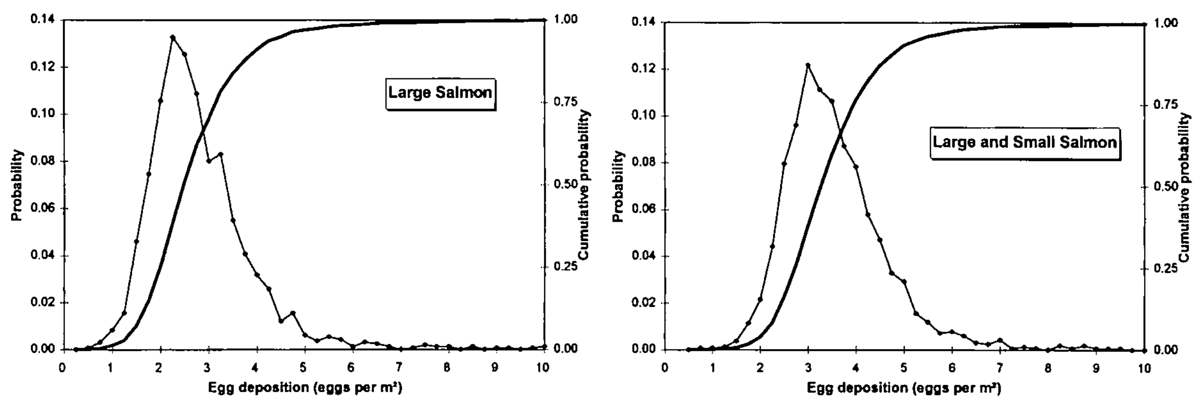


Figure 10. Length-fecundity relationship for Miramichi River broodstock spawned at the hatchery in South Esk compared to the relationship derived by Randall (1989).

Northwest Miramichi



Southwest Miramichi



Miramichi River

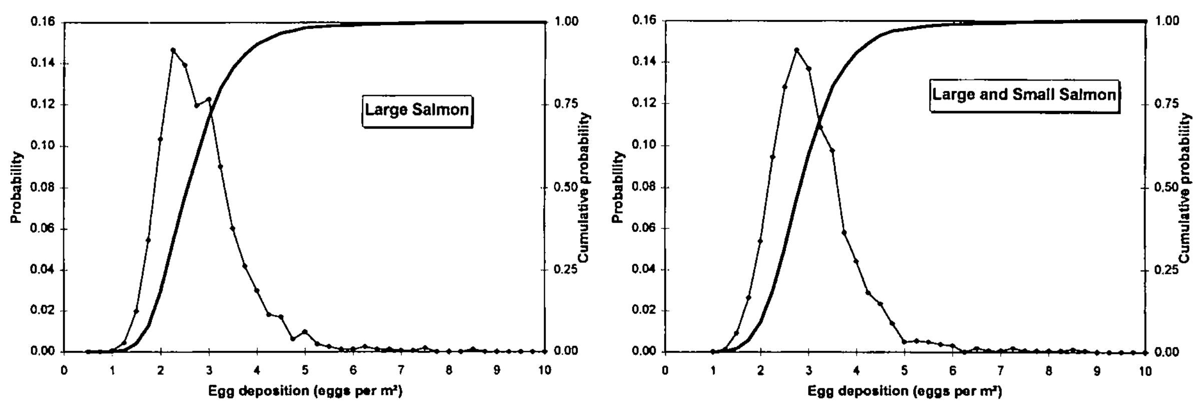


Figure 11. Probable egg depositions (eggs per m^2) in the Northwest Miramichi (top), Southwest Miramichi (middle) and Miramichi River (bottom) by large salmon only (left) and by large and small salmon combined (right) in 1996.

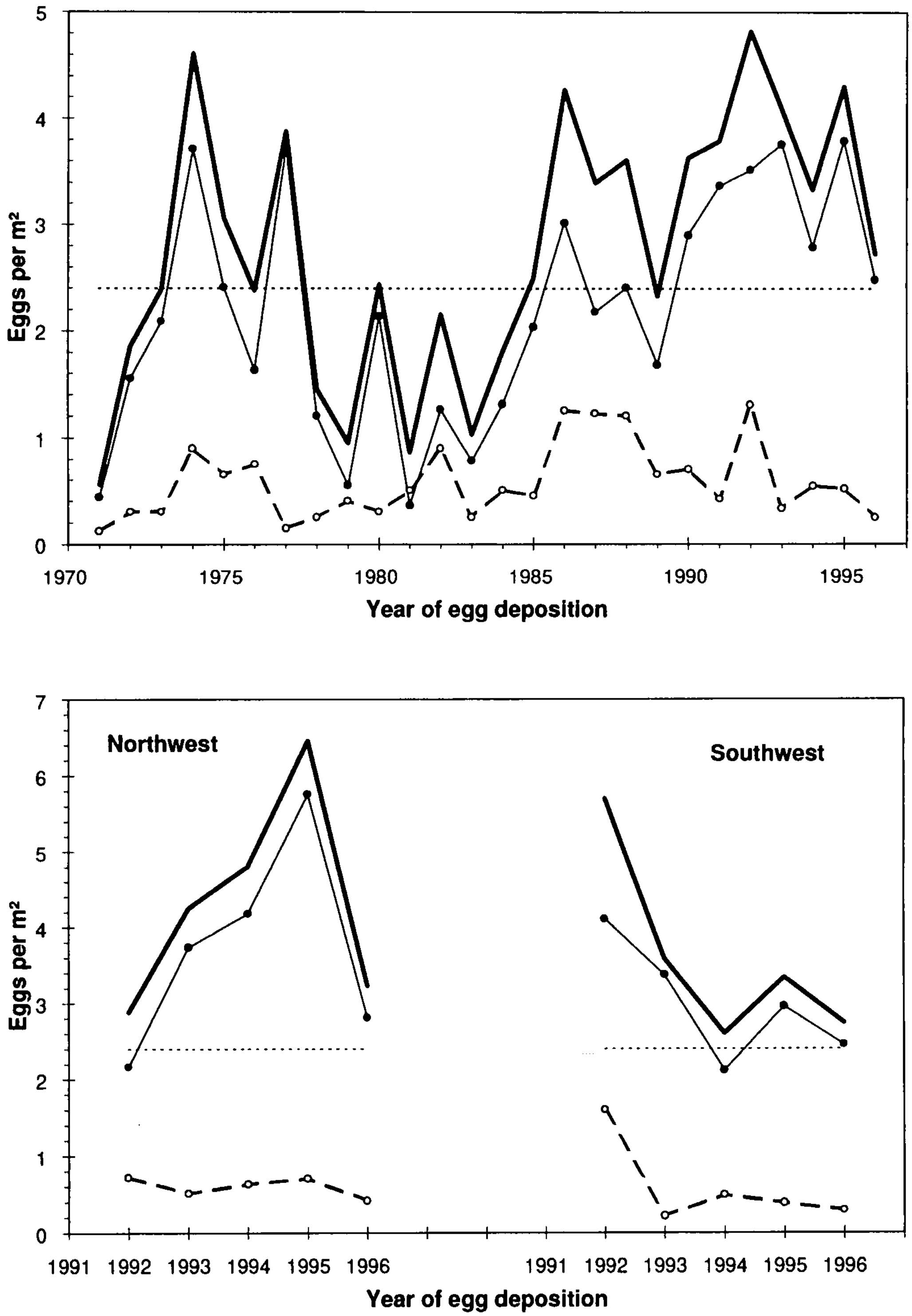
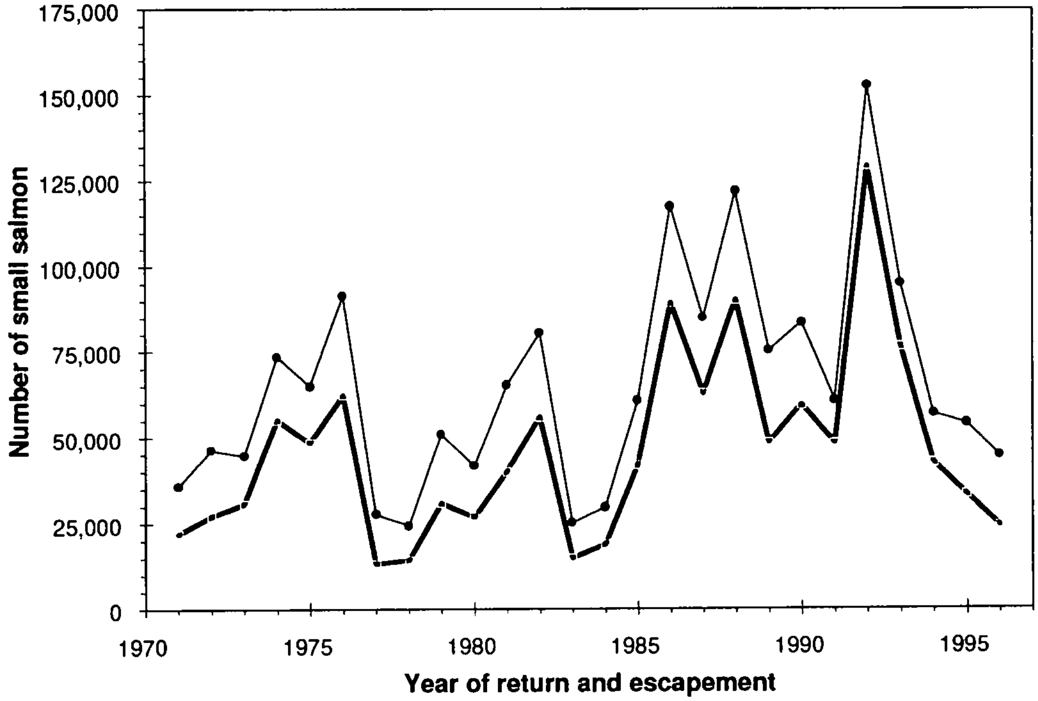


Figure 12. Point estimate annual egg depositions (eggs per m^2) by small (circle dashed line), large (dots and narrow line) and combined (thick line) for the Miramichi River, 1971 to 1996 (upper panel) and for the Northwest and Southwest branches, 1992 to 1996 (lower). Dashed line is the conservation egg requirement of 2.4 eggs per m^2.



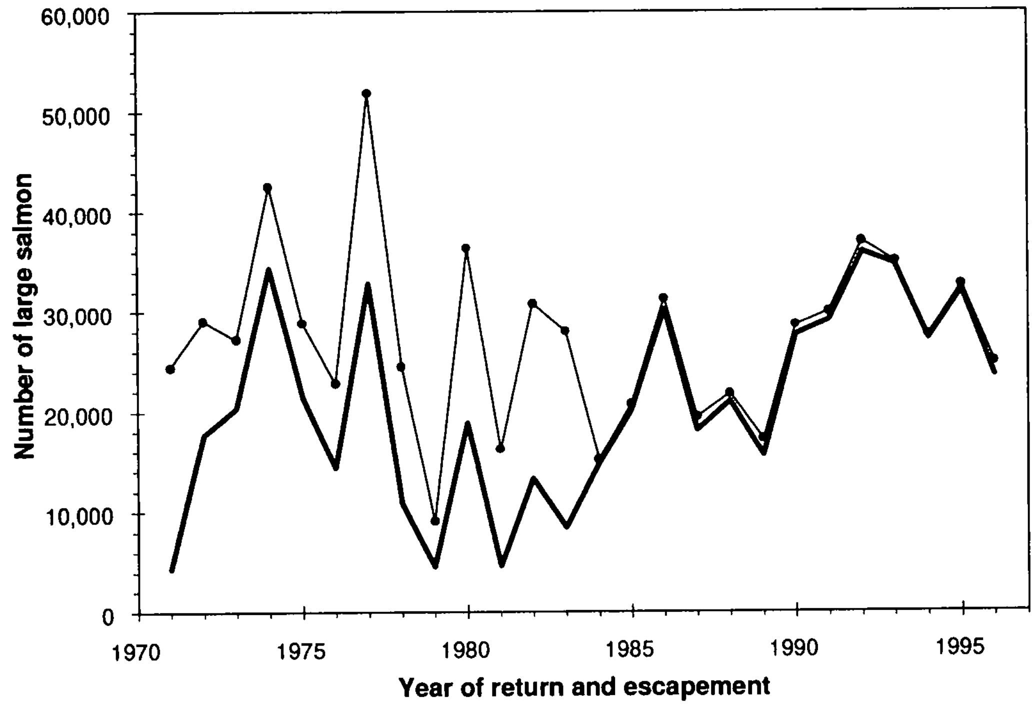


Figure 13. Point estimates of total returns to the Miramichi River estuary and number of spawners for small salmon (upper) and large salmon (lower), 1971 to 1996.

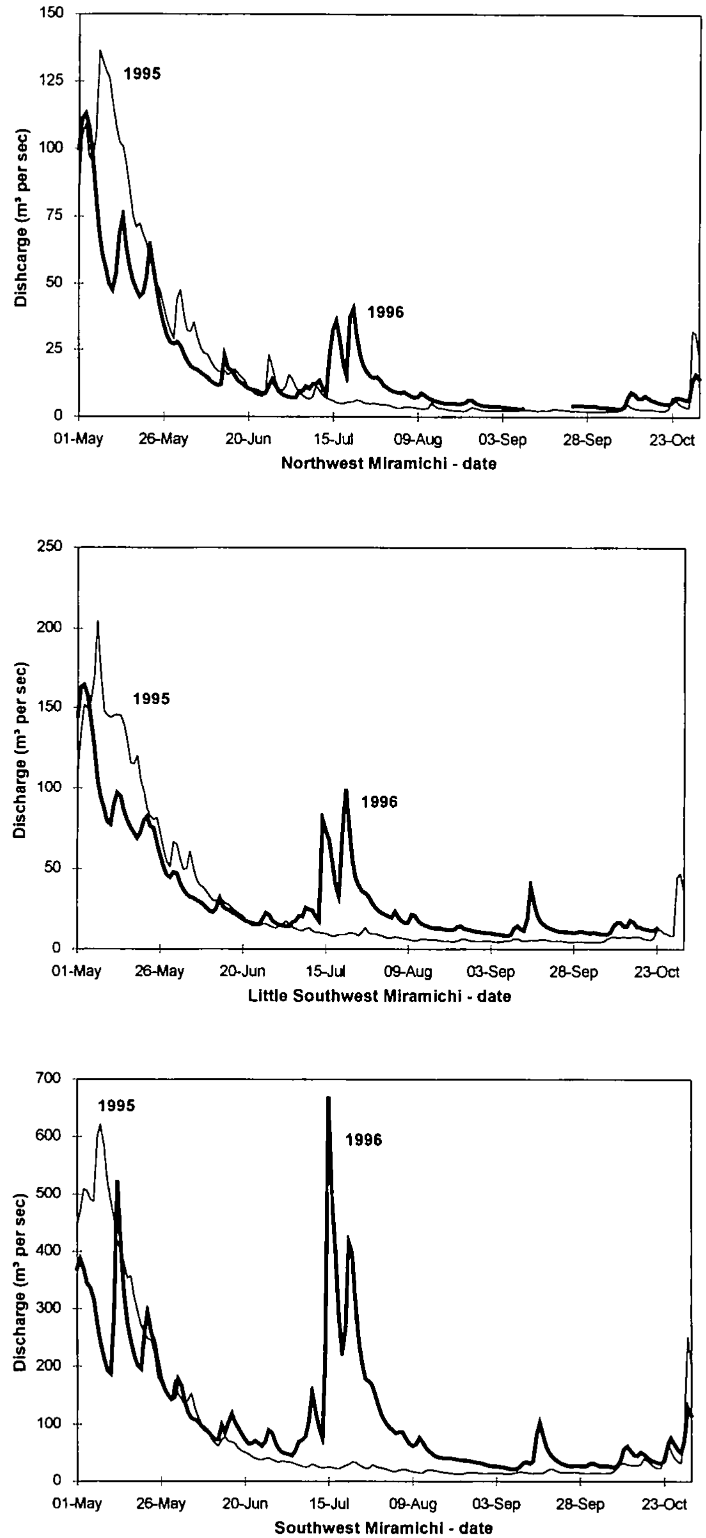


Figure 14. Discharge (m^3 per sec) profiles for the Northwest Miramichi (upper), Little Southwest Miramichi (middle) and Southwest Miramichi (lower) from May 1 to October 31, 1995 and 1996.

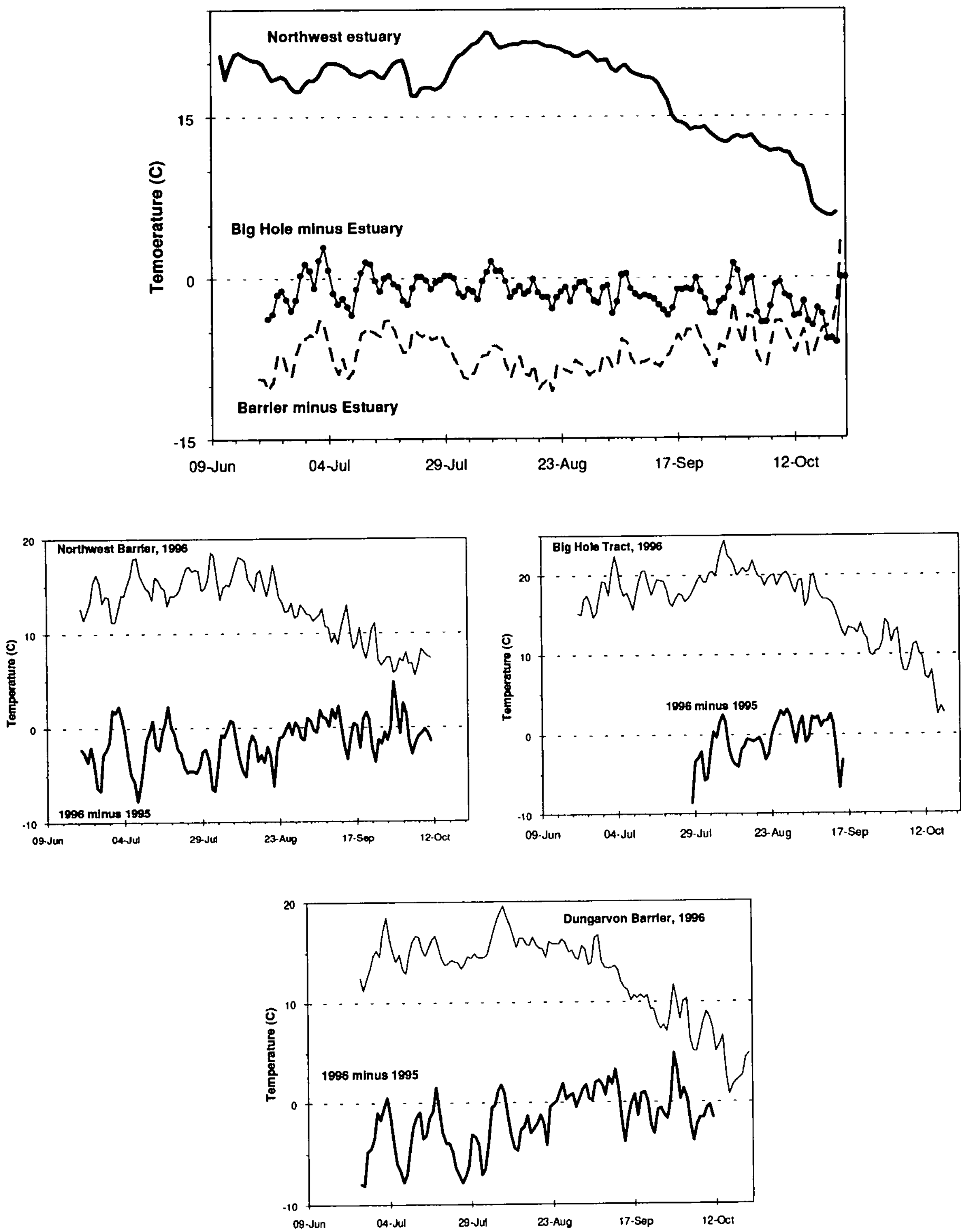


Figure 15. Mean daily water temperatures recorded at Northwest Miramichi sites in 1996 (upper) and comparisons between 1995 and 1996 at two Northwest Miramichi stations (middle) and at the Dungarvon Barrier in the Southwest Miramichi (lower).

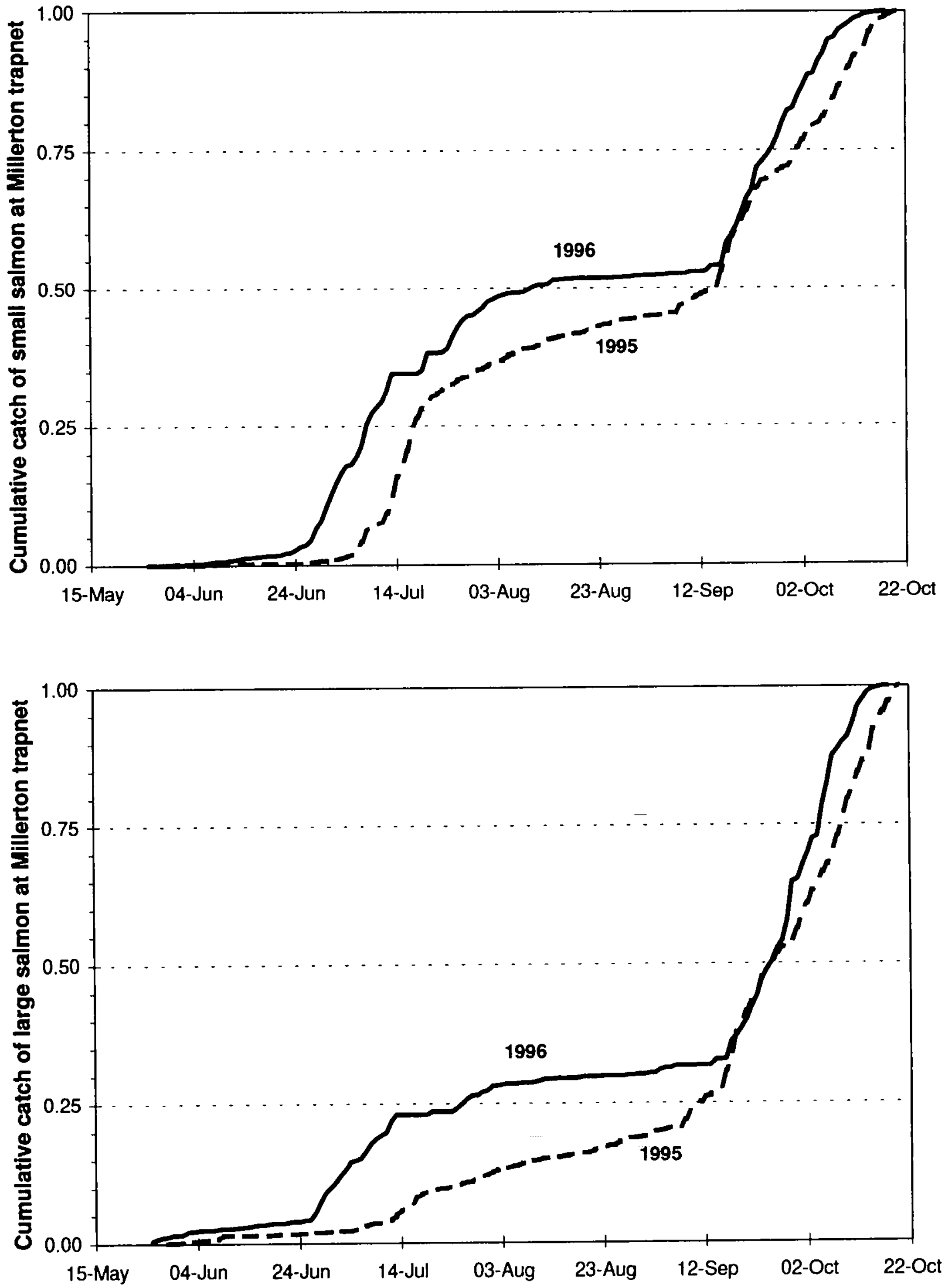


Figure 16. Distribution and timing of small salmon (upper) and large salmon (lower) catches at the Millerton trapnet (Southwest Miramichi) in 1995 and 1996.

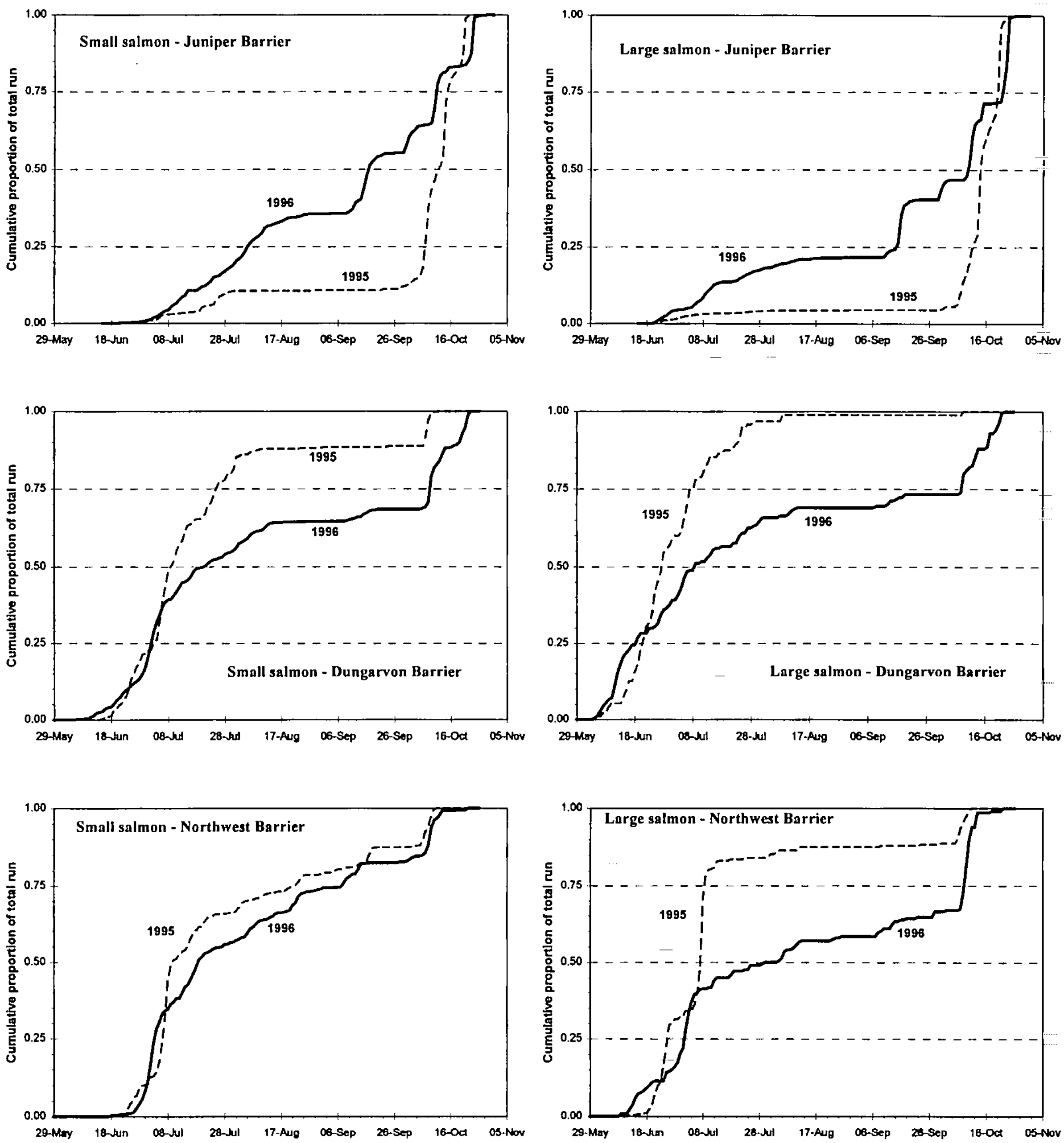


Figure 17. Distribution and timing of small and large salmon runs to the Bridge Pool at the Juniper Barrier in the Southwest Miramichi (upper), to the Dungarvon Barrier (middle) and to the Northwest Miramichi Barrier (lower) in 1995 and 1996.

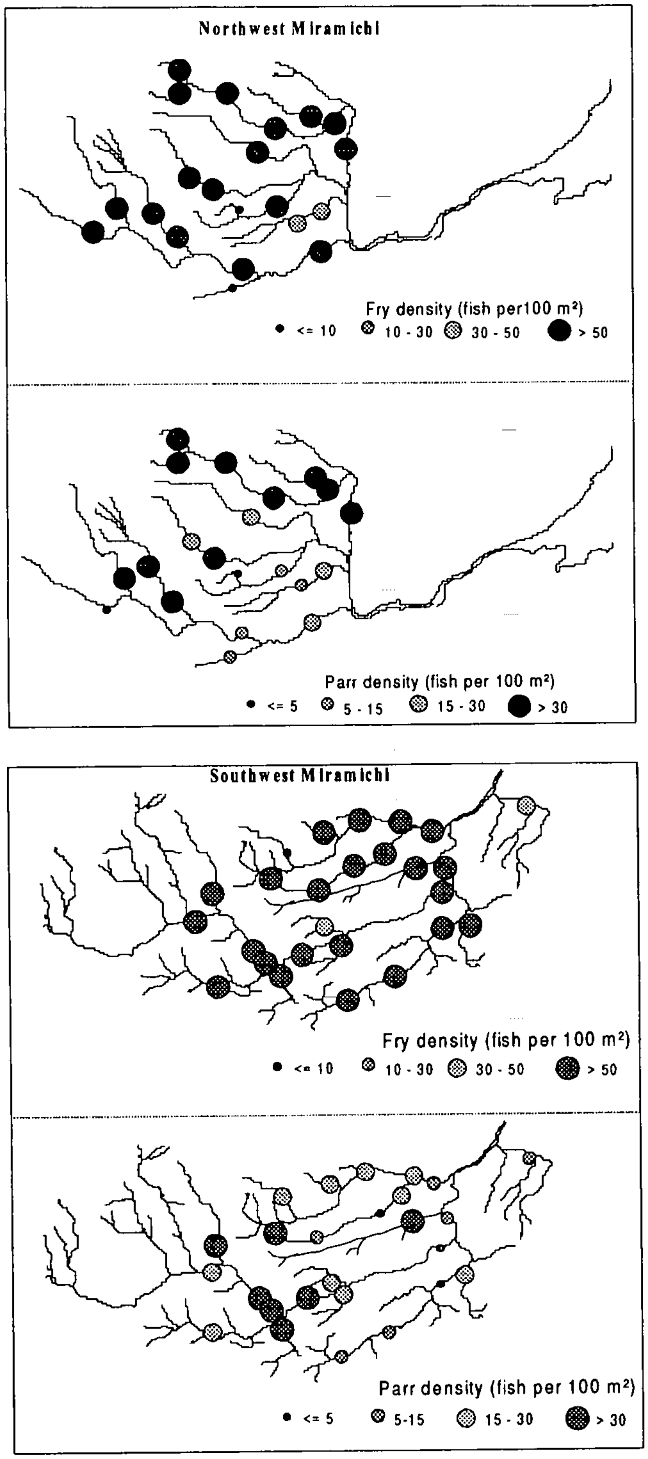
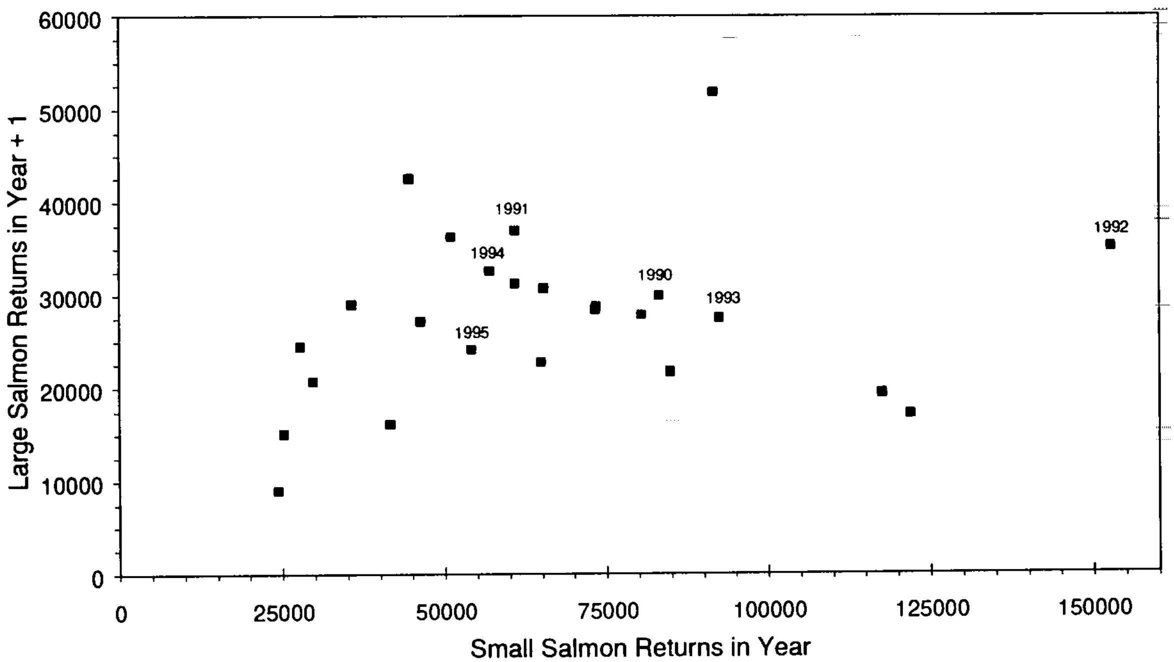


Figure 18. Observed fry and parr densities in the Northwest Miramichi (upper) and Southwest Miramichi sites sampled in 1996.



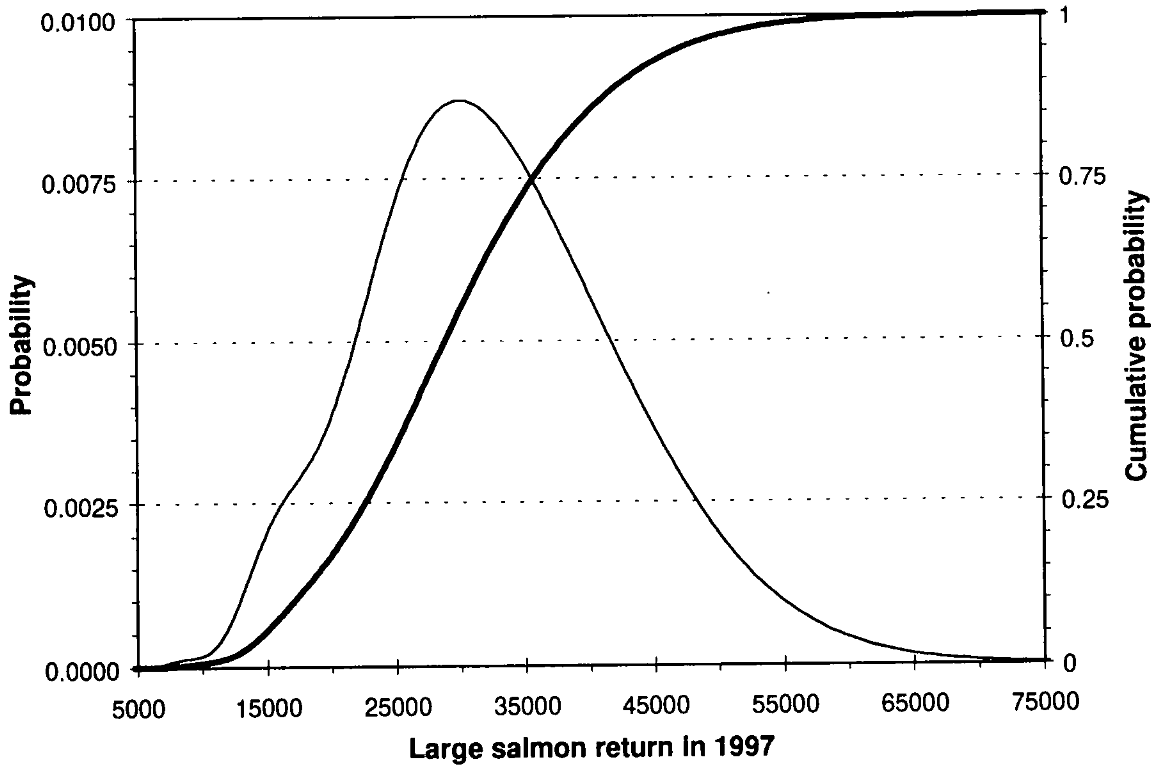


Figure 19. Preseason forecast model of the large salmon returns to the Miramichi River (upper) and the 1997 large salmon return forecast probability (bottom).

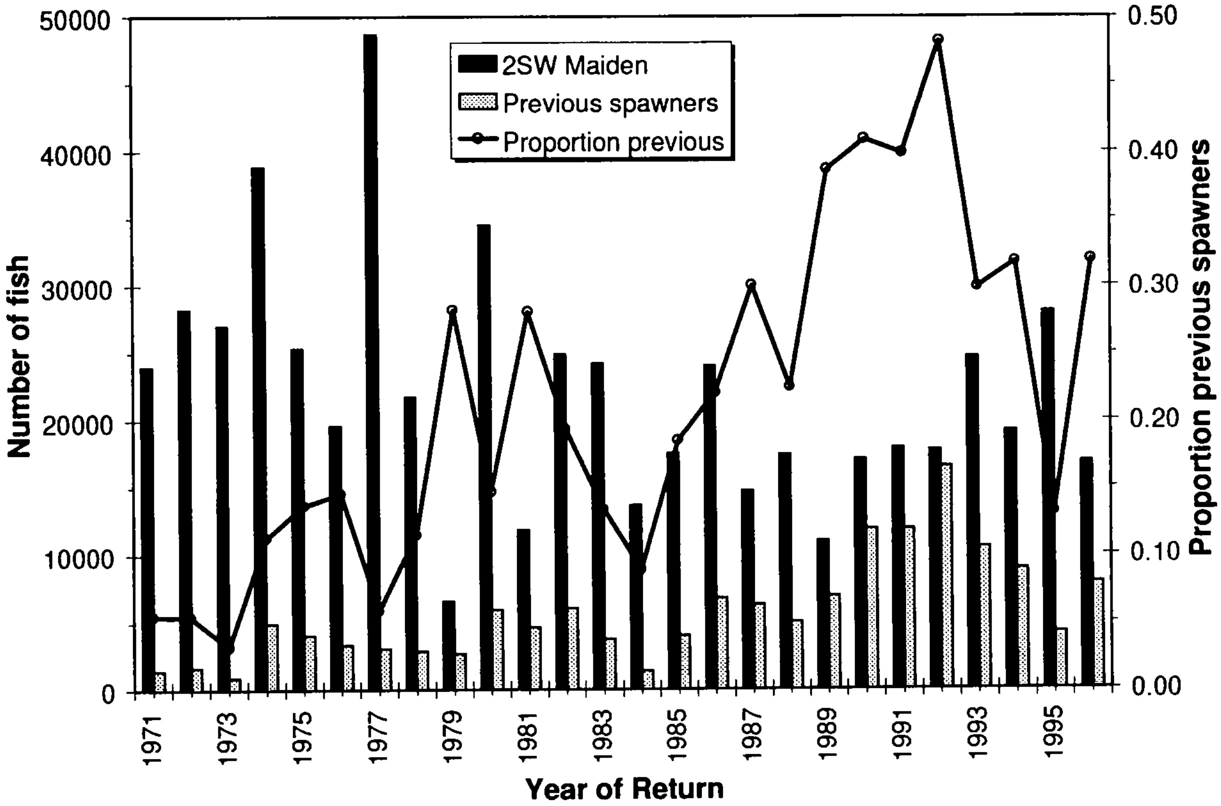


Figure 20. Estimates of abundance of 2SW maiden salmon and previous spawner salmon in the annual returns of large salmon to the Miramichi River for 1971 to 1996.

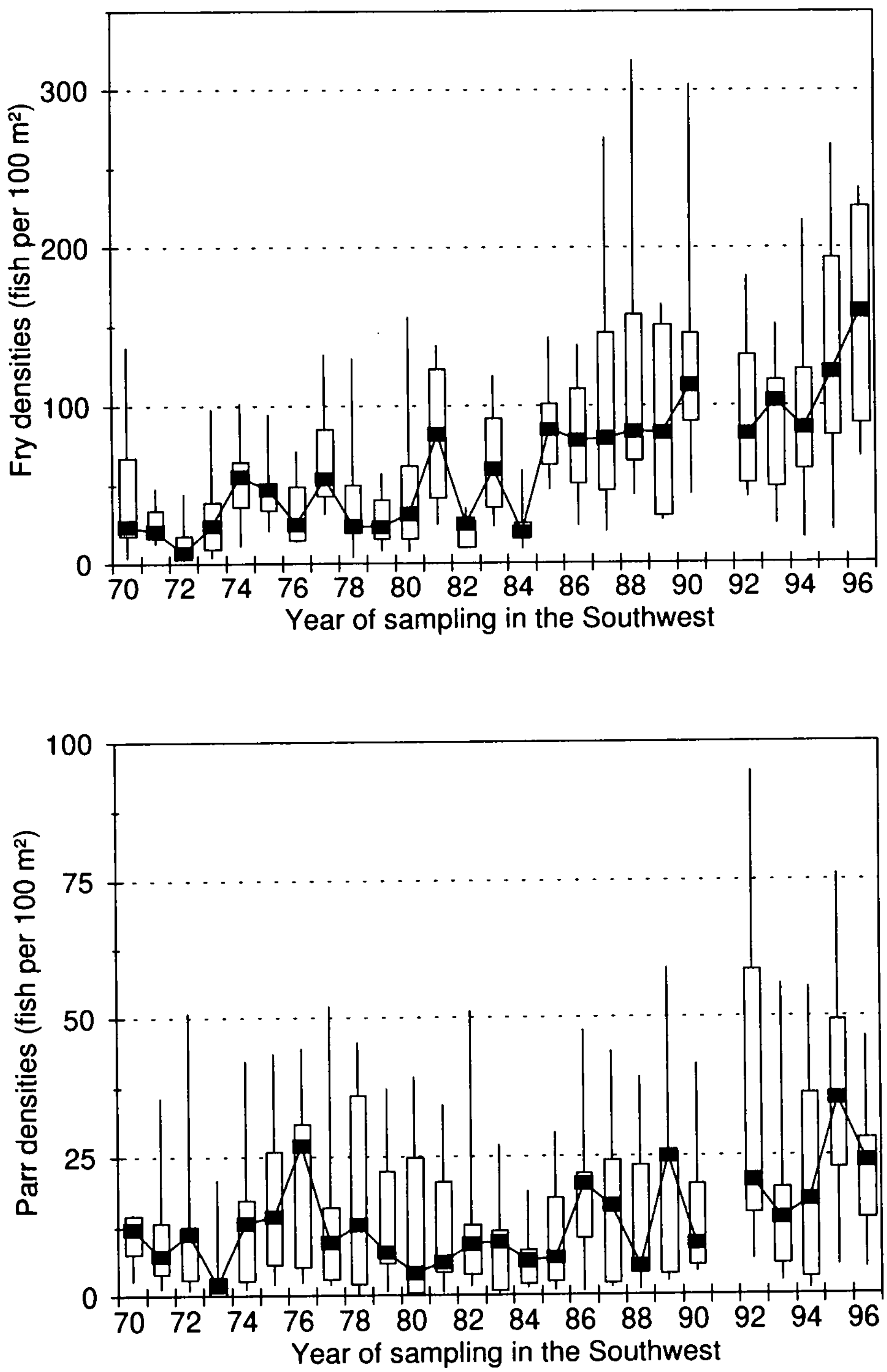


Figure 21. Atlantic salmon fry (upper) and parr (lower) densities at nine index sites in the Southwest Miramichi, 1970 to 1996. Box plots are interpreted as follows: vertical line = 5th to 95th percentile range, box = 25th to 75th percentile range, square = median value.

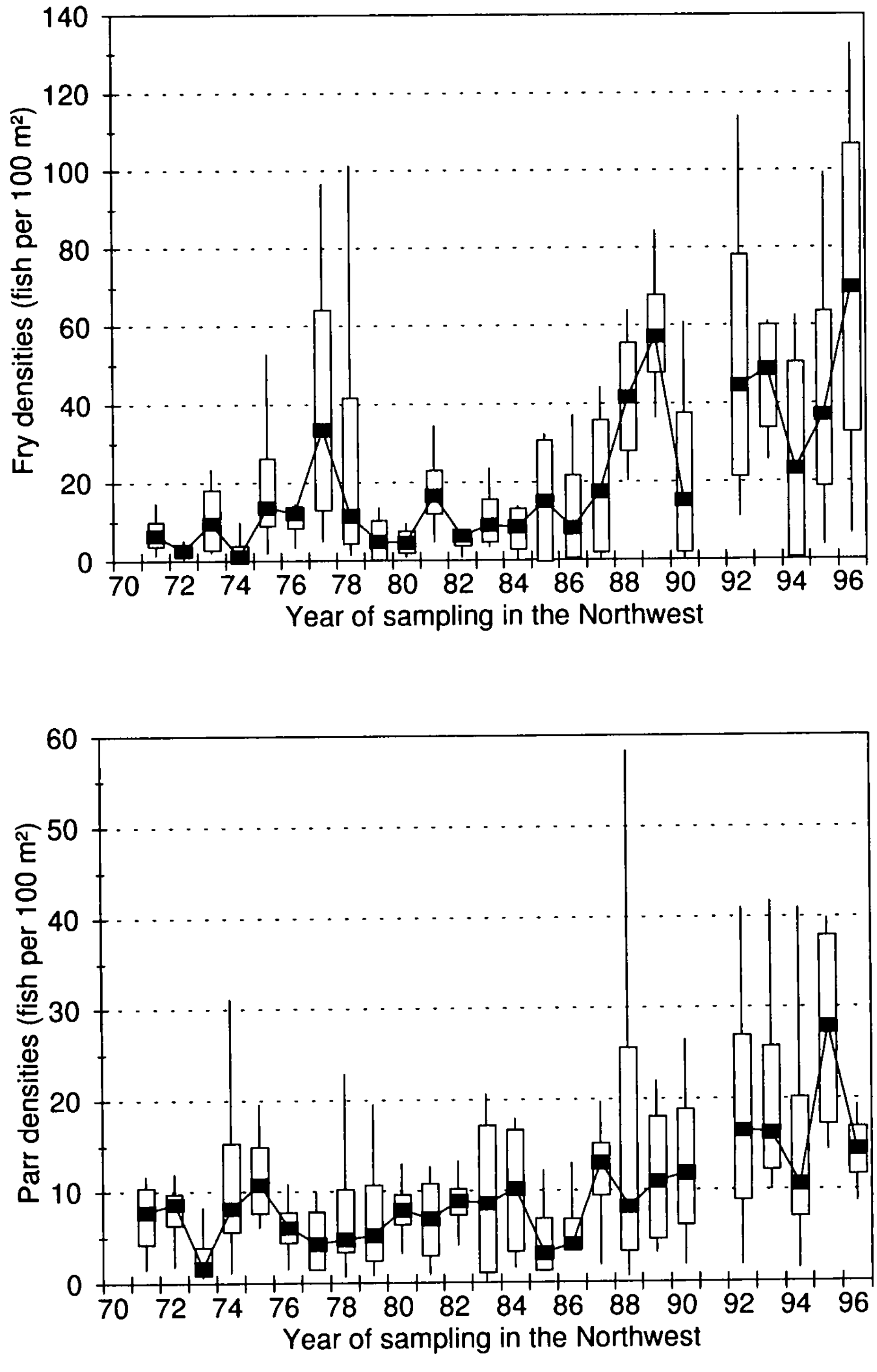
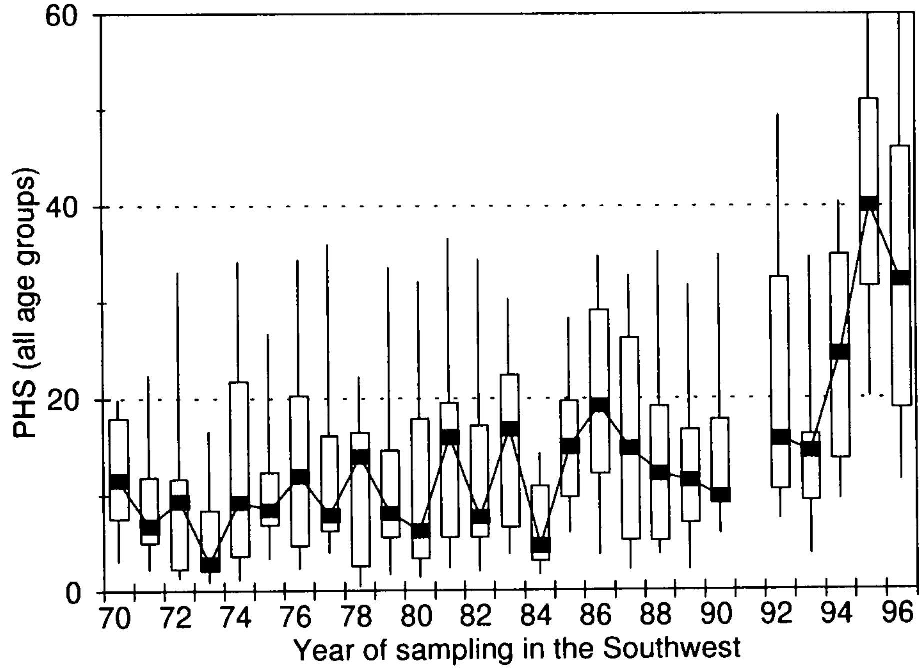


Figure 22. Atlantic salmon fry (upper) and parr (lower) densities at four index sites in the Northwest Miramichi, 1970 to 1996. Box plots are interpreted as in Figure 21.



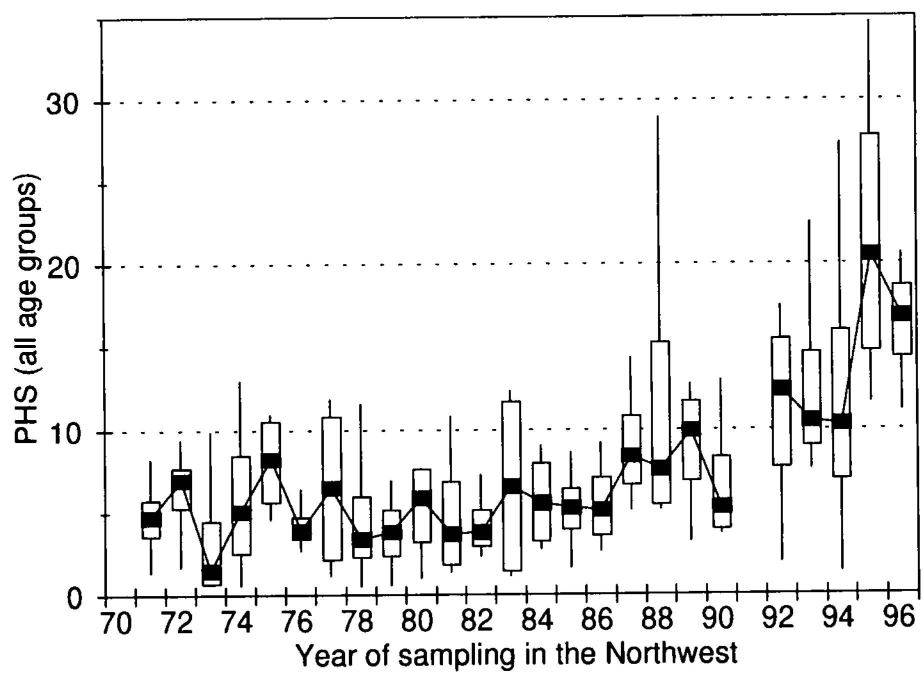


Figure 23. Percent habitat saturation (PHS) index of juvenile Atlantic salmon at nine index sites in the Southwest Miramichi (upper) and four index sites in the Northwest Miramichi (lower) for 1970 to 1996. Box plots are interpreted as in Figure 21.

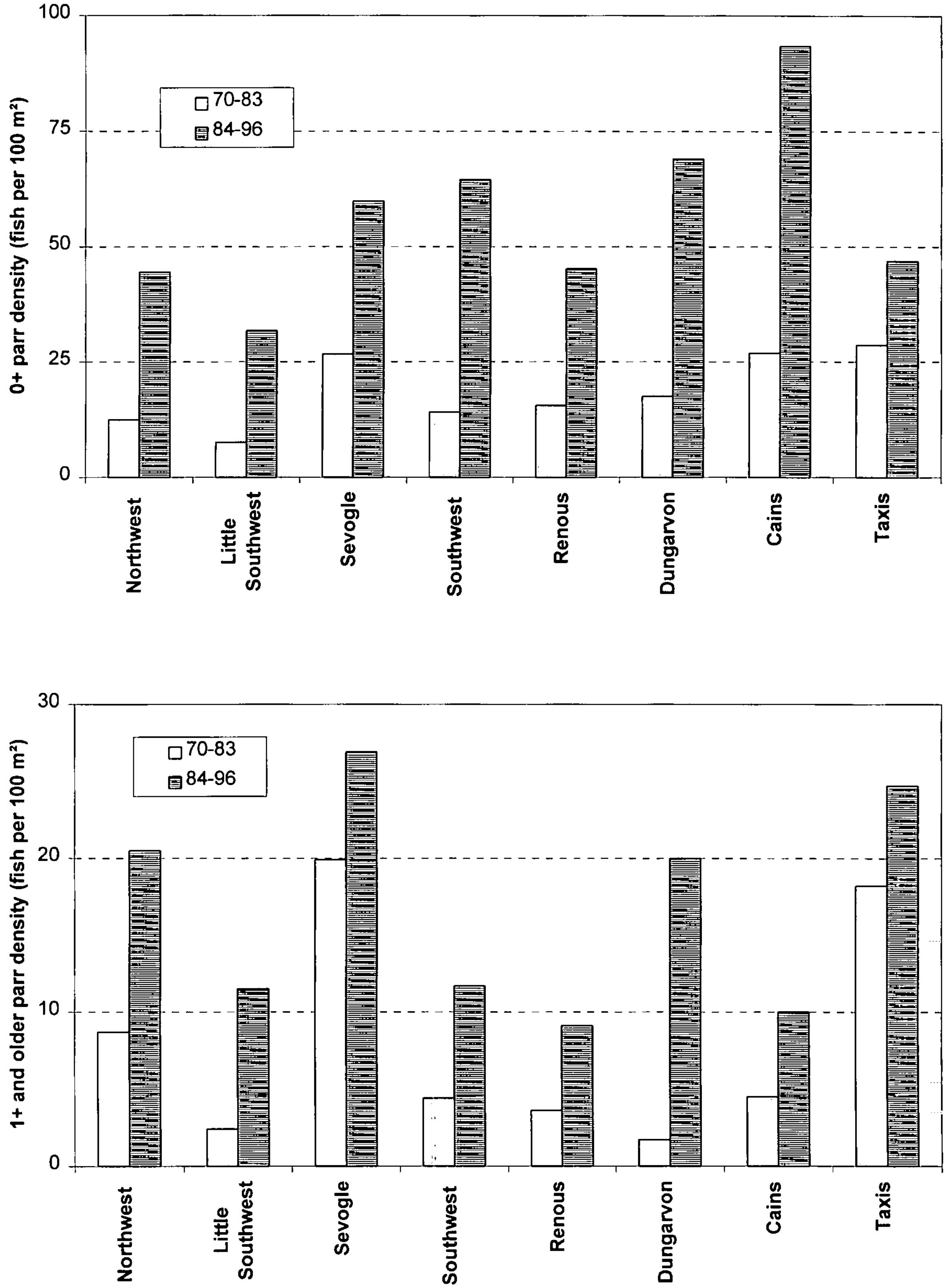


Figure 24. Changes in median densities of 0+ parr (upper) and 1+ and older parr (lower) in different sections of the Miramichi River for 1970 to 1983 versus 1984 to 1996.

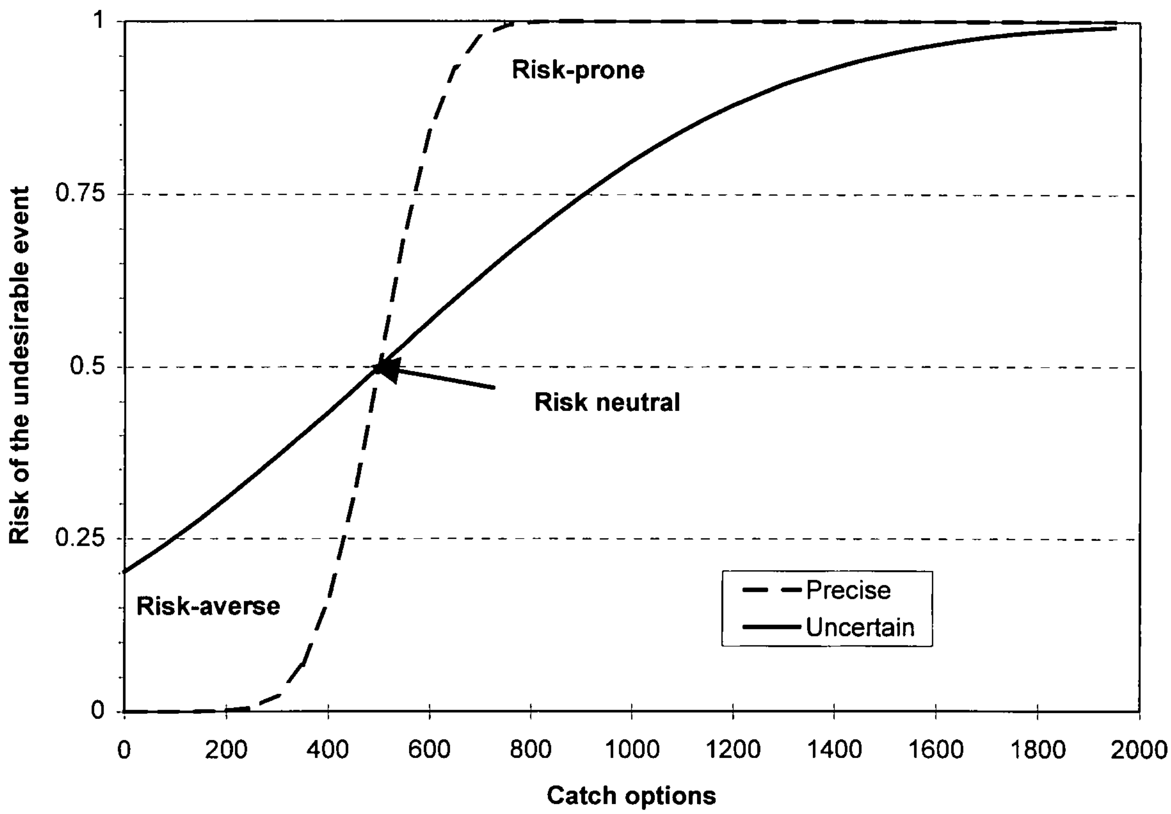


Figure 25. Theoretical risk assessment curves relative to harvest options for Atlantic salmon from the Miramichi River.

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

1. SPECIES / STOCK:

- **Atlantic salmon - Miramichi River**

2. ARRANGEMENTS:

DATE: January 7, 1997

TIME: 9:00 to 16:00

LOCATION: Dept. of Natural Resources and Energy boardroom, Newcastle (Miramichi City), New Brunswick

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

- **Science workshop**

4. PARTICIPANTS (Name and Affiliation)

- **Don Archibald, Chairman, Miramichi River Environmental Assessment Committee**
- **Gérald Chaput, DFO Science, Moncton**
- **Harry Collins, Executive Director, Miramichi River Environmental Assessment Committee, Miramichi City**
- **Bill Donald, Chair, Miramichi Watershed Management Committee, Miramichi City**
- **Bernie Dube, Regional Biologist, Dept. of Natural Resources and Energy, Miramichi City**
- **Dave Dunn, DFO, Recreational Fisheries, Moncton**
- **Clifford Ginnish, Eel Ground First Nation, Eel Ground, New Brunswick (afternoon only)**
- **Mark Hambrook, DFO Science, Miramichi Salmonid Enhancement Centre, Miramichi City**
- **John Hayward, DFO Science, Miramichi Salmonid Enhancement Centre, Miramichi City**
- **Tim Lutzac, DFO Science, Aboriginal Fisheries Coordination, Moncton**
- **Ron McKnight, Tabusintac Fish and Game Club, Tabusintac, New Brunswick**
- **Dave Moore, DFO Science, Moncton**
- **Manley Price, Rocky Brook Camp / Avenor inc., Boiestown, New Brunswick**
- **Bill Scott, DFO Conservation and Protection, Miramichi City, New Brunswick**
- **Joe Sheasgreen, DFO Science, Miramichi Salmonid Enhancement Centre, Miramichi City**
- **Cletus Sturgeon, Northumberland Salmon Protection Association, Miramichi City (afternoon only)**
- **Vince Swazey, Miramichi Salmon Association, Boiestown, New Brunswick**
- **Bruce Whipple, Northumberland Salmon Protection Association, Miramichi City**

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

- **Crown Reserve angling catches for 1996 (Benie Dube, DNRE NB)**
- **Update on Little River project (Bruce Whipple, Northumberland Salmon Protection Association)**
- **Habitat surveys and satellite rearing monitoring, Rocky Brook (Manley Price, Avenor inc.)**
- **Juvenile densities at Clearwater Brook (Bernie Dube, DNRE / ASF / Irving)**

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

- **Very few seizures of illegal nets in 1996 may reflect reduced enforcement activities on the river rather than reduced poaching. Recent court rulings have imposed important fines and this may also have deterred poaching activity. No follow-up action or response required.**
- **Absence of angling statistics needs to be resolved. This is an issue which the watershed management committee should address. Follow-up from Dave Dunn (DFO), DNRE and watershed groups expected.**
- **Angling data from leased waters should be analyzed for trends in angling catches. Follow-up expected for next year by Gerald Chaput and staff from the Fish and Wildlife Branch, DNRE**
- **Results from recent catch and release studies were not used to address the appropriateness of the 3% hook and release mortality value used for the Miramichi. As well, protocols for monitoring water temperatures which would provide criteria for closures/openings to angling have not been established. This issue should be considered by the watershed management committee with input from DFO Science and DFO Fisheries Management.**

Appendix 1 (continued).

• **Juvenile densities in the Little Southwest Miramichi are consistently lower than in other parts of the Miramichi. A similar trend was noted in the 1970s suggesting that the Little Southwest has either consistently received poor spawning escapements, the habitat quality may be different or both. An assessment of the Little Southwest Miramichi would require additional resources from user groups. No specific plans were made but a collaboration between DFO Science and user groups is possible.**
7. RECOMMENDATIONS: *(Only a brief description is required)*
a.) Pertaining to Assessment
• **Need to determine the optimum spawning escapement for the river (the spawning escapement which will provide maximum benefit). This is the level which should guide the management decisions** • **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 would be a valuable addition to the assessment** **Other Concerns:**

Various — **NAME OF PRESENTER**

Gérald Chaput — **NAME OF RAPPORTEUR**

Appendix 2. Tag and recapture histories for small salmon from the Northwest Miramichi River, 1996.

Tagging Area		Northwest Food/Science Lower							Northwest Food/Science Upper					
		June	July	August	Sept.	Oct. 1-15	> Oct. 15	Total	June	July	August	Sept.	Oct.	Total
	Tags Placed	100	251	0	68	130	2	549	71	127	0	34	6	238
Recapture Data														
Percent reported														
Angling	Total	4.0%	6.0%	.	4.4%	2.3%	0.0%	4.6%	5.6%	7.9%	.	0.0%	0.0%	5.9%
Traps	NW	7.0%	3.2%	.	19.1%	26.9%	0.0%	11.5%	1.4%	7.9%	.	5.9%	16.7%	5.9%
	SW	1.0%	4.0%	.	1.5%	7.7%	0.0%	4.0%	0.0%	3.9%	.	5.9%	16.7%	3.4%
Angling Recaptures														
In Southwest		1	5	0	2	2	0	10	1	4	0	0	0	5
	Unknown	.	.	.	1	.	.	1	.	.	.	.	.	0
	June	1	.	.	.	.	.	1	.	.	.	.	.	0
	July	.	3	.	.	.	.	3	.	1	.	.	.	1
	August	.	2	.	.	.	.	2	.	.	.	.	.	0
	Sept.	.	.	.	.	.	.	0	1	3	.	.	.	4
	Oct.	.	.	.	1	2	.	3	.	.	.	.	.	0
In Northwest		3	10	0	1	1	0	15	3	6	0	0	0	9
	Unknown	.	.	.	.	.	.	0	.	.	.	.	.	0
	June	1	.	.	.	.	.	1	1	.	.	.	.	1
	July	2	5	.	.	.	.	7	1	3	.	.	.	4
	August	.	4	.	.	.	.	4	1	3	.	.	.	4
	Sept.	.	1	.	.	.	.	1	.	.	.	.	.	0
	Oct.	.	.	.	1	1	.	2	.	.	.	.	.	0
Miramichi		.	.	.	.	.	.	0	.	.	.	1	.	1
Mortalities recovered upriver (in freshwater)														
Northwest		.	.	.	.	.	.	0	.	.	.	.	.	0
Southwest		.	.	.	.	.	.	0	.	.	.	.	.	0
Unmarked fish recovered at facility above														
		147	352	23	175	131	2	828	103	185	13	66	7	374
Fish with tagging scars recovered at facility above														
		.	1	.	1	.	.	2	.	.	.	.	.	0
Recaptured fish lost before reading tag number at facility above														
		.	.	.	.	.	.	0	.	.	.	.	.	0
Recoveries of tags at facility above														
Southwest Food/Science L		0	3	0	1	2	0	6	0	4	0	1	0	5
	June	.	.	.	.	.	.	0	.	.	.	.	.	0
	July	.	2	.	.	.	.	2	.	4	.	.	.	4
	August	.	.	.	.	.	.	0	.	.	.	.	.	0
	Sept.	.	1	.	1	.	.	2	.	.	.	.	.	0
	Oct. 1-15	.	.	.	.	2	.	2	.	.	.	1	.	1
Southwest Food/Science U		0	2	0	0	0	0	2	0	0	0	0	0	0
	June	.	.	.	.	.	.	0	.	.	.	.	.	0
	July	.	2	.	.	.	.	2	.	.	.	.	.	0
	August	.	.	.	.	.	.	0	.	.	.	.	.	0
Millerton Trap		1	5	0	0	8	0	14	0	1	0	1	1	3
	May	.	.	.	.	.	.	0	.	.	.	.	.	0
	June	.	.	.	.	.	.	0	.	.	.	.	.	0
	July	1	4	.	.	.	.	5	.	1	.	.	.	1
	August	.	.	.	.	.	.	0	.	.	.	.	.	0
	Sept.	.	1	.	.	.	.	1	.	.	.	.	.	0
	Oct. 1-15	.	.	.	.	8	.	8	.	.	.	1	1	2
	> Oct. 15	.	.	.	.	.	.	0	.	.	.	.	.	
Northwest Food/Science L		4	5	0	3	12	0	24	0	3	0	1	0	4
	June	2	.	.	.	.	.	2	.	.	.	.	.	0
	July	2	5	.	.	.	.	7	.	2	.	.	.	2
	Aug.	.	.	.	.	.	.	0	.	.	.	.	.	0
	Sept.	.	.	.	2	.	.	2	.	.	.	1	.	1
	Oct. 1-15	.	.	.	1	11	.	12	.	1	.	.	.	1
	> Oct. 15	.	.	.	.	1	.	1						
Northwest Food/Science U		0	0	0	0	2	0	2	0	2	0	0	0	2
	June	.	.	.	.	.	.	0	.	.	.	.	.	0
	July	.	.	.	.	.	.	0	.	2	.	.	.	2
	August	.	.	.	.	.	.	0	.	.	.	.	.	0
	Sept.	.	.	.	.	.	.	0	.	.	.	.	.	0
	Oct.	.	.	.	.	2	.	2	.	.	.	.	.	0
Red Bank Traps		1	2	0	9	19	0	31	1	4	0	1	1	7
	June	1	.	.	.	.	.	1	1	.	.	.	.	1
	July	.	1	.	.	.	.	1	.	1	.	.	.	1
	August	.	.	.	.	.	.	0	.	1	.	.	.	1
	Sept.	.	.	.	2	.	.	2	.	.	.	.	.	0
	Oct. 1-15	.	1	.	7	15	.	23	.	2	.	1	1	4
	> Oct. 15	.	.	.	.	4	.	4	.	.	.	.	.	0
Big Hole Partial Fence		2	1	0	1	2	0	6	0	1	0	0	0	1
	June	1	.	.	.	.	.	1	.	.	.	.	.	0
	July	1	1	.	.	.	.	2	.	.	.	.	.	0
	August	.	.	.	.	.	.	0	.	1	.	.	.	1
	Sept.	.	.	.	.	.	.	0	.	.	.	.	.	0
	Oct. 1-15	.	.	.	.	1	.	1	.	.	.	.	.	0
	> Oct. 15	.	.	.	1	1	.	2	.	.	.	.	.	0
Barrier Fences		4	3	0	0	2	0	9	1	2	0	1	0	4
Dungarvon	June-Aug.	1	1	.	.	.	.	2	.	.	.	.	.	0
	Sept.-Oct.	.	.	.	.	.	.	0	.	.	.	.	.	
SW Miramichi	June-Aug.	.	.	.	.	.	.	0	.	.	.	.	.	0
	Sept.-Oct.	.	.	.	.	.	.	0	.	1	.	1	.	
NW Miramichi	June-Aug.	3	2	.	.	.	.	5	1	.	.	.	.	1
	Sept.-Oct.	.	.	.	.	.	.	0	.	1	.	.	.	
Catamaran	June-Aug.	.	.	.	.	.	.	0	.	.	.	.	.	0
	Sept.-Nov.	.	.	.	.	2	.	2	.	.	.	.	.	
Broodstock Seining		0	1	0	0	0	0	1	1	0	0	0	0	1
	Southwest Mir	.	1	.	.	.	.	1						
	Dungarvon	.	.	.	.	.	.	0	.	.	.	.	.	0
	Little Southwe	.	.	.	.	.	.	0	1	.	.	.	.	1
	Sevogle	.	.	.	.	.	.	0	.	.	.	.	.	0
	Northwest	.	.	.	.	.	.	0	.	.	.	.	.	0

Red Bank Trapnets - Northwest Miramichi

	June	July	August	Sept.	Oct. 1-15	> Oct. 15	Total
Unmarked fish recovered at facility	86	217	104	201	255	7	870
Fish with tagging scars recovered at facility	.	.	.	.	.	.	0
Recaptured fish lost before reading tag number at facility abov	.	.	.	.	1	.	1

Big Hole Partial Fence

	June	July	August	Sept.	Oct. 1-15	> Oct. 15	Total
Unmarked fish recovered at facility	26	99	3	29	2	7	166
Fish with tagging scars recovered at facility	.	.	.	.	.	.	0
Recaptured fish lost before reading tag number at facility abov	.	.	.	.	.	.	0

Appendix 2. Tag and recapture histories for small salmon in the Southwest Miramichi, 1996.

	Tagging Area	Southwest Food/Science Lower							Southwest Food/Science Upper			
		June	July	August	Sept.	Oct. 1-15	> Oct. 15	Total	June	July	August	Total
	Tags Placed	79	115	0	212	144	0	550	45	67	0	112
Recapture Data												
Percent reported												
Angling	Total	3.8%	5.2%	.	4.2%	1.4%	.	3.8%	13.3%	7.5%	.	9.8%
Traps	NW	2.5%	1.7%	.	4.2%	7.6%	.	4.4%	2.2%	7.5%		5.4%
	SW	6.3%	7.0%	.	20.8%	22.9%	.	16.4%	2.2%	6.0%		4.5%
Angling Recaptures												
In Southwest		2	4	0	9	2	1	18	2	2	0	4
	Unknown	.	.	.	4	.	1	5	.	.	.	0
	June	.	.	.	.	.	.	0	1	.	.	1
	July	2	2	.	.	.	.	4	1	1	.	2
	August	.	1	.	.	.	.	1	.	1	.	1
	Sept.	.	.	.	2	.	.	2	.	.	.	0
	Oct.	.	1	.	3	2	.	6	.	.	.	0
In Northwest		1	2	0	0	0	0	3	4	3	0	7
	Unknown	.	.	.	.	.	.	0	.	.	.	0
	June	.	.	.	.	.	.	0	1	.	.	1
	July	1	1	.	.	.	.	2	2	1	.	3
	August	.	.	.	.	.	.	0	.	1	.	1
	Sept.	.	1	.	.	.	.	1	.	1	.	1
	Oct.	.	.	.	.	.	.	0	1	.	.	1
Miramichi	Unknown	.	.	.	1	.	.	1	.	.	.	0
Mortalities recovered upriver (in freshwater)												
Northwest		.	.	.	.	.	.	0	.	.	.	0
Southwest		.	.	.	.	.	.	0	.	.	.	0
Unmarked fish recovered at facility above		207	434	249	426	145	0	1461	90	204	.	294
Fish with tagging scars recovered at facility above		.	.	.	.	.	.	0	.	.	.	0
Recaptured fish lost before reading tag number at facility above		.	.	.	.	.	.	0	.	.	.	0
Recoveries of tags placed at facility above												
west Food/Science Lower		0	3	0	21	12	0	36	0	0	0	0
	June	.	.	.	.	.	.	0	.	.	.	0
	July	.	3	.	.	.	.	3	.	.	.	0
	August	.	.	.	.	.	.	0	.	.	.	0
	Sept.	.	.	.	19	.	.	19	.	.	.	0
	Oct. 1-15	.	.	.	2	12	.	14	.	.	.	0
west Food/Science Upper		2	0	0	0	0	0	2	0	1	0	1
	June	2	.	.	.	.	.	2	.	.	.	0
	July	.	.	.	.	.	.	0	.	1	.	1
Millerton Trapnet		3	5	0	23	21	0	52	1	3	0	4
	May	.	.	.	.	.	.	0	.	.	.	0
	June	1	.	.	.	.	.	1	.	.	.	0
	July	2	4	.	.	.	.	6	.	3	.	3
	August	.	1	.	.	.	.	1	.	.	.	0
	Sept.	.	.	.	16	.	.	16	.	.	.	0
	Oct. 1-15	.	.	.	7	21	.	28	1	.	.	1
	> Oct. 15	.	.	.	.	.	.	0	.	.	.	0
Northwest Food/Science Lower		0	2	0	4	5	0	11	0	2	0	2
	June	.	.	.	.	.	.	0	.	.	.	0
	July	.	2	.	.	.	.	2	.	2	.	2
	August	.	.	.	.	.	.	0	.	.	.	0
	Sept.	.	.	.	1	.	.	1	.	.	.	0
	Oct. 1-15	.	.	.	3	5	.	8	.	.	.	0
	> Oct. 15	.	.	.	.	.	.	0	.	.	.	0
Northwest Food/Science Upper		1	0	0	0	0	0	1	0	0	0	0
	June	.	.	.	.	.	.	0	.	.	.	0
	July	1	.	.	.	.	.	1	.	.	.	0
	August	.	.	.	.	.	.	0	.	.	.	0
	Sept.	.	.	.	.	.	.	0	.	.	.	0
	Oct. 1-15	.	.	.	.	.	.	0	.	.	.	0
Red Bank Trapnets		0	0	0	5	5	0	10	0	2	0	2
	June	.	.	.	.	.	.	0	.	.	.	0
	July	.	.	.	.	.	.	0	.	1	.	1
	August	.	.	.	.	.	.	0	.	.	.	0
	Sept.	.	.	.	1	.	.	1	.	1	.	1
	Oct. 1-15	.	.	.	3	4	.	7	.	.	.	0
	>Oct. 15	.	.	.	1	1	.	2	.	.	.	0
Big Hole Patial Fence		1	0	0	0	1	0	2	1	1	0	2
	June	1	.	.	.	.	.	1	.	.	.	0
	July	.	.	.	.	.	.	0	1	1	.	2
	August	.	.	.	.	.	.	0	.	.	.	0
	Sept.	.	.	.	.	.	.	0	.	.	.	0
	Oct. 1-15	.	.	.	.	.	.	0	.	.	.	0
	> Oct. 15	.	.	.	.	1	.	1	.	.	.	0
Barrier Fences		2	4	0	3	2	0	11	0	0	0	0
Dungarvon	June-Aug.	.	.	.	.	.	.	0	.	.	.	0
	Sept.-Oct.	1	1	.	.	.	.	2	.	.	.	0
SW Miramichi	June-Aug.	.	.	.	.	.	.	0	.	.	.	0
	Sept.-Oct.	.	2	.	.	.	.	2	.	.	.	0
NW Miramichi	June-Aug.	.	1	.	.	.	.	1	.	.	.	0
	Sept.-Oct.	1	.	.	1	1	.	3	.	.	.	0
Catamaran	June-Aug.	.	.	.	.	.	.	0	.	.	.	0
	Sept.-Nov.	.	.	.	2	1	.	3	.	.	.	0
Broodstock Seining		0	0	0	0	0	0	0	0	0	0	0
	Dungarvon	.	.	.	.	.	.	0	.	.	.	0
	Southwest	.	.	.	.	.	.	0	.	.	.	0
	Little Southwest	.	.	.	.	.	.	0	.	.	.	0
	Sevogle	.	.	.	.	.	.	0	.	.	.	0
	Northwest	.	.	.	.	.	.	0	.	.	.	0

Appendix 2. Tag and recapture histories for small salmon in the Southwest Miramichi, 1996.

Tagging Area		Millerton Trapnet - Southwest Miramichi							
		May	June	July	August	Sept.	Oct. 1-15	>Oct. 15	Total
	Tags Placed	0	222	772	127	614	275	5	2015
Recapture Data									
Percent reported									
Angling	Total	.	14.0%	7.9%	4.7%	5.0%	4.4%	0.0%	7.0%
Traps	NW	.	0.5%	2.5%	2.4%	2.8%	1.1%	0.0%	2.1%
	SW	.	6.8%	6.3%	10.2%	10.3%	8.4%	0.0%	8.1%
Angling Recaptures									
In Southwest		0	26	47	6	29	12	0	120
	Unknown	.	1	3	.	2	5	.	11
	June	.	.	.	.	.	.	.	0
	July	.	17	17	.	.	.	.	34
	August	.	4	23	3	.	.	.	30
	Sept.	.	4	3	1	14	.	.	22
	Oct.	.	.	1	2	13	7	.	23
In Northwest		0	5	14	0	2	0	0	21
	Unknown	.	.	.	.	.	.	.	0
	June	.	2	.	.	.	.	.	2
	July	.	1	9	.	.	.	.	10
	August	.	2	5	.	.	.	.	7
	Sept.	.	.	.	.	2	.	.	2
	Oct.	.	.	.	.	.	.	.	0
Miramichi	Unknown	.	.	1	.	.	.	.	1
Mortalities recovered upriver (in freshwater)									
Northwest		.	.	.	.	.	.	.	0
Southwest	July	.	.	2	.	.	.	.	2
Unmarked fish recovered at facility above		0	238	806	130	646	293	6	2119
Fish with tagging scars recovered at facility above		.	.	.	.	.	.	.	0
Recaptured fish lost before reading tag number at facility above		.	.	.	.	.	.	.	0
Recoveries of tags placed at facility above									
st Food/Science Lower		0	4	19	4	13	2	0	42
	June	.	2	.	.	.	.	.	2
	July	.	2	13	.	.	.	.	15
	August	.	.	3	.	.	.	.	3
	Sept.	.	.	2	1	9	.	.	12
	Oct. 1-15	.	.	1	3	4	2	.	10
st Food/Science Upper		0	0	7	0	0	0	0	7
	June	.	.	.	.	.	.	.	0
	July	.	.	7	.	.	.	.	7
Millerton Trapnet		0	11	23	9	50	21	0	114
	May	.	.	.	.	.	.	.	0
	June	.	5	.	.	.	.	.	5
	July	.	5	17	.	.	.	.	22
	August	.	.	3	3	.	.	.	6
	Sept.	.	1	2	5	29	.	.	37
	Oct. 1-15	.	.	1	1	21	20	.	43
	> Oct. 15	.	.	.	.	.	1	.	1
Northwest Food/Science Lower		0	1	7	0	3	2	0	13
	June	.	.	.	.	.	.	.	0
	July	.	1	6	.	.	.	.	7
	August	.	.	1	.	.	.	.	1
	Sept.	.	.	.	.	1	.	.	1
	Oct. 1-15	.	.	.	.	2	2	.	4
	> Oct. 15	.	.	.	.	.	.	.	0
Northwest Food/Science Upper		0	0	3	2	1	0	0	6
	June	.	.	.	.	.	.	.	0
	July	.	.	3	.	.	.	.	3
	August	.	.	.	.	.	.	.	0
	Sept.	.	.	.	2	1	.	.	3
	Oct. 1-15	.	.	.	.	.	.	.	0
Red Bank Trapnets		0	0	8	1	13	1	0	23
	June	.	.	.	.	.	.	.	0
	July	.	.	3	.	.	.	.	3
	August	.	.	1	.	.	.	.	1
	Sept.	.	.	3	.	3	.	.	6
	Oct. 1-15	.	.	1	1	10	1	.	13
	>Oct. 15	.	.	.	.	.	.	.	
Big Hole Patial Fence		0	0	1	0	0	0	0	1
	June	.	.	.	.	.	.	.	0
	July	.	.	1	.	.	.	.	1
	August	.	.	.	.	.	.	.	0
	Sept.	.	.	.	.	.	.	.	0
	Oct. 1-15	.	.	.	.	.	.	.	0
	> Oct. 15	.	.	.	.	.	1	.	1
Barrier Fences		0	14	14	0	1	1	0	30
Dungarvon	June-Aug.	.	8	4	.	.	.	.	12
	Sept.-Oct.	.	2	1	.	.	1	.	4
SW Miramichi	June-Aug.	.	.	.	.	.	.	.	0
	Sept.-Oct.	.	3	4	.	.	.	.	7
NW Miramichi	June-Aug.	.	1	4	.	.	.	.	5
	Sept.-Oct.	.	.	1	.	1	.	.	2
Catamaran	June-Aug.	.	.	.	.	.	.	.	0
	Sept.-Nov.	.	.	.	.	.	.	.	0
Broodstock Seining		0	2	1	0	0	0	0	3
	Dungarvon	.	.	1	.	.	.	.	1
	Southwest	.	.	.	.	.	.	.	0
	Little Southwest	.	.	.	.	.	.	.	0
	Sevogle	.	1	.	.	.	.	.	1
	Northwest	.	1	.	.	.	.	.	1

Appendix 2. Tag and recapture histories for large salmon from the Northwest Miramichi River, 1996.

Tagging Area		Northwest Food/Science Lower							Northwest Food/Science Upper					
		June	July	August	Sept.	Oct. 1-15	> Oct. 15	Total	June	July	August	Sept.	Oct.	Total
	Tags Placed	18	53	11	49	92	3	223	21	51	4	21	11	108
Recapture Data														
Percent reported														
Angling	Total	0.0%	0.0%	0.0%	0.0%	1.1%	0.0%	0.4%	.	.	.	.	.	.
Traps	NW	0.0%	5.7%	0.0%	6.1%	12.0%	33.3%	8.1%	.	.	.	.	.	.
	SW	0.0%	1.9%	0.0%	6.1%	0.0%	0.0%	1.8%	.	.	.	.	.	.
Angling Recaptures														
In Southwest		0	0	0	0	1	0	1	1	1	0	0	1	3
	Unknown	.	.	.	.	.	.	0	.	.	.	.	1	1
	June	.	.	.	.	.	.	0	.	.	.	.	.	0
	July	.	.	.	.	.	.	0	.	.	.	.	.	0
	August	.	.	.	.	.	.	0	1	.	.	.	.	1
	Sept.	.	.	.	.	.	.	0	.	1	.	.	.	1
	Oct.	.	.	.	.	1	.	1	.	.	.	.	.	0
In Northwest		0	0	0	0	0	0	0	0	0	0	0	1	1
	Unknown	.	.	.	.	.	.	0	.	.	.	.	.	0
	June	.	.	.	.	.	.	0	.	.	.	.	.	0
	July	.	.	.	.	.	.	0	.	.	.	.	.	0
	August	.	.	.	.	.	.	0	.	.	.	.	.	0
	Sept.	.	.	.	.	.	.	0	.	.	.	.	.	0
	Oct.	.	.	.	.	.	.	0	.	.	.	.	1	1
Miramichi		.	.	.	.	.	.	0	.	.	.	.	.	0
Mortalities recovered upriver (in freshwater)														
Northwest		.	.	.	.	.	.	0	.	.	.	.	.	0
Southwest		.	.	.	.	.	.	0	.	.	.	.	.	0
Unmarked fish recovered at facility above		22	51	12	59	92	4	240	21	52	5	26	11	115
Fish with tagging scars recovered at facility above		.	.	.	.	2	.	2	.	.	.	.	.	0
Recaptured fish lost before reading tag number at facility above		.	.	.	.	.	.	0	.	.	.	.	.	0
Recoveries of tags at facility above														
Southwest Food/Science Lower		0	1	0	0	0	0	1	0	2	0	0	1	3
	June	.	.	.	.	.	.	0	.	.	.	.	.	0
	July	.	.	.	.	.	.	0	.	.	.	.	.	0
	August	.	1	.	.	.	.	1	.	.	.	.	.	0
	Sept.	.	.	.	.	.	.	0	.	2	.	.	.	2
	Oct. 1-15	.	.	.	.	.	.	0	.	.	.	.	1	1
Southwest Food/Science Upper		0	0	0	0	0	0	0	0	0	0	0	0	0
	June	.	.	.	.	.	.	0	.	.	.	.	.	0
	July	.	.	.	.	.	.	0	.	.	.	.	.	0
	August	.	.	.	.	.	.	0	.	.	.	.	.	0
Millerton Trap		0	0	0	3	0	0	3	0	0	1	0	2	3
	May	.	.	.	.	.	.	0	.	.	.	.	.	0
	June	.	.	.	.	.	.	0	.	.	.	.	.	0
	July	.	.	.	.	.	.	0	.	.	.	.	.	0
	August	.	.	.	.	.	.	0	.	.	.	.	.	0
	Sept.	.	.	.	1	.	.	1	.	.	1	.	.	1
	Oct. 1-15	.	.	.	2	.	.	2	.	.	.	.	2	2
	> Oct. 15	.	.	.	.	.	.	0	.	.	.	.	.	0
Northwest Food/Science Lower		0	2	0	1	7	1	11	0	2	0	0	0	2
	June	.	.	.	.	.	.	0	.	.	.	.	.	0
	July	.	1	.	.	.	.	1	.	1	.	.	.	1
	Aug.	.	.	.	.	.	.	0	.	.	.	.	.	0
	Sept.	.	1	.	.	.	.	1	.	.	.	.	.	0
	Oct. 1-15	.	.	.	1	7	.	8	.	1	.	.	.	1
	> Oct. 15	.	.	.	.	.	1	1	.	.	.	.	.	0
Northwest Food/Science Upper		0	1	0	0	1	0	2	0	0	0	1	0	1
	June	.	.	.	.	.	.	0	.	.	.	.	.	0
	July	.	1	.	.	.	.	1	.	.	.	.	.	0
	August	.	.	.	.	.	.	0	.	.	.	.	.	0
	Sept.	.	.	.	.	.	.	0	.	.	.	1	.	1
	Oct.	.	.	.	.	1	.	1	.	.	.	.	.	0
Red Bank Traps		0	0	0	1	3	0	4	1	1	0	1	0	3
	June	.	.	.	.	.	.	0	.	.	.	.	.	0
	July	.	.	.	.	.	.	0	.	.	.	.	.	0
	August	.	.	.	.	.	.	0	.	.	.	.	.	0
	Sept.	.	.	.	.	.	.	0	.	.	.	1	.	1
	Oct. 1-15	.	.	.	1	3	.	4	1	1	.	.	.	2
	> Oct. 15	.	.	.	.	.	.	0	.	.	.	.	.	0
Big Hole Partial Fence		0	0	0	1	0	0	1	1	0	0	0	0	1
	June	.	.	.	.	.	.	0	1	.	.	.	.	1
	July	.	.	.	.	.	.	0	.	.	.	.	.	0
	August	.	.	.	.	.	.	0	.	.	.	.	.	0
	Sept.	.	.	.	.	.	.	0	.	.	.	.	.	0
	Oct. 1-15	.	.	.	1	.	.	1	.	.	.	.	.	0
	> Oct. 15	.	.	.	.	.	.	0	.	.	.	.	.	0
Barrier Fences		0	0	0	0	0	0	0	0	1	1	0	0	2
Dungarvon	June-Aug.	.	.	.	.	.	.	0	.	.	.	.	.	0
	Sept.-Oct	.	.	.	.	.	.	0	.	.	.	.	.	0
SW Miramichi	June-Aug.	.	.	.	.	.	.	0	.	.	.	.	.	0
	Sept.-Oct.	.	.	.	.	.	.	0	.	.	.	.	.	0
NW Miramichi	June-Aug.	.	.	.	.	.	.	0	.	.	.	.	.	0
	Sept.-Oct.	.	.	.	.	.	.	0	.	.	1	.	.	1
Catamaran	June-Aug.	.	.	.	.	.	.	0	.	1	.	.	.	1
	Sept.-Nov.	.	.	.	.	.	.	0	.	.	.	.	.	0
Broodstock Seining		0	0	0	0	0	0	0	0	0	0	0	0	0
	Dungarvon	.	.	.	.	.	.	0	.	.	.	.	.	0
	Little Southwest	.	.	.	.	.	.	0	.	.	.	.	.	0
	Sevogle	.	.	.	.	.	.	0	.	.	.	.	.	0
	Northwest	.	.	.	.	.	.	0	.	.	.	.	.	0

Red Bank Trapnets - Northwest Miramichi	June	July	August	Sept.	Oct. 1-15	> Oct. 15	Total
Unmarked fish recovered at facility	13	39	41	76	115	4	288
Fish with tagging scars recovered at facility	.	.	.	.	.	.	0
Recaptured fish lost before reading tag number at facility above	.	.	.	.	.	.	0

Big Hole Partial Fence	June	July	August	Sept.	Oct. 1-15	> Oct. 15	Total
Unmarked fish recovered at facility	0	22	2	16	2	8	50
Fish with tagging scars recovered at facility	.	.	.	.	.	.	0
Recaptured fish lost before reading tag number at facility above	.	.	.	.	.	.	0

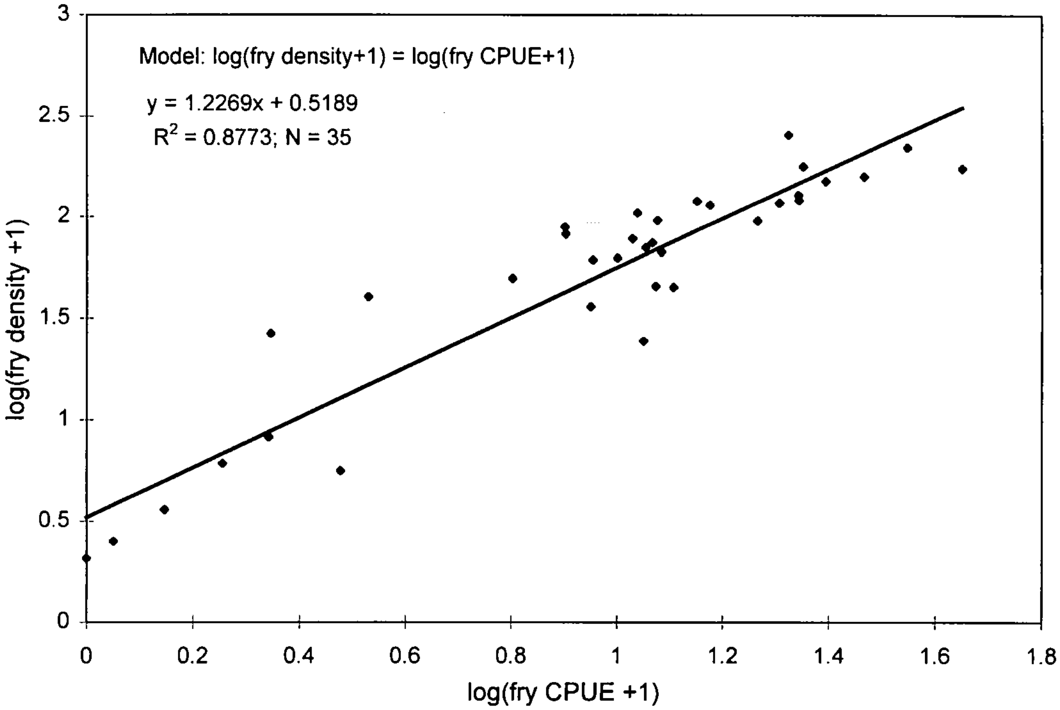
Appendix 2. Tag and recapture histories for large salmon in the Southwest Miramichi, 1996.

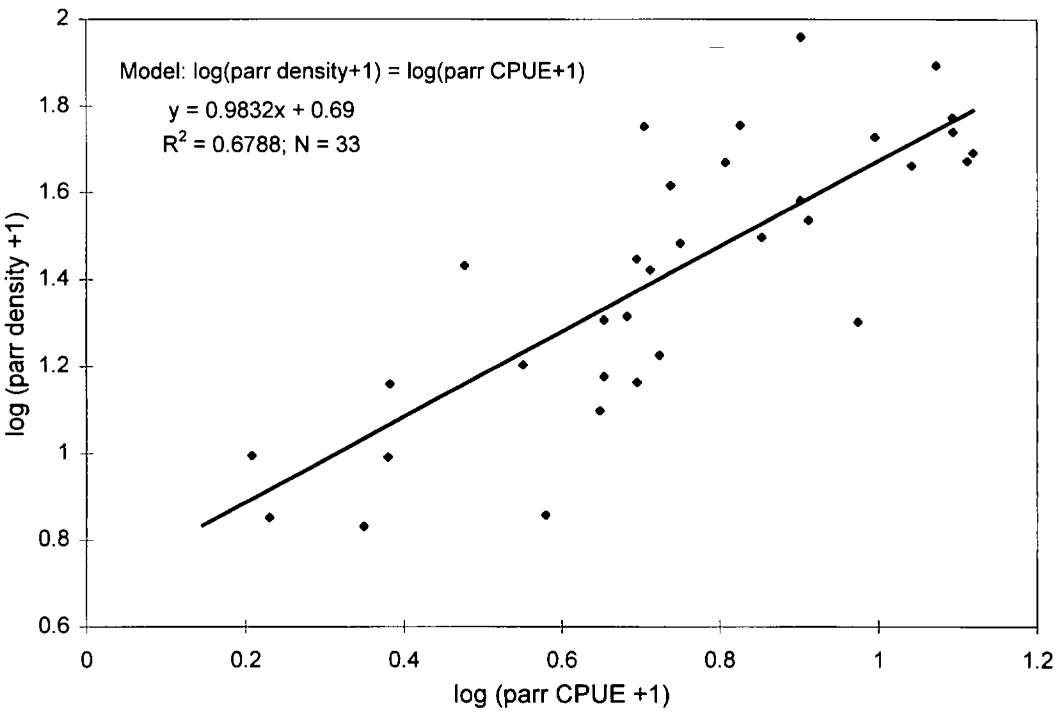
	Tagging Area	Southwest Food/Science Lower							Southwest Food/Science Upper			
		June	July	August	Sept.	Oct. 1-15	> Oct. 15	Total	June	July	August	Total
	Tags Placed	47	73	58	145	135	0	458	14	18	0	32
Recapture Data												
Percent reported												
Angling	Total	0.0%	4.1%	.	4.8%	1.5%		2.6%	7.1%	0.0%	.	3.1%
Traps	NW	2.1%	2.7%	3.4%	2.8%	1.5%		2.4%	0.0%	0.0%		0.0%
	SW	0.0%	4.1%	15.5%	15.9%	8.9%		10.3%	0.0%	0.0%		0.0%
Angling Recaptures												
In Southwest		0	3	0	6	2	0	11	1	0	0	1
	Unknown	.	.	.	1	1	.	2	.	.	.	0
	June	.	.	.	.	.	.	0	.	.	.	0
	July	.	.	.	.	.	.	0	.	.	.	0
	August	.	.	.	.	.	.	0	1	.	.	1
	Sept.	.	3	.	1	.	.	4	.	.	.	0
	Oct.	.	.	.	4	1	.	5	.	.	.	0
In Northwest		0	0	0	1	0	0	1	0	0	0	0
	Unknown	.	.	.	.	.	.	0	.	.	.	0
	June	.	.	.	.	.	.	0	.	.	.	0
	July	.	.	.	.	.	.	0	.	.	.	0
	August	.	.	.	.	.	.	0	.	.	.	0
	Sept.	.	.	.	1	.	.	1	.	.	.	0
	Oct.	.	.	.	.	.	.	0	.	.	.	0
Miramichi	Unknown	.	.	.	.	.	.	0	.	.	.	0
Mortalities recovered upriver (in freshwater)												
Northwest		.	.	.	.	.	.	0	.	.	.	0
Southwest		.	.	.	.	.	.	0	.	.	.	0
Unmarked fish recovered at facility above		47	75	61	145	137	0	465	14	22	.	36
Fish with tagging scars recovered at facility above		1	.	.	2	1	.	4	.	.	.	0
Recaptured fish lost before reading tag number at facility above		.	.	.	.	.	.	0	.	.	.	0
Recoveries of tags placed at facility above												
st Food/Science Lower		0	1	3	12	7	0	23	0	0	0	0
	June	.	.	.	.	.	.	0	.	.	.	0
	July	.	.	.	.	.	.	0	.	.	.	0
	August	.	.	2	.	.	.	2	.	.	.	0
	Sept.	.	1	.	10	.	.	11	.	.	.	0
	Oct. 1-15	.	.	1	2	7	.	10	.	.	.	0
	> Oct. 15	.	.	.	.	.	.	0	.	.	.	0
st Food/Science Upper		0	1	0	0	0	0	1	0	0	0	0
	June	.	.	.	.	.	.	0	.	.	.	0
	July	.	1	.	.	.	.	1	.	.	.	0
	August	.	.	.	.	.	.	0	.	.	.	0
Millerton Trapnet		0	1	6	11	5	0	23	0	0	0	0
	June	.	.	.	.	.	.	0	.	.	.	0
	July	.	1	.	.	.	.	1	.	.	.	0
	August	.	.	1	.	.	.	1	.	.	.	0
	Sept.	.	.	3	9	.	.	12	.	.	.	0
	Oct. 1-15	.	.	2	2	4	.	8	.	.	.	0
	> Oct. 15	.	.	.	.	1	.	1	.	.	.	0
Northwest Food/Science Lower		0	0	1	0	1	0	2	0	0	0	0
	June	.	.	.	.	.	.	0	.	.	.	0
	July	.	.	.	.	.	.	0	.	.	.	0
	August	.	.	1	.	.	.	1	.	.	.	0
	Sept.	.	.	.	.	.	.	0	.	.	.	0
	Oct.	.	.	.	.	1	.	1	.	.	.	0
Northwest Food/Science Upper		0	1	0	1	0	0	2	0	0	0	0
	June	.	.	.	.	.	.	0	.	.	.	0
	July	.	.	.	.	.	.	0	.	.	.	0
	August	.	.	.	.	.	.	0	.	.	.	0
	Sept.	.	1	.	.	.	.	1	.	.	.	0
	Oct. 1-15	.	.	.	1	.	.	1	.	.	.	0
Red Bank Trapnets		1	1	1	3	1	0	7	0	0	0	0
	June	.	.	.	.	.	.	0	.	.	.	0
	July	.	.	.	.	.	.	0	.	.	.	0
	August	.	1	1	.	.	.	2	.	.	.	0
	Sept.	.	.	.	2	.	.	2	.	.	.	0
	Oct. 1-15	1	.	.	1	1	.	3	.	.	.	0
	>Oct. 15	.	.	.	.	.	.	0	.	.	.	0
Big Hole Patial Fence		0	0	0	0	0	0	0	0	0	0	0
	June	.	.	.	.	.	.	0	.	.	.	0
	July	.	.	.	.	.	.	0	.	.	.	0
	August	.	.	.	.	.	.	0	.	.	.	0
	Sept.	.	.	.	.	.	.	0	.	.	.	0
	Oct. 1-15	.	.	.	.	.	.	0	.	.	.	0
	> Oct. 15	.	.	.	.	.	.	0	.	.	.	0
Barrier Fences		0	0	0	0	0	0	0	0	0	0	0
Dungarvon	June-Aug.	.	.	.	.	.	.	0	.	.	.	0
	Sept.-Oct.	.	.	.	.	.	.	0	.	.	.	0
SW Miramichi	June-Aug.	.	.	.	.	.	.	0	.	.	.	0
	Sept.-Oct.	.	.	.	.	.	.	0	.	.	.	0
NW Miramichi	June-Aug.	.	.	.	.	.	.	0	.	.	.	0
	Sept.-Oct.	.	.	.	.	.	.	0	.	.	.	0
Catamaran	June-Aug.	.	.	.	.	.	.	0	.	.	.	0
	Sept.-Nov.	.	.	.	.	.	.	0	.	.	.	0
Broodstock Seining		0	0	0	0	0	0	0	0	0	0	0
	Dungarvon	.	.	.	.	.	.	0	.	.	.	0
	Southwest	.	.	.	.	.	.	0	.	.	.	0
	Little Southwest	.	.	.	.	.	.	0	.	.	.	0
	Sevogle	.	.	.	.	.	.	0	.	.	.	0
	Northwest	.	.	.	.	.	.	0	.	.	.	0

Appendix 2. Tag and recapture histories for large salmon in the Southwest Miramichi, 1996.

Tagging Area		Millerton Trapnet - Southwest Miramichi							
		May	June	July	August	Sept.	Oct. 1-15	>Oct. 15	Total
	Tags Placed	12	70	137	21	214	240	2	696
Recapture Data									
Percent reported									
Angling	Total	.	5.7%	2.2%	4.8%	2.8%	1.7%		2.6%
Traps	NW								
	SW								
Angling Recaptures									
In Southwest		0	4	3	1	6	4	0	18
	Unknown	.	.	1	.	1	1	.	3
	June	.	.	.	.	.	.	.	0
	July	.	1	.	.	.	.	.	1
	August	.	1	1	.	.	.	.	2
	Sept.	.	1	1	.	.	.	.	2
	Oct.	.	1	.	1	5	3	.	10
In Northwest		0	0	0	0	0	0	0	0
	Unknown	.	.	.	.	.	.	.	0
	June	.	.	.	.	.	.	.	0
	July	.	.	.	.	.	.	.	0
	August	.	.	.	.	.	.	.	0
	Sept.	.	.	.	.	.	.	.	0
	Oct.	.	.	.	.	.	.	.	0
Miramichi	Unknown	.	.	.	.	.	1	.	1
Mortalities recovered upriver (in freshwater)									
Northwest			.	.	.	.	.	.	0
Southwest	July	.	1	.	.	.	.	.	1
Unmarked fish recovered at facility above									
		12	71	141	22	223	256	3	728
Fish with tagging scars recovered at facility above									
		.	.	.	.	.	.	.	0
Recaptured fish lost before reading tag number at facility above									
		.	.	.	.	.	1	.	1
Recoveries of tags placed at facility above									
Enclosure Trapnet		0	0	2	0	2	2	0	6
	June	.	.	.	.	.	.	.	0
	July	.	.	.	.	.	.	.	0
	August	.	.	.	.	.	.	.	0
	Sept.	.	.	1	.	1	.	.	2
	Oct. 1-15	.	.	1	.	1	2	.	4
	> Oct. 15	.	.	.	.	.	.	.	0
Southwest Food Fis		0	0	0	0	0	0	0	0
	June	.	.	.	.	.	.	.	0
	July	.	.	.	.	.	.	.	0
	August	.	.	.	.	.	.	.	0
Millerton Trapnet		0	1	3	1	13	8	0	26
	June	.	1	.	.	.	.	.	1
	July	.	.	1	.	.	.	.	1
	August	.	.	.	.	.	.	.	0
	Sept.	.	.	2	1	7	.	.	10
	Oct. 1-15	.	.	.	.	6	8	.	14
	> Oct. 15	.	.	.	.	.	.	.	0
Renous River fence		0	0	1	0	3	1	0	5
	June	.	.	.	.	.	.	.	0
	July	.	.	.	.	.	.	.	0
	August	.	.	.	.	.	.	.	0
	Sept.	.	.	.	.	1	.	.	1
	Oct.	.	.	1	.	2	1	.	4
Northwest Eel Groun		0	0	0	0	0	0	0	0
	June	.	.	.	.	.	.	.	0
	July	.	.	.	.	.	.	.	0
	August	.	.	.	.	.	.	.	0
	Sept.	.	.	.	.	.	.	.	0
	Oct. 1-15	.	.	.	.	.	.	.	0
Red Bank Trapnets		0	0	1	0	2	0	0	3
	June	.	.	.	.	.	.	.	0
	July	.	.	.	.	.	.	.	0
	August	.	.	.	.	.	.	.	0
	Sept.	.	.	1	.	1	.	.	2
	Oct. 1-15	.	.	.	.	1	.	.	1
		.	.	.	.	1	.	.	
		0	0	0	0	0	0	0	0
		.	.	.	.	.	.	.	0
		.	.	.	.	.	.	.	0
		.	.	.	.	.	.	.	0
		.	.	.	.	.	.	.	0
		.	.	.	.	.	.	.	0
		.	.	.	.	.	1	.	1
Barrier Fences		0	3	2	0	1	1	0	7
Dungarvon	June-Aug.	.	1	1	.	.	.	.	2
	Sept.-Oct.	.	.	1	.	.	.	.	1
SW Mirami	June-Aug.	.	1	.	.	.	.	.	1
	Sept.-Oct.	.	1	.	.	.	.	.	1
NW Mirami	June-Aug.	.	.	.	.	.	.	.	0
	Sept.-Oct.	.	.	.	.	.	1	.	1
Catamaran	June-Aug.	.	.	.	.	.	.	.	0
	Sept.-Nov.	.	.	.	.	1	.	.	1
Broodstock Seining		0	0	1	0	0	0	0	1
	Dungarvon	.	.	1	.	.	.	.	1
	Southwest	.	.	.	.	.	.	.	0
	Little South	.	.	.	.	.	.	.	0
	Sevogle	.	.	.	.	.	.	.	0
	Northwest	.	.	.	.	.	.	.	0

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. Performance of estimation models under conditions particular to the returns of Atlantic salmon to the Miramichi River.

The factors which potentially bias the estimates of returns to the Miramichi River and to each branch include the different run sizes between the two branches, the emigration of fish between branches after tagging and the differential tagging and recapture efficiencies at the estuary trapnets. The returns of tags by anglers have been used to estimate the emigration rates between branches. Simulations were performed to examine the bias in the emigration rate estimates from angling returns and the estimation of returns to the Miramichi River and to each branch. Three models are used to estimate the returns based on mark and recapture experiments: Darroch (see Dempson and Stansbury 1991 for formulation), the Schaeffer model (see Ricker 1975) and the Petersen model (see Ricker 1975). Both the Darroch and Schaeffer are stratified models whereas the Petersen is a pooled model. Stratifications of the Darroch and Schaeffer model can be temporal, spatial (separate branches) or both.

The run of salmon to the Miramichi and the operation of the tagging and recapture trapnets were simulated under the following conditions:

Run of salmon:	to Southwest (L)		=	30000 fish
	to Northwest (S)		=	15000 fish
Emigration rates (E)		from L to S (EL)	=	0.1; 0.4
		from S to L (ES)	=	0.1; 0.4
Tagging trap efficiency (T)			=	0.1; 0.15
Recapture trap efficiency '(R)			=	0.1; 0.15
Return rate of tags by anglers (rr)			=	0.2; 0.4

The combinations of factors of interest were:

EL = ES; EL > ES; EL < ES
TL = TS; TL > TS; TL < TS
RL = RS; RL > RS; RL < RS
rrL = rrS; rrL > rrS

A total of 500 simulations were performed for combinations of the factors. The results of the simulations are summarized in terms of the percent difference of the estimate relative to the value ([estimate - true] / true). The median percent difference is used to evaluate performance; median differences less than 5% are considered unbiased.

1 - Estimation of emigration rates

Emigration rate estimates were unbiased for all combinations of factors; the median percent differences were all less than 2%. The precision of the estimates varied with the relative efficiencies of the tagging trapnets such that precision was best when tagging efficiencies were highest.

2- Estimation of returns to the Miramichi

All three methods (Darroch, Schaefer and Petersen) provide generally unbiased estimates of total returns. The Darroch model produced estimates which were negatively biased when the efficiencies of the trapnets were higher in the large branch relative to the smaller branch and positively biased for the opposite situation for the conditions when the emigration rate from the large branch was higher than the rate from the small branch.

Appendix 4 (continued).

		EL = ES = 0.1	EL = 0.1; ES = 0.4	EL = 0.4; ES = 0.1
TL = TS; RL = RS	Darroch	0	0	0
	Schaefer	0	0	0
	Petersen	0	0	0
TL > TS; RL > RS	Darroch	0	0	-
	Schaefer	0	0	0
	Petersen	0	0	0
TL < TS; RL < RS	Darroch	0	0	+
	Schaefer	0	0	0
	Petersen	0	0	0
TL = TS; RL > RS	Darroch	0	0	-
	Schaefer	0	0	0
	Petersen	0	0	0
Symbols are:	*0 <= 5%*	*5% < -,+ <= 10%*	*10% < --,++ <=25%*	*---,+++ > 25%*

3 - Separate branch estimates are less well behaved. Estimates were obtained for two locations in the estuary: returns to the tagging trapnets (before emigration occurs) and returns to the recapture trapnets (after emigration has occurred). Petersen estimates for each branch were obtained after reallocating the marks available to each tributary based on estimates of emigration rates. L = large branch, S = small branch.

Estimates of fish at the tagging locations

		EL = ES		EL < ES		EL > ES	
		L	S	L	S	L	S
TL = TS; RL = RS	Darroch	0	0	0	0	0	0
	Schaefer	-	+	-	+	++	---
TL > TS; RL > RS	Darroch	0	0	0	++	0	--
	Schaefer	+	--	0	0	++	---
TL < TS; RL < RS	Darroch	0	0	0	--	++	0
	Schaefer	0	0	--	++	+	--
TL = TS; RL > RS	Darroch	0	+	0	++	--	0
	Schaefer	0	0	-	++	+	---
Symbols are:	*0 <= 5%*	*5% < -,+ <= 10%*		*10% < --,++ <= 25%*		*---,+++ > 25%*	

Appendix 4 (continued).

Estimates of fish at the recapture locations

		EL = ES		EL < ES		EL > ES	
		L	S	L	S	L	S
TL = TS; RL = RS	Petersen	+	--	-	++	+++	---
	Schaefer	++	--	-	++	+++	---
TL > TS; RL > RS	Petersen	0	0	-	+++	+++	---
	Schaefer	+	--	-	++	+++	---
TL < TS; RL < RS	Petersen	+	--	0	+	+++	---
	Schaefer	0	0	--	+++	+++	---
TL = TS; RL > RS	Petersen	0	0	--	+++	+++	---
	Schaefer	+	--	0	++	+++	---

Symbols are: *0 <= 5%* *5% < -,+ <= 10%* *10% < --,++ <= 25%* *---,+++ > 25%*

Particular conditions of interest to the Miramichi estimation of returns are when the emigration rates from the small tributary (S = Northwest) are greater than the emigration rates from the large tributary (L = Southwest). Under this condition, regardless of the tagging and recapture efficiencies in each branch, the returns at the point of recapture to the large tributary are generally underestimated whereas the returns to the small tributary are overestimated, often by a very large amount (> 25% of true). This is the case for the Schaefer and Petersen models. Note that the Petersen estimates are obtained after reallocating marks available from the emigration rate calculations (overall, the emigration rate estimation is unbiased).

Appendix 5. Detailed distributions of salmonid juveniles from the Miramichi Salmonid Enhancement Centre in 1996. Symbols for mark are: AC = adipose fin clip, NM = no external mark.

Stocking location name	Day	Month	Stock Origin	Life stage	Mark	Stage	Length (cm)	Fish/Kg	Number
Northwest Miramichi									
LSW Little North Pole	13	6	LSW Mir.	0+ parr	AC	5	12.6	75.8	7081
LSW Mir. W Br Rd Crossing	12	6	LSW Mir.	0+ parr	AC	5	12.6	75.8	8300
NW Mir. Camp Adam	12	9	NW Mir.	0+ parr	AC		6.2		3000
Sevogle	21	10	Sevogle	0+ parr	AC		6.52		9848
South Sevogle, Barrack's Brook	2	7	Sevogle	0+ parr	NM	1		1695	3836
LSW Mouth of Tuadook R.	14	11	LSW Mir.	1+ parr	AC			25.3	2727
LSW Smith Forks	18	11	LSW Mir.	1+ parr	AC			22.1	2613
LSW Smith Forks	19	11	LSW Mir.	1+ parr	AC			22.1	1211
LSW Smith Forks	20	11	LSW Mir.	1+ parr	AC			22.1	1909
NW Mir. Miners Bridge	9	5	LSW Mir.	1+ smolts	AC		14.5	28.6	1736
Little River by old bridge	23	5	NW Mir.	2+ smolts	AC		17.5	18.7	2472
Little River Old Bridge	23	5	NW Mir.	2+ smolts	AC	AS	17.5	18.7	2472
NW Mir. Bridge Pool	1	5	NW Mir.	2+ smolts	AC		16.7	25.9	2917
NW Mir. Bridge Pool	1	5	NW Mir.	2+ smolts	AC		16.7	25.9	3333
NW Mir. Bridge Pool	1	5	NW Mir.	2+ smolts	AC		16.7	25.9	8288
NW Mir. Bridge Pool	2	5	NW Mir.	2+ smolts	AC		16.7	25.9	2624
NW Mir. Bridge Pool	2	5	NW Mir.	2+ smolts	AC		16.7	25.9	4388
NW Mir. Bridge Pool	2	5	NW Mir.	2+ smolts	AC		16.7	25.9	2831
NW Mir. Bridge Pool	2	5	NW Mir.	2+ smolts	AC		16.7	25.9	2846
NW Mir. Bridge Pool	2	5	NW Mir.	2+ smolts	AC		16.7	25.9	2626
NW Mir. Bridge Pool	2	5	NW Mir.	2+ smolts	AC		16.7	25.9	4323
NW Mir. Bridge Pool	3	5	NW Mir.	2+ smolts	AC		16.7	25.9	622
LSW Devils Brook	8	6	LSW Mir.	Non-feeding fry	NM	D		5000	3084
LSW DFO Camp	8	6	LSW Mir.	Non-feeding fry	NM	D		5000	6168
LSW Indian Brook	8	6	LSW Mir.	Non-feeding fry	NM	D		5000	3084
LSW Libbies Brook	8	6	LSW Mir.	Non-feeding fry	NM	D		5000	3084
LSW Little North Pole	8	6	LSW Mir.	Non-feeding fry	NM	D		5000	3084
LSW Smith Forks	8	6	LSW Mir.	Non-feeding fry	NM	D		5000	6168
LSW Tuadook	8	6	LSW Mir.	Non-feeding fry	NM	D		5000	6168
LSW Upper West Branch	8	6	LSW Mir.	Non-feeding fry	NM	D		5000	6168
Southwest Miramichi									
Cains	15	10	Cains R.	0+ parr	AC		6.71		4979
Cains River, Salmon Brook	2	7	Cains R.	0+ parr	NM	1		2041	13776
Clearwater	8	10	Clearwater	0+ parr	AC		5.89		4878
Clearwater Brook Bridge	26	6	Clearwater	0+ parr	NM	1		1923	18000
Rocky Brook	28	9	Rocky Brook	0+ parr	AC		6.4		4908
Rocky Brook	23/24	10	Rocky Brook	0+ parr	AC		7.92		9708
Rocky Brook Hurd Pool	16	10	Rocky Brook	0+ parr	AC		7.54		4964
SW Mir. Black Brook	15	7	Cains R.	0+ parr	NM				10000
SW Mir. Deadman Brook	3	10	Clearwater	0+ parr	AC		7.92		4950
SW Mir. Gillman Brook	3	10	Clearwater	0+ parr	AC		6.4		9883
SW Mir. Harris Brook Ludlow	12	10	Rocky Brook	0+ parr	AC		7.38		4980
SW Mir. Mountain Channel	2	10	Cains R.	0+ parr	AC		6.38		4936
SW Mir. Salmon Brook	10	10	Clearwater	0+ parr	AC		7.49		4993
Upper Sisters Brook	27	6	Rocky Brook	0+ parr	NM	1		2222	8339
South Branch Renous, Drake Falls	8	5	Dungarvon R.	1+ smolts	AC		13.6	36.5	3891
South Branch Renous, Drake Falls	7	5	Dungarvon R.	2+ smolts	NM		17.1	19.7	1954
South Branch Renous, Drake Falls	10	5	Dungarvon R.	2+ smolts	NM		17.1	19.7	936
Dungarvon, Iron Bridge	7	6	Dungarvon R.	Non-feeding fry	NM	D		5000	42793
Northwest Miramichi - trout stocking									
NW Millstream	9	5	NW Mir. sea run	1+	NM		14.5	29	957
Stewart Brook	9	5	NW Mir. sea run	1+	NM		14.5	29	562