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Stock status of Atlantic salmon (*Salmo salar*) in the Miramichi River, 1994

by

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ABSTRACT

Atlantic salmon (*Salmo salar*) in the Miramichi River, New Brunswick, were harvested by two user groups in 1994; First Nations and recreational fishers. The Aboriginal food fishery catches in 1994 represented an increase of 128% for small and a decrease of 79% for large salmon relative to previous years. Essentially all (99%) of the large salmon harvests and 84% of the small salmon harvests were taken from the early run in 1994. In the recreational fishery, the catches of small and large salmon were down about 42% from the previous 5-year mean while the effort was up 4%, from the average. For the Southwest Miramichi, 33775 small salmon and 14000 large salmon were estimated to have returned in 1994. After accounting for all removals, egg depositions in the Southwest Miramichi by both small and large salmon were 108% of target. For the Northwest Miramichi, 21500 small salmon and 12660 large salmon were estimated to have returned. Egg depositions by small and large salmon in the Northwest in 1994 were 197% of target. Egg depositions have exceeded the target in each branch during the last three years. The 1995 forecast for large salmon returning to the Miramichi is 30,040 with a 78% 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 1994, les captures de grands saumons dans les pêches autochtones ont diminué de 79% par rapport à la moyenne des années antérieures tandis que les captures de madeleineaux (<63 cm longueur à la fourche) ont augmenté de 128%. Presque tous les grands saumons (99%) et 84% des madeleineaux récoltés par les autochtones provenaient de la remontée d'été (avant le 1er septembre). Les captures de madeleineaux et de grands saumons dans la pêche récréative ont diminué de 42% par rapport à la moyenne des cinq années précédentes malgré l'effort de pêche qui a faiblèment augmenté (4%). La montaison de saumon dans la rivière Miramichi sud-ouest s'est situé à 33 775 madeleineaux et 14 000 grands saumons. Les géniteurs auraient contribué à une ponte d'oeufs équivalente à 108% de la cible d'oeufs pour la rivière Miramichi sud-ouest. Dans la Miramichi nord-est, la montaison a été estimée à environ 21 500 madeleineaux et 12 660 grands saumons. Les géniteurs de cette montaison auraient contribué une ponte d'oeufs équivalente à 197% de la cible d'oeufs. Durant les trois dernières années, les pontes d'oeufs ont été supérieures aux cibles pour les deux affluents principales de la Miramichi, le sud-ouest et le nord-est. La prévision de la remontée de grands saumons pour 1995 est 30 040 poissons. Il est toutefois probable, à 78%, que la remontée soit égale ou supérieure au niveau de cible de géniteurs. 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 très récemment.

Summary sheets for the Miramichi River, Northwest Miramichi River and Southwest Miramichi River.

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

	1989	1990	1991	1992	1993	1994	MIN[1]	MAX[1]	MEAN[7]
Angling harvest[2]									
Large	11928	9258	6147	9476	8131	8988	1792	14215	8988
Small	24382	21372	11300	21482	16898	19087	8310	30586	19087
Native harvest[3]									
Large	540	609	544	608	208	124	124[6]	898[6]	502
Small	1085	2110	1111	1652	601	2977	100[6]	2977[6]	1312
Other harvest[4]									
Large	153	99	131	142	166	119	99[7]	166[7]	138
Small	155	142	189	198	236	270	142[7]	270[7]	184
Spawning escapement									
Large (x 1000)	16	28	29	36	35	26	4	36	29
Small (x 1000)	48	60	48	135	76	32	13	135	73
Total returns									
Large (x 1000)	17	29	30	37	35	27	9	52	30
Small (x 1000)	75	83	61	153	92	54	24	153	93
% Egg target met	98	152	159	242	170	130	23	242	164

[1] MIN MAX over the period 1971-1994 unless stated otherwise.
[2] Angling harvest of hook and release estimates of catch.
[3] Native harvest includes catch reported by Burnt Church, Red Bank, and Eel Ground Indian Bands.
[4] Other harvest includes broodstock removals, mortalities at all index traps, and all samples.
[6] For 1975 to 1994.
[7] For 1989 to 1993.

Recreational catches: Have ranged from 7686 to 14,215 large and 11,300 to 30,586 small salmon during the past 10 years. Effort in rod-days has increased in recent years. Angling catches for 1994 are average catches from 1989-93 since preliminary estimates for 1994 are not yet available. Large and small salmon catches in 1993 were 25 and 30% below average.

Data and assessment: For 1989-1991, returns were estimated from trap efficiency at a DFO trap operated in the estuary of the Miramichi River at Millbank. The efficiency of this trap was calibrated from tag recapture experiments in 1985 thru 1992. Index traps were operated in the estuaries of the Northwest and Southwest Miramichi Rivers in 1992, 1993, and 1994. Returns of small and large salmon were estimated separately from marks applied at these traps and recaptures upstream. Escapements were estimated as returns minus known removals.

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

Forecast for 1995: The probability distribution model prediction for large salmon returns in 1995 is 30,040 with a probability of meeting the spawning target (23,600) of 78% (i.e., a 22% chance of returns being less than 23,600).

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

	1989	1990	1991	1992	1993	1994	MIN[1]	MAX[1]	MEAN[7]
Angling harvest[2]									
Large	2805	2229	1533	1519	1794	2109	419	3836	2109
Small	7568	6825	3056	6960	6171	6116	2232	9825	6116
Native harvest[3]									
Large	462	502	462	580	54	81	54[6]	898[6]	412
Small	1054	2095	1109	1616	477	2921	100[6]	2921[6]	1270
Other harvest[4]									
Large	26	39	44	56	100	51			53
Small	0	0	29	61	106	68			39
Spawning escapement									
Large (x 1000)	n.a.	n.a.	n.a.	9	10	12			
Small (x 1000)	n.a.	n.a.	n.a.	22	40	11			
Total returns									
Large (x 1000)	n.a.	n.a.	n.a.	10	11	13			
Small (x 1000)	n.a.	n.a.	n.a.	31	46	21			
% Egg target met	n.a.	n.a.	n.a.	198	175	197			

[1] MIN MAX over the period 1972 to present unless stated otherwise.
[2] All angling catches are NB DNRE Fishsys values. Angling harvest for large salmon are hook and release estimates of catch.
[3] Native harvest includes catch reported by Red Bank, and Eel Ground Indian Bands.
[4] Other harvest includes broodstock removals, mortalities at all index traps, and all samples.
[6] For 1972 to present.
[7] For 1989 to 1993.

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

Data and assessment: Returns of small salmon and large salmon to the Northwest Miramichi River were estimated in 1992, 1993, and 1994 from a mark-recapture program, applying tags at Eel Ground Enclosure trap and recovering tags from traps at Redbank (NW), and from fences in the headwaters of the Northwest Miramichi and in Catamaran Brook. Spawners were estimated as returns minus known and estimated removals.

State of the stock: The spawning target for large salmon was exceeded in 1992, 1993, and 1994.

Forecast for 1995: Because 1994 is only the third year of data on returns, no quantitative forecast can be made of returns in 1995.

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

	1989	1990	1991	1992	1993	1994	MIN[1]	MAX[1]	MEAN[7]
Angling harvest[2]									
Large	9123	7029	4614	7682	5945	6879	1373	10387	6879
Small	16814	14547	8244	14522	10727	12971	4570	22137	12971
Native harvest[3]									
Large	0	0	0	0	0	0			
Small	0	0	0	0	0	0			
Other harvest[4]									
Large	78	49	39	75	66	68			61
Small	0	0	39	26	130	202			37
Spawning escapement									
Large (x 1000)	n.a.	n.a.	n.a.	27	22	14			
Small (x 1000)	n.a.	n.a.	n.a.	106	33	21			
Total returns									
Large (x 1000)	n.a.	n.a.	n.a.	27	22	14			
Small (x 1000)	n.a.	n.a.	n.a.	121	43	34			
% Egg target met	n.a.	n.a.	n.a.	259	150	108			

[1] MIN MAX over the period 1972 to present unless stated otherwise.
[2] All angling catches are NB DNRE Fishsys values. Angling harvest for large salmon are hook and release estimates of catch.
[3] No Native harvests have occurred in the Southwest branch.
[4] Other harvest includes broodstock removals, mortalities at all index traps, and all samples.
[6] For 1972 to present.
[7] For 1989 to 1993.

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

Data and assessment: Returns of small salmon and large salmon to the Southwest Miramichi River were estimated in 1992, 1993, and 1994 from a mark-recapture program, applying tags at Enclosure trap and recovering tags from creel surveys, and from fences and barriers in the Southwest Miramichi. Spawners were estimated as returns minus known and estimated removals.

State of the stock: The spawning target for large salmon was exceeded in 1992, 1993, and 1994.

Forecast for 1993: Because 1994 is only the third year of data on returns, no quantitative forecast can be made of returns in 1995.

INTRODUCTION

The Miramichi River has a maximum axial length of 250 km and its watershed drains an area of about 14,000 km^2. There are two major branches: the Northwest Branch covers about 3,900 km^2 and the Southwest Branch about 7,700 km^2 of drainage area (Randall et al. 1989). The two branches join at Newcastle New Brunswick and drain into the Gulf of St. Lawrence at latitude 47°N (Fig. 1). The total fluvial habitat area of the system above head of tide has been estimated at 54.6 million m^2 with the Northwest Branch containing 16.8 million m^2 and the Southwest Branch 36.7 million m^2 (Amiro MS1983). The main Miramichi, below the confluence of the branches, contains about 1.2 million m^2 of fluvial habitat.

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).

There is considered to be two runs of Atlantic salmon in the Miramichi River. 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 are 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 primary innovation to the 1994 assessment is the estimation of the returns by size group in the early and late run. This was made possible through increased tagging and recapture efforts in both the Northwest and Southwest Miramichi in 1994. We estimate egg depositions for each run in each branch by incorporating the variability in run composition, sex ratio, and size of fish. Through juvenile surveys and recreational catch data, we provide finer spatial scale assessments of a few larger tributaries of each branch. Finally, using time series data of escapements, juvenile surveys, and angling catches, we provide a prognosis for the future stock status of Atlantic salmon from the Miramichi River.

Input from industry, user groups and other government agencies was obtained during a science assessment workshops (minutes in Appendix 1). Peer review notes are available in Science Branch (1995).

DESCRIPTION OF FISHERIES

Atlantic salmon were harvested by two user groups in 1994; 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 reduction and elimination of gillnetting effort in the Northwest Miramichi, compensated by food fishery trapnets operated by the bands. In 1994, two food fishery trapnets were fished by each of Eel Ground and Red Bank.

There were no significant changes in recreational fishery regulations in 1994 relative to previous years (Moore et al. MS1995). 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).

Aboriginal Food Fisheries

With the exception of the Burnt Church catches, which occurred in estuary waters of Miramichi Bay, salmon were harvested exclusively in the Northwest Miramichi River. The breakdown of the catches by size and week are summarized in Table 2. Reported catches from food fisheries in the Northwest Miramichi in 1994 were 81 large salmon and 2921 small salmon. These catches are exclusive of harvest from Eel Ground First Nation prior to June 12 and all harvests taken off reserve. Gillnet harvests represented 68% of the large salmon catch and 42% of the small salmon catch. The Eel Ground First Nation released all the large salmon from the food fishery trapnets (214 salmon) and Red Bank First Nation released 94% of the large salmon catch (432 of 458 large salmon). Food fishery harvests from the estuary by Burnt Church First Nation were 56 small and 43 large salmon; all were taken by gillnets (Table 2). Essentially all (99%) of the large salmon and 84% of the small salmon were harvested from the early run in 1994. The Aboriginal food fishery catches in 1994 represented an increase of 128% for small salmon and a decrease of 79% for large salmon relative to previous years (Table 3)

Recreational Fisheries

Angling catch data are available from two sources: from the New Brunswick Department of Natural Resources and Energy (DNRE), and from the Government of Canada Department of Fisheries and Oceans (DFO) (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 have generally been lower than the DNRE estimates.

<u>Black salmon fishery</u>

The black salmon catch in 1994 was estimated at 925 kept and 895 released small salmon and 3403 released large salmon. These catches represented a decrease of 44% for kept small and 31% for released large salmon relative to the previous 5-year mean (Table 4) (Moore et al. MS1995). Effort during the black salmon fishery, estimated to have been 9555 rod days, was down by 9% relative to the previous 5-year mean. Because black salmon harvests in the spring represent removals of survivors from the previous year's spawning, they are not considered in any of the spawning escapement calculations. Black salmon catches are considered representative of the abundance of spawners (escapement in the previous year) (Randall and Chadwick MS1983a). Catches of black salmon in the spring fishery and catches of bright salmon in the previous year are highly correlated; large salmon catch R^2 is 0.77 (P<0.01), small salmon catch R^2 is 0.70 (P<0.01) (Fig. 2).

Bright salmon fishery

The estimated catch of bright salmon in 1994 was 11203 small salmon and 5129 large salmon hooked and released (at 3% H&R mortality, this represents losses of 154 large salmon). The estimated effort in 1994 was 113376 rod days (Table 4) (Moore et al. MS1995). The 1994 catches of small and large salmon were down about 42% from the previous 5-year mean catches while the effort was up slightly, 4%, from the average. With the exception of 1991, 1993 and 1994, small salmon recreational catches in the Miramichi have been above 20,000 fish since 1986, a level which was occasionally exceeded prior to 1986 (Fig. 3). Although large salmon catches are now exclusively hook and release, and the comparison of these data to the years when large salmon could be killed may not be direct, large salmon fishing activity has been over 9,000 fish since 1985, except for 1991, 1993 and 1994 (Moore et al. MS1995).

The distribution of the recreational catches of salmon between the Northwest and the Southwest branches was generally about two thirds Southwest, one third Northwest (Moore et al. MS1995) and this distribution continued in 1994.

There has been a doubling of the effort in both the Northwest and Southwest branches of the Miramichi since 1990 relative to the effort between 1984 and 1990 (Chaput et al. MS1994b). The catches of both small and large salmon have not increased over the same period. This doubling of effort has resulted in a corresponding decrease in the catch per unit effort of both small and large salmon in both branches.

The Crown Reserve waters of the Northwest Miramichi are regulated in terms of effort and the estimated fishing effort in those waters has not changed since 1972 (Moore et al. MS1995). Reported catches in 1994 from crown reserve waters in the Northwest Miramichi were 1234 small salmon and 130 large salmon released (Table 4). Crown reserve small salmon catch in 1994 decreased 7% from the previous 5-year average catch whereas the large salmon catch increased 13% (Table 4). The small salmon CPUE has fluctuated by almost two times while the large salmon CPUE has fluctuated by almost four times since 1972 (Fig. 4). The CPUE for small salmon in 1994 was the second lowest since 1984. The CPUE for large salmon has fluctuated much more in the last ten years and the 1994 value was similar to the median value.

Timing of Harvests

Recreational fisheries harvested from both the early and late portions of the run. 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 were angled 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 1994, the proportion of marked fish angled in the Southwest was highest for the June and September groups, while large salmon tag returns were highest for September fish (Appendix 2). In the Northwest Miramichi, small salmon from August were the most heavily exploited while June and September were the tag group with the highest return rate for large salmon (Appendix 2). Exploitation has generally been heaviest on the early run fish and decreases progressively for September and October tag groups (Chaput et al. MS1994b).

TARGET

The conservation spawning requirement for the Miramichi River and each branch separately is based on an egg requirement of 2.4 eggs/m^2 of spawning and rearing habitat area (CAFSAC 1991). Habitat area estimates are from Amiro (MS1983).

	Habitat area (m^2)	Egg requirement (million eggs)
Miramichi River	54.6 million	131.05
Northwest Branch	16.8 million	40.32
Southwest Branch	36.7 million	88.08
Main Miramichi	1.1 million	2.65

RESEARCH DATA

Data collected in 1994 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 Southwest Enclosure trapnet and the Northwest Eel Ground Index trapnet were the main tagging trapnets. An upstream trapnet on the Southwest Miramichi (Millerton, Fig. 1) was used for tagging and recapture. Additional tagging in the Northwest Miramichi was conducted at the food fishery trapnets at Eel Ground and at the two Red Bank food fishery trapnets. 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 5.

The trapnets, with the exception of the Eel Ground food fishery trapnets, were constructed of 5.5 cm stretched mesh, knotless twine. The leaders were constructed of 12.5 cm knotted stretched mesh. The leaders at the Red Bank trapnets were constructed of 7.5 cm knotted stretched mesh twine.The Eel Ground food fishery trapnets and leaders were constructed of 5 cm knotted stretched mesh.

Salmon were marked with individually numbered blue Carlin tags (dimensions 9.5 mm X 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 to third small salmon. Scale samples were stored dry. Every eleventh small salmon from the Southwest trapnets was sacrificed and sampled for fork length, whole weight, sex (internal examination), gonad weight, and scale samples.

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 and many small and large salmon from Red Bank were tagged in 1994 (Table 5). The number of tags placed and the time and location of recaptures, by size group and month, at each of the tagging facilities in 1994 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, tag numbers of marked fish, and sex ratio of salmon.

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).

Tag loss was estimated in 1994 by tagging 51 salmon (small and large) collected for broodstock prior to placement in holding tanks at the Miramichi Salmonid Enhancement Centre. Tagging procedures were similar to those at the trapnets and fish were not anesthetized prior to marking.

Juvenile Surveys in the Miramichi River

Electrofishing surveys were conducted at 87 sites between July 13 and September 2 1994, 15 of which have been sampled every year since 1971, and one site on the North Branch of the Southwest Miramichi has been sampled annually since 1980 (Fig. 5). A combination of open and closed sites was used. The density of salmon juveniles at closed sites was estimated using the successive removal method. Sites were closed using upstream and downstream fine-mesh barrier nets. Population estimates were obtained by the Zippin method (Zippin 1956). The procedure is more fully described in Locke et al. (MS1993). Open sites, fished in a manner similar to 1993, provide an estimate of abundance based on catch per 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 one metre wide by 0.75 metre high lip seine, and a third person with the fish holding bucket and dipnet. The amount of fishing effort was recorded from the timer on the shocker unit and represents the total seconds of actual shocking time. Catch per effort was transformed to density (number of fish$\cdot$100 m^{-2}) by calibrating the open site technique within the closed site. Catch per unit effort was a significant explanatory variable of density for fry and parr within closed sites (Appendix 3).

Habitat characteristics obtained at each site included: composition of the site (proportion riffle, run, rapid, pool), water temperature, width and length of stream or sampled area, maximum depth, substrate composition (estimated by eye as proportion of total), surface water velocity, average site gradient, percent of left and right banks with overhanging vegetation (Appendix 4).

All fish were identified to species and measured for length (fork length except lamprey for which total length was recorded). At several sites, whole weights to the nearest 0.1 g were obtained using a portable electronic balance. Large eels were counted but not measured. Fish were anesthetized, using sodium bicarbonate salts, before measuring.

Length distributions were used to partition the catches into fry (young-of-the-year) and parr. Generally fry were less than 5.5 cm fork length whereas parr were larger. The criterion length did not change over the sampling period early July to the end of August.

Detailed surveys of the fry and parr densities above and below the Northwest Miramichi barrier fence (Fig. 5) were conducted in 1993 and 1994 at eleven sites. Sites were partitioned into four habitat categories: pool, rapid, riffle, and run. Fry and parr were determined on the basis of fork length.

Hatchery Stocking

Various life stages are reared and stocked annually to the Miramichi River. Satellite rearing was initiated in 1984 and in 1994 a total of 80,000 young-of-the-year were distributed to satellite facilities and reared for release as fall fingerlings (Table 6). Smolt stocking is also an important component of the hatchery program. About 33000 smolts were released to the Southwest Miramichi in 1994, an increase of 15% from the previous five-year mean. In the Northwest Miramichi, 41400 smolts were released in 1994, an increase of 292% from the 1989-93 mean (Fig. 6, Table 6). Unfed fry releases to the Northwest Miramichi consisted of 185000 to the Sevogle River and 105000 to the Little Southwest (Table 6).

Broodstock collections in 1994 consisted of 53 large salmon and 34 small salmon from the Southwest Miramichi, 51 large salmon and 46 small salmon from the Northwest Miramichi (Table 7).

ESTIMATION OF STOCK PARAMETERS

Estimation of Returns

Returns of small and large salmon are estimated using mark/recapture methods which require three inputs: number of fish marked and released in the first trapping event (M), number of fish in the second trapping event which were marked in the first trapping event (R), and number of fish in the second event which were not previously marked (U). The simplest estimator of the population size is:

$$\hat{N} = \frac{M}{R} * (R+U)$$

In 1994, we used the upper trapnets in the Southwest Miramichi and at Red Bank as the second trapping event. We used a temporally stratified method (Schaefer; Ricker 1975) for estimating the returns of small and large salmon from the Northwest and Southwest Miramichi. The stratified procedure was used to account for differences in efficiency of both the tagging and recapture gears during June to October. Initially, monthly strata were used. These were then pooled, if required, to provide at least 5 recaptures within an individual cell. Pooling was done within early and late groups such that at most June, July and August were pooled into early while September and October were pooled into late. An exception was made for the Southwest Miramichi large salmon matrix where only three recaptures were recorded during June through August. We used all observed recaptures at the trapnets regardless of the branch where they were originally marked. The marks available for recapture in each branch were calculated using the emigration rate estimates calculated below.

Only marks placed up to and including Oct. 15 are considered to be available for recapture. The recapture trapnets in the Northwest Miramichi fished until Oct. 15, the upper trapnet on the Southwest Miramichi fished until Oct. 21 but tagging at that trapnet ended on Oct. 15. Tagging of unmarked fish is important for addressing multiple captures at the recapture gear.

At the recapture traps, both R and U are known without error but M is not.

1 - In 1994, salmon with tagging scars were recorded at both recapture trapnets in the Northwest (4 large salmon at Red Bank) and Southwest (2 small salmon at Millerton). 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). Since all fish at the trapnets are examined for tags and tagging scars, R can be considered as 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 is 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, this study). A dead tagged salmon washed up against the trapnet leader at Red Bank on Sept. 30 1994; it was a tagged reconditioned kelt which had been released 25 days earlier. In the absence of survival rate data, a combined tag loss/tagged fish mortality factor of 10% is 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 (Fig. 7). The emigration rate of marked fish out of the branch where they were tagged was calculated using recaptures from angling. Of 2948 small salmon tagged in the Southwest trapnets, 176 tags were returned by anglers from the Southwest, 11 tags were returned by anglers from the Northwest (Fig. 7, Appendix 2). Similarly, fish tagged in the Northwest were recovered by anglers in both the Northwest branch and in the Southwest branch. 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:

$$\frac{NWTR_{NW}}{RR_{NW}} + \frac{NWTR_{SW}}{RR_{SW}} = TotalTags_{NW}$$

$$\frac{SWTR_{NW}}{RR_{NW}} + \frac{SWTR_{SW}}{RR_{SW}} = TotalTags_{SW}$$

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 from June to Oct. 15 were used to estimate the emigration rates (Table 8) because:

1 - we need to estimate emigration rates for both size groups,
2 - large salmon emigration rates using only large salmon tag returns could not be estimated,
3 - although the emigration rates of the early-run small salmon could be estimated (both return rates were non-negative), the rates for fall-run small salmon were not usable (Table 8).

The point estimates and the resampling estimates for small and large salmon emigration in 1994 were:

	Emigration rate to other branch		
Origin	Point Estimate	Resampling median	90% C.I.
Southwest	0.125	0.115	0.052 to 0.264
Northwest	0.371	0.375	0.228 to 0.577

The uncertainty in the estimation of returns was determined by resampling methods. There were two components to the estimation of uncertainty: the first was associated with the recapture matrix itself while the second component was associated with the estimation of the emigration rate which affected the marks available for recapture. The uncertainty of the emigration rate estimates 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.

Verification of programming code

To ensure that the resampling programming code was correct (Appendix 5), the population was estimated for a single recapture event (pooled matrix) using the resampled Schaefer (which simplifies to a Peterson) and compared to the results from a programmed Darroch algorithm (POPAN-PC; Dempson and Stansbury 1989) and a bayesian estimator (Gazey and Staley 1986). The results from the three analyses were identical (Fig. 8). A further verification was made for a stratified estimate using a 2X2 matrix (early and late seasons) by comparing the results from the Darrock software and the Schaefer resampling code. The two analyses gave similar results for the mode but the median estimate of the resampled Schaefer was 8% higher than the Darroch value (Fig. 8). The confidence intervals were also different because the Darroch analysis generated a symmetrical distribution whereas the resampled Schaefer distribution was skewed. The coefficient of variation was similar for the two methods at 18% for the Schaefer and 19% for the Darroch analysis. We chose to use the resampled Schaefer because the uncertainty in the emigration rate (or tags available) could be incorporated in the estimation much more readily than the programmed Darroch software.

Returns to the Southwest Miramichi in 1994

For small salmon, a 4X4 matrix was used for the time periods June-July, August, September and October. For large salmon, a 3X3 matrix was used to estimate returns in June-August, September and October. An estimated 33775 small salmon returned to the Southwest in 1994 with a 95% probability that the returns were at least 23450 fish (Fig. 9). By season, 21850 small salmon returned in the early run and 11600 in the late run. Large salmon returns were estimated at 14000 fish with a 95% probability that the returns were at least 9100 fish (Fig. 9). About 5775 large salmon returned early and 8000 returned in the late run (Fig. 9). The pooled estimate (Peterson) for the entire run was lower, -27% for small and -12% for large salmon (Fig. 9).

The Enclosure trapnet was more efficient at capturing small salmon relative to large salmon and it had a lower efficiency in the early run.

	Early	Late	Total
Small salmon			
Catch	437	543	980
Efficiency	2.0%	4.7%	2.9%

	Early	Late	Total
Large salmon			
Catch	86	207	293
Efficiency	1.5%	2.6%	2.1%

The efficiency of the Enclosure trapnet for the entire season was estimated at 1.7% for large salmon in 1992 and 1993, 1.3% and 2.8% for small salmon in 1992 and 1993 respectively.

The upper trapnet, Millerton recapture trap, had a higher efficiency than the Enclosure trap and had a much lower efficiency during the early run as compared to the late run.

	Early	Late	Total
Small salmon			
Catch	907	1777	2684
Efficiency	4.2%	15.3%	7.9%
Large salmon			
Catch	125	839	964
Efficiency	2.2%	10.5%	6.9%

Returns to the Northwest Miramichi in 1994

For both small and large salmon, a 2X2 matrix was used for the time periods June-August and September-October. An estimated 20600 small salmon returned to the Northwest in 1994 with a 95% probability that the returns were at least 11750 fish (Fig. 9). When the food fishery harvests in tidal waters by Eel Ground First Nation are included (848 small salmon), returns to the Northwest Miramichi were about 21500 fish. By season, 12400 small salmon returned in the early run and 8100 in the late run (Fig. 9). About 12660 (12600 + 60 food fishery harvests at Eel Ground) large salmon returned to the Northwest with 95% probability that the returns were at least 6450 fish. About 2800 large salmon returned early and 9450 returned in the late run (Fig. 9). The pooled estimate (Peterson) for the entire run was 4% higher for small salmon and 8% lower than the stratified estimate for large salmon (Fig. 9).

As in the Southwest trapnets, the Northwest Eel Ground Index trapnet was more efficient at capturing small salmon than large salmon and it had a lower efficiency in the early run.

	Early	Late	Total
Small salmon			
Catch	178	373	551
Efficiency	1.4%	4.6%	2.7%
Large salmon			
Catch	21	104	125
Efficiency	0.8%	1.1%	1.0%

The efficiency of the Northwest Eel Ground Index trapnet for the entire season was estimated at 4.7% and 1.6% for large salmon, 3.4% and 0.9% for small salmon in 1992 and 1993 respectively.

Robustness of the emigration rate estimates

The movement of marked fish between branches is in part determined by environmental conditions and would be higher in tidal water trapping operations than in exclusively freshwater locations. In 1992 and 1993, the emigration of Southwest salmon was estimated to have been higher than that of Northwest tagged fish.

	Emigration rate NW to SW	SW to NW
1992	0.22	0.27
1993	0.14	0.32
1994	0.37	0.13

Ideally, we would expect the probability of recapture of resident and migrant tags to be similar at a specific trapnet. Based on the emigration rates estimated from angling catches, the probabilities of recapture of small salmon migrant tags were higher than resident tags at the Red Bank trapnets but the rates were close at the Southwest recapture trapnet (Table 9). Large salmon recapture probabilities were also different and migrant tags had a higher probability of recapture than resident tags in the Southwest but lower in the Northwest. In order for the probabilities of recapture at each trapnet to be more similar, regardless of tag origin, the emigration rate of Northwest tags would have to increase by 46% (0.37 to 0.54) and the Southwest rate by 37% (0.13 to 0.17) (Table 9). At these adjusted levels, the recapture probabilities are more similar except for large salmon at the Northwest recapture traps.

Robustness of the estimated returns

The use of resident tags only or both resident and migrant tags affects the separate branch estimates and the total returns to the river. Total returns to the Miramichi are calculated as the sum of the separate branch estimates. In all cases, the resident+migrant estimates are lower than the values derived using only resident tags.

	Resident tags	Resident+migrant	Resident+migrant / resident
Small salmon			
Northwest	44304	20158	0.45
Southwest	35584	33348	0.94
Miramichi	79888	53506	0.67
Large salmon			
Northwest	13773	11979	0.87
Southwest	20718	14694	0.71
Miramichi	34491	26673	0.77

In the 1993 assessment, the returns to the Miramichi were more similar between the two models than in 1994.

Using adjusted emigration rates instead of angling emigration rates also changes the estimates of the returns (Table 9). In all cases, the adjusted emigration rates result in higher estimated returns of both small and large salmon in both branches and overall. The increase in overall returns is less than 10%, however, and use of the adjusted emigration rates is not warranted.

Alternate estimates of returns

Alternate estimates of returns to the Southwest Miramichi for the fall period are available from tag recaptures at the Renous partial fence on the Southwest Miramichi. The marked to catch ratios were lower at the Renous fence for both small and large salmon than at the Millerton trap; this resulted in estimates of returns for the fall period which were 116% to 117% higher for small salmon and 50% higher for large salmon than the recapture trapnet estimates.

	Marked to catch ratios (unadjusted for emigration)	
Tag origin	Millerton	Renous fence
Small salmon		
Enclosure	0.028	0.012
Millerton		0.010
Large salmon		
Enclosure	0.011	0.010
Millerton		0.006

Angling and counting fence recaptures can also be used to calibrate the recapture trapnets. This method does not require an estimate of the emigration rate of tags. In the Southwest Miramichi, a total of 98 tags originating below Millerton (from Enclosure and Northwest migrant tags) were returned by anglers fishing the Southwest above Millerton. Of these, 8 tags had been previously intercepted at Millerton. The ratio of these values, 0.082, is an estimate of the efficiency of the Millerton trapnet. The total catch of small salmon at Millerton relative to the total returns to the Southwest Miramichi gave an efficiency for Millerton of 0.076, very similar to the preceding value. This would indicate that returns to the Southwest Miramichi were in the order of 33000 small salmon rather than the higher values indicated by recaptures at the Renous fence. A similar analysis for the Northwest Miramichi was not possible because only one tagged small salmon angled in the Northwest had been previously intercepted by the index trap. Large salmon recaptures were also insufficient.

These alternate methods indicate that the migrant and resident tags model provides the more reliable estimate of the returns to the Southwest and Northwest Miramichi. The larger number of recaptures available with this model would provide a more precise estimate of the returns than other models which use fewer tag recaptures.

Estimation of Egg Depositions in 1994

The estimated egg depositions in 1994 are obtained from the estimates of the escapement of small and large salmon and the biological characteristics of the salmon in 1994.

Escapement in 1994

The escapement of salmon refers to fish which were not harvested in fisheries or otherwise removed from the river. No adjustments are made for illegal removals or disease. Removals include broodstock collections (Table 10), scientific sampling, and incidental mortalities at the tagging trapnets.

The total harvests and removals of salmon from the Miramichi River in 1994 were 14,437 small salmon and 397 large salmon (Table 10). Total removals in the Northwest Branch were 7,107 small salmon and 188 large salmon while Southwest Branch removals were 7,274 small salmon and 166 large salmon. Seizures are not considered as removals for the purposes of calculating the escapement relative to the conservation target.

The point estimates of escapements of small and large salmon in each branch by season are summarized below.

	Number of fish Returns	Removals	Escapement
Northwest Miramichi			
Small - early	13156	5958	7198
- late	8192	1149	7043
- total	21448	7107	14341
Large - early	2801	173	2628
- late	9450	15	9435
- total	12651	188	12463
Southwest Miramichi			
Small - early	21850	4539	17311
- late	11600	2735	8865
- total	33775	7274	26501
Large - early	5775	121	5654
- late	8000	45	7955
- total	14000	166	13834
Miramichi River			
Small - early	36412	10553	25859
- late	19992	3884	16108
- total	56929	14437	42492
Large - early	8994	337	8657
- late	18025	60	17965
- total	27544	397	27147

Biological Characteristics of Salmon in 1994

The sex ratios of small salmon for the early run were determined from internal examinations, whereas both internal examinations and external secondary sexual characteristics were used for the late run. At index trapnets in the Northwest and Southwest, every 11th small salmon was sacrificed. In the case of the food fishery traps (Eel ground, Red Bank), all fish kept by the bands were internally sexed. During the late run, all the fish released at the traps were sexed by external characteristics. The sexing of large salmon at all trapnets was determined using external secondary sexual characteristics. Accurate sexing was possible only during the late runs for all the traps. All fish at the index trapnets were sampled for length and scales for ageing were collected from all large salmon and from a subsample of the small salmon.

Sex ratios of small salmon

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 11). Small salmon from the Northwest had a higher female component than small salmon from the Southwest in the early run but similar proportions of female in the late run. There was a higher female proportion in the broodstock collection in the Little Southwest, Sevogle, and Dungarvon sites in mid-September than in the early run at the trapnets (Table 12). The fish in these tributaries are considered to be essentially early run stocks. The proportion female for the month of June in the Eel Ground food fishery was 0.56, more comparable to the proportions observed in the broodstock samples. For the fall run, the observations at the partial counting fence at Renous (Aug. 17-Nov. 12) produce similar sex ratios to those recorded at the Southwest trapnets.

The contribution by small salmon to the egg depositions was estimated separately for both branches from trapnet sex ratios of the early and late runs.

Sex ratios of large salmon

For the late run period, the large salmon were composed of 76% female in the Northwest and 82% female in the Southwest branch (Table 13); these proportions were significantly different. The broodstock collections in the Little Southwest, Sevogle, and Dungarvon sites in mid-September provide estimates of the proportion female of the early run of over 97% female in the Northwest and 90% for the Southwest (Table 12). At the Renous fence in the fall, the percent female was estimated to be 66% female (Table 12). As with the small salmon, proportionally more females return in the early run than in the late run. In 1994, we used the trapnet sex ratios from the fall run to calculate early and late run estimates of egg deposition.

Size and age

The early runs in both the Northwest and Southwest Miramichi were dominated by small salmon (Fig. 10, 11). In the Northwest Miramichi, small salmon represented 82% of the returns of all fish, in the Southwest it was 79% (Fig. 10). In the fall run, large salmon were more abundant in the Northwest (54% of all fish) while in the Southwest Miramichi, large salmon represented 41% of the run. Small salmon in the fall runs were longer by 5% in the Northwest and 4% in the Southwest (Table 14). The average size of the large salmon decreased slightly over the season in the Southwest catches but increased in the Northwest samples (Table 14). Previous spawners made up over 30% of the large salmon in the Northwest and 28% of the large salmon in the Southwest (Table 14). This continues the trend of high proportions of previous spawners in the returns.

Egg depositions in 1994

In the Northwest Miramichi, almost three times as many eggs were contributed by the late run fish as compared to the early run (Fig. 10). By contrast, the late run in the Southwest contributed only 10% more eggs than the early run (Fig. 11). Large salmon contribute the largest proportion of the eggs in both the early (over 70%) and late runs (over 90%) in each branch. Early run small salmon have the potential to be a more important contributor to the egg depositions (proportionally larger returns than in the fall, higher proportion of females) but because of the larger removals of small salmon in the early run, the resultant early run escapement was lower than the fall run. Egg depositions by season, size group and river system are summarized below.

Egg depositions (million)

		Small	Large	Total	by Large
Northwest	Early	7.4	14.7	22.1	66%
	Late	3.1	53.2	56.3	94%
	Total	10.6	70.2	80.8	87%
Southwest	Early	12.9	31.9	44.8	71%
	Late	4.7	44.5	49.1	90%
	Total	17.8	77.6	95.4	81%
Miramichi	Early	21.4	48.7	70.2	69%
	Late	7.9	100.9	108.8	93%
	Total	29.6	152.5	182.1	84%

STATUS OF STOCK

A total of 77.6 million eggs, 88% of target (88 million eggs over 36.7 million m^2 = 2.4 eggs m^{-2}), were deposited by large salmon in the Southwest Miramichi in 1994. There was a 45% probability that the egg depositions by large salmon in the Southwest Miramichi exceeded the target (Fig. 12). Egg depositions by both small and large salmon were 95.4 million, (108% of target), with a 59% probability of having met or exceeded the target.

In the Northwest Miramichi, 70.2 million eggs were contributed by large salmon, 171% of target (41 million eggs over 16.8 million m^2), There was a 70% probability that the target egg deposition was exceeded by large salmon alone (Fig. 12). Egg depositions by small and large salmon were 197% of target with a 95% probability of having met or exceeded the target.

Total egg depositions to the Miramichi by large salmon were 152.5 million eggs, 116% of target, with an 84% probability of having met or exceeded the target. Egg depositions by both small and large salmon were 138% of target, with a 91% probability of the target having been met or exceeded.

Returns and escapements of small salmon to the Miramichi have been increasing since 1986. The return in 1994 of 56,900 small salmon is 39% below and 16% below the previous 5-year and historical (1971 to 1993) average returns to the river. The escapement of small salmon was 41% below the 5-year average and 12% below the historical average. The large salmon returns were 7% below and 1% above the previous 5-year and historical averages respectively. The large salmon escapement was 5% below but 38% above the 5-year and historical averages, respectively (Fig. 13, Table 15).

Decreased returns of small salmon in 1994 were probably in part attributable to fewer smolts leaving in 1993 as compared to 1991 and 1992. The count of smolts at Catamaran Brook on the Northwest Miramichi in 1993 was 34% of the 1991 count and 21% of the 1992 count (Table 16). Estimated returns of small salmon to the Northwest Miramichi from these smolt years (1991 to 1993) were of the same rank order:

count of smolts:	1993 < 1991 < 1992
small salmon return (by smolt year):	1993 < 1991 < 1992.

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 17). 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 1994 at the barrier fences of the Southwest Miramichi were contradictory; at the Southwest Miramichi fence, counts of large salmon were identical to the previous 5-year mean but at the Dungarvon barrier, the large salmon counts were down by 39% from the average (Table 17). Counts at both barriers indicated that 1994 large salmon returns were below 1992 (-16% to -34%) and 1993 (-23 to -31%). Small salmon counts were also contradictory, up slightly at the Southwest barrier, down 40% at the Dungarvon barrier. For the Dungarvon barrier, water conditions could have severely impacted on the movement of fish into the Renous River in 1994. Low flows in late summer and fall in the Renous River had an estimated 50-year recurrence interval (Caissie MS1995). Low flows also affected the movement of salmon at the Southwest barrier; more than 75% of the large salmon and 50% of the small salmon passed through in the last week of October.

Returns of large salmon at the Northwest Barrier were down 11% from the average but the 1994 counts were just slightly above the 1991 to 1993 values (Table 17). Small salmon were down 36% from the average, about the same from 1992 and 1993. Counts at Catamaran Brook were consistently down for both small and large from 1992 to 1994.

Based on barrier counts and estimated escapements to the Northwest and Southwest branches, the following pattern was observed:

Southwest Miramichi

	Small salmon	Large salmon
barriers:	1994 < 1993 < 1992	1994 < 1992 <= 1993
mark/recapture	1994 < 1993 < 1992	1994 < 1993 < 1992

Northwest Miramichi

	Small salmon	Large salmon
barriers/fence	1994 < 1993 < 1992	1994 < 1993 < 1992 (Catamaran)
		1993 < 1992 < 1994 (NW Barrier)
mark/recapture	1994 < 1992 < 1993	1992 < 1993 < 1994

In both the Northwest and Southwest branches, small salmon counts and escapement estimates for 1994 were down from 1992 and 1993. Large salmon escapement in the Southwest was down from 1992 and 1993 whereas in the Northwest, large salmon escapements were higher than in 1992 and 1993. Migration of salmon into Catamaran Brook may have been negatively impacted by low water levels in October and November (Caissie MS1995, Rick Cunjak DFO pers. comm.).

ECOLOGICAL CONSIDERATIONS

Fisheries Interactions

The Northwest Miramichi index trapnet was situated about 500 m upstream of one of the food trapnets, on the same shore. The presence of this food fishery trapnet as well as gillnets at Eel Ground which were fished downstream of the index trapnet seemingly affected the catch efficiency of the Northwest Index trapnet in 1994. Small salmon and large salmon catches remained low compared to the two food trapnets over the duration of the food fishery (Fig. 14). Catches at the two food trapnets were more similar, high catches of small and large salmon occurred simultaneously but not at the index trapnet. Small salmon and large salmon catches in September increased dramatically after the lower food trapnet was brailed for the season. This would in part explain the reduced efficiency of the NW Index trapnet during the early run as compared to the late run. However, a much greater number of large salmon were tagged and released in the early run from the two food trapnets and the index trapnet then would have been possible with only the index trap. This proved to be the difference in 1994 between estimating an early and late run return and a total return versus no estimate for the Northwest (six of the 11 large salmon recaptures at Redbank were from the food fishery trapnet tagging)

Species Interactions

The index trapnets intercept a smaller proportion of the salmon run in the summer compared to the fall. In June, large catches of gaspereau in the trapnets generally meant minimal to no catch of salmon on the same day (Fig. 15). One hypothesis is that the presence of large numbers of gaspereau alters the behaviour of salmon moving through the estuary - salmon stay in the centre of the river when gaspereau are abundant thus avoiding the trapnets which are set from shore. An alternate hypothesis would be that the run-timing of the salmon is just different enough to produce the observed negative correlations between salmon and gaspereau catches at the traps.

Seasonal and Environmental Conditions

Caissie (MS1995) indicated that 1994 was a year in which several extreme environmental conditions in the Miramichi were observed. Severe ice movement in mid-April undoubtedly produced some scouring of the river bottom, especially in the Little Southwest Miramichi. A spring runoff pH depression of 6.0 was measured at Catamaran Brook, a relatively well buffered stream compared to other streams in the region which probably experienced even lower pH values. Low precipitation during July, August, and October produced low discharge in the Miramichi - the Renous River had a low discharge value in the fall in the order of a 1 in 50 year recurrence (Caissie MS1995). These low water levels in the fall may have limited or delayed access to spawners in several headwater areas; as was mentioned previously, more than 75% of the large salmon passing through the Southwest Miramichi headwater barrier were counted in the last week of October. The median date for large salmon passing through the barrier for 1981 to 1993 is Sept. 23 (R. Claytor, DFO, pers. comm).

Water temperatures in tidal waters at the index trapnets reached more than 25°C for a brief period in July but stayed above 20°C at the surface and bottom between July 1 and early September (Fig. 16). The water column was well mixed, surface temperatures were at most 2.5°C warmer than the bottom temperatures briefly in early July. Surface temperatures tended to be cooler than bottom temperatures in the fall in the Southwest Miramichi.

Spawner Distribution and Habitat Utilization

In 1993, spawning occurred throughout the Northwest and Southwest Miramichi. Fry densities were higher in the Southwest than in the Northwest. At 71% of the sites in the Southwest and 39% of the sites in the Northwest, fry densities were greater than 50 fish per 100m^2 (Fig. 17 & 18). Juvenile abundance was especially low in the Little Southwest sites, for both fry and parr (Fig. 18). Parr densities were high throughout the Southwest Miramichi (Fig. 17). The densities in the main stems of the rivers were generally lower than in the upper sections of the rivers and smaller tributaries. Elson (1967) had indicated that parr densities of 38 fish per 100 m^2 were normal average values for New Brunswick rivers producing 3-year old smolts and normal average fry densities were in the order of 29 per 100 m^2 (Elson 1967). Observed densities of fry and parr in 1993 indicated that spawning had also occurred throughout the Miramichi River in 1991 and 1992 (Chaput et al. MS1994b).

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 1994 return of small salmon to the Miramichi of 56000 fish, the 1995 forecast for large salmon returning to the Miramichi is 30,040 with a 78% 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	%(Actual-Predicted)/Predicted
1992	29,000	37,000	+28%
1993	18,315	35,200	+92%
1994	28,200	27,500	-2%
1995	30,040		

In the last three years, the large salmon returns to the Miramichi have been divided about 2/3 Southwest and 1/3 Northwest Miramichi. This would indicate that the returns to the Northwest

Miramichi would be about 10,000 large salmon whereas returns to the Southwest would be about 20,000 large salmon.

There is no forecast model for small salmon but based on the smolt counts at Catamaran Brook in 1994 and the observed temporal trend in smolt counts in year i, small salmon returns to the Northwest in year i+1, we would expect the small salmon returns in 1995 to be in the order of those observed in 1994 and 1992, i.e. between 20,000 and 30,000 small salmon to the Northwest.

Long Term

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 (Fig. 20 and 21). For fry, the among-site variation in densities has decreased since 1986 suggesting that spawning distribution has become more homogeneous in the Miramichi system. Parr densities have also increased but the inter-site variation has not decreased over time. At least in the freshwater portion of the life cycle, the abundance of the cohorts is increasing in both the Northwest and Southwest Miramichi.

MANAGEMENT CONSIDERATIONS

The spawning target for the Miramichi River was met by large salmon in 1994. There was a 45% chance that the target for the Southwest Miramichi was met by large salmon and a 70% probability that the Northwest Miramichi target was met.

There is a higher exploitation rate on the early run small and large salmon but the overall exploitation rate on large salmon is very low, 1% in the both the Northwest and Southwest branches.

The observed low abundance of juveniles in the Little Southwest Miramichi may be partly related to habitat quality, pH. This should be examined further to determine if low juvenile abundance is due to habitat limitations or insufficient escapement.

Low water conditions in the fall of 1994 could have limited the distribution of spawners in the Northwest and Southwest Miramichi. Although egg depositions were good in both branches in 1994, the spawning may have been more clustered than in previous years. This could have an effect on juvenile survivals in 1995. Juvenile surveys in 1995 could determine the distribution of spawning relative to that observed in the previous two years.

Inseason forecasting may provide a means of assessing the probability of meeting spawning escapement targets within season. Modelling of the timing of the salmon returns to the Miramichi has revealed that improvements to the preseason forecast would be possible for the early run to the Northwest and Southwest branches by mid-July. Improvements to the pre-season forecast of the fall-run to the Southwest Miramichi would be possible by Sept. 22 but no improvement was detected for the Northwest Miramichi (Ross Claytor, DFO, pers. comm.).

RESEARCH RECOMMENDATIONS

1 - Emigration of tagged fish between the branches continues to be a complicating factor in the assessment of returns to the individual branches. The use of tags recaptured by angling to assess the emigration rate should be explored in a simulation to determine the sensitivity of the estimation process to the sample size, temporal and spatial heterogeneity and other factors.

2 - Biological characteristics of salmon spawned at the fish culture station should be examined and used to update, if warranted, the fecundity data currently used for the Miramichi. Differences in the fecundity and egg size of early versus late run fish have been observed in a European stock (ICES 1994). Differences in the sex ratios of small and large salmon by season should also be explored further - the food fisheries of the Miramichi are an ideal data source for such an analysis.

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Table 1. Food fishery agreements on the Northwest and Southwest Miramichi rivers for 1994.

Branch	Size Group	Allocation	Gear	Time Period
Eel Ground First Nation				
Northwest	Small	1,400	gill nets[1] and trapnets[2]	May 1 to Aug. 31[3]
	Large	100	gill nets[1]	May 1 to end of year[3]
Southwest	Small	1,000	trapnet[2]	May 1 to Aug. 31[3]
Red Bank First Nation				
Little Southwest	Small	1,000	trapnet[4] and angling	June 1 to Aug. 31[5]
	Small	1,000	trapnet[4] and angling	Sept. 1 to Oct. 31[5]
	Large	5	trapnet[4] and angling	June 1 to Aug. 31[5]
	Large	5	trapnet[4] and angling	Sept. 1 to Oct. 31[5]
Northwest	Small	1,000	trapnet[4] and angling	June 1 to Aug. 31[5]
	Small	1,000	trapnet[4] and angling	Sept. 1 to Oct. 31[5]
	Large	5	trapnet[4] and angling	June 1 to Aug. 31[5]
	Large	5	trapnet[4] and angling	Sept. 1 to Oct. 31[5]

[1]Maximum of 14 gill nets of maximum length 125 feet each

[2] Maximum of 3 trapnets, 2 in the Northwest and 1 in the Southwest

[3]Harvesting permitted only between Monday 12:00 to Saturday 12:00

[4]Maximum of one trapnet

[5] Harvesting permitted only between Monday 12:00 to Saturday 12:00, allowed 7 days per week after August 29

Table 2. Catch and effort (net days) for native food fisheries on the Miramichi in 1994 for early and late runs by week, as reported by band councils.

	Burnt Church		Eel Ground				Red Bank					
	Gillnets		Gillnets			Trapnets	Trapnet (NW)		Trapnet (LSW)		Gillnets	
Week	Small	Large	Effort	Small	Large	Small	Small	Large	Small	Large	Small	Large
Early run												
May 22-28	-	-	-	-	-	-	-	-	-	-	-	-
May 29-June 4	-	-	-	-	-	-	-	-	-	-	-	-
June 5-11	-	-	-	-	-	4	-	-	-	-	-	-
June 12-18	-	-	42	45	3	3	-	-	-	-	-	-
June 19-25	-	-	60	72	5	6	-	-	-	-	-	-
June 26-July 2	-	-	41	58	5	36	-	-	-	-	-	-
July 3-9	-	-	46	34	16	51	59	0	-	-	-	-
July 10-16	-	-	48	74	16	72	131	0	-	-	-	-
July 17-23	-	-	42	21	3	81	59	0	-	-	-	-
July 24-30	-	-	12	1	1	30	76	4	5	0	-	-
July 31-Aug. 6	-	-	12	1	0	44	69	5	13	0	-	-
Aug. 7-13	-	-	10	5	0	45	62	12	28	0	-	-
Aug. 14-20	-	-	12	7	1	77	42	4	38	0	-	-
Aug. 21-27	-	-	1	4	1	30	14	0	21	0	-	-
Aug. 28-Sept. 3	-	-	-	-	-	55	43	0	25	0	-	-
(May/June)											906	4
(June)	25	28										
(July)	31	15										
Subtotal	56	43	325	322	51	534	555	25	130	0	906	4
Late run												
Sept. 4-10	-	-	-	-	-	92	37	0	35	1	-	-
Sept. 11-17	-	-	-	-	-	-	44	0	27	0	-	-
Sept. 18-24	-	-	-	-	-	-	55	0	21	0	-	-
Sept. 25-Oct. 1	-	-	-	-	-	-	76	0	26	0	-	-
Oct. 2-8	-	-	-	-	-	-	20	0	5	0	-	-
Oct. 9-15	-	-	-	-	-	-	33	0	3	0	-	-
Subtotal	-	-	-	-	-	92	265	0	117	1	-	-
Total Season	56	43	325	322	51	626	820	25	247	1	906	4
% Early run	100%	100%	100%	100%	100%	85%	68%	100%	53%	0%	100%	100%

Note: These figures do not include catch and effort data for native fishing off reserve.

Table 3. Recorded harvests of salmon in all fisheries, Miramichi River and Bay, 1951-94 (includes commercial, by-catch, recreational, and native). Kelts angled in year i are added to landings in year i-1. 1994 data are preliminary. All data are numbers X 1000.

	Commercial Fishery			Angling Fisheries: Kelts (yr i+1)			Angling Fisheries: Brights (yr i)			Angling Fisheries	Native Fishery			All Fisheries
Year	Small	Large	Total	Small	Large	Total	Small	Large	Total	All	Small	Large	Total	
1951		27.6	27.6			12.0			9.6	21.6				49.2
1952		27.3	27.3			11.3			15.9	27.2				54.5
1953		24.4	24.4			10.1	41%		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	-	-	-	11.2	0.0	11.2	-	3.0	0.1	3.1	-
1989-93 Mean							18.8				1.4	0.5	1.9	
change = (94-mean)/mean							-41%				+128%	-79%	+72%	

Note: Angling catches from 1951-68 are from DFO while catches from 1969-94 are from DNRE FISHSYS

Table 4. Recreational Atlantic salmon fishery statistics from the Miramichi River, 1994. Mean is for the years 1989 to 1993. % change represents 1994 minus mean divided by mean. Detailed catches are in Moore et al. MS1995. 1994 data are preliminary.

		Miramichi River	Northwest	Southwest
Black salmon fishery				
Effort (rod days)	1994	9,555	1,861	7,694
	Mean	10,451	1,766	8,685
	% change	-9%	5%	-11%
Small salmon	1994	925	115	810
	Mean	3,269	503	2,766
	% change	-44%	-77%	-71%
Large salmon	1994	3,403	687	2,716
	Mean	4,909	755	4,153
	% change	-31%	-9%	-35%
Bright salmon fishery				
Effort (rod days)	1994	113,376	39,471	73,905
	Mean	108,860	33,915	74,945
	% change	4%	16%	-1%
Small salmon	1994	11,203	4,131	7,072
	Mean	19,087	6,116	12,971
	% change	-41%	-32%	-455
Large salmon	1994	5,129	1,868	3,261
	Mean	8,988	2,109	6,879
	% change	-43%	-11%	-53%

Northwest Miramichi crown reserve angling			Individual stretches		
		Total	Little Southwest	Sevogle	Northwest Miramichi
Effort (rod days)	1994	2,342	529	710	1,103
	Mean	2,446	530	802	1,113
	% change	-2	0	-11	-1
Small salmon	1994	1,234	195	342	697
	Mean	1,329	173	360	796
	% change	-7	+13	-5	-12
Large salmon	1994	130	38	41	51
	Mean	115	25	35	55
	% change	+13	+52	+17	-7

Table 5. Summary of trapnet operation dates, catch and tags applied in the Miramichi River, 1994. Catch represents all fish sampled, including recaptures.

Trapnets	Time Period	Catch		Tagged	
		Small	Large	Small	Large
NW Miramichi					
Eel Ground Index	May 30 to Oct. 15	508	111	440	100
	Oct. 16 to Oct. 19	43	14	0	0
	Total for the year	551	125	440	100
Eel Ground FFT#1	May 30 to Aug. 31	384	46	40	42
(food trapnet)	Sept. 1 to Sept. 19	131	56	39	49
	Total for the year	515	102	79	91
Eel Ground Hatchery	May 30 to Aug. 31	223	63	45	50
(food trapnet)	Sept. 1 to Sept. 19	131	50	74	46
	Total for the year	354	113	119	96
Red Bank NW	July 6 to Oct. 14	1069	389	112	306
Red Bank LSW	July 26 to Oct. 14	313	105	46	87
SW Miramichi					
Enclosure	June 3 to Oct. 15	968	288	870	265
	Oct. 16 to Oct. 18	12	5	8	3
	Total for the year	980	293	878	268
Millerton	June 15 to Oct. 15	2531	822	2070	741
	Oct. 16 to Oct. 24	153	142	0	0
	Total for the season	2684	964	2070	741

Table 6. Distributions, by life stage, of Atlantic salmon to the Miramichi River from the Miramichi Salmonid Enhancement Centre in 1994. Stock refers to location where spawners were collected.

Stock:
DUN = Dungarvon
NWM = N.W. Mir.
RBK = Rocky Brook
LSW = L.S.W.MIR.
BBK = Black Brook
JUN = Juniper
SEV = Sevogle
CLR = Clearwater

Stage:
A = Adult
2+SM = 2 year smolt
1+SM = 1 year smolt
1+ PR = 1+ parr
0+ PR = 0+ parr
FF = feeding fry
NFF = non-feeding fry

Mark:
AC = Adipose Clip
NT = Wire Nose Tag
NM = No Mark
BR = Brand

Date	Stock	Stage	Mark	River	Distribution Site/#	Number	Total
Southwest Miramichi System							
04-19-94	DUN	2+SM	AC	DUNGARVON	HALFWAY INN	12,553	
03-18-94	DUN	2+SM	AC	RENOUS	PONDS OUTFLOW	270	
04-20-94	DUN	2+SM	AC	DUNGARVON	HALFWAY INN	11,098	
04-20-94	DUN	2+SM	AC	S.BR. RENOUS	REDROCK	6,284	30,205
04-15-94	DUN	1+SM	AC	DUNGARVON	HALFWAY INN	2,867	2,867
04-20-94	DUN	2+PR	AC	DUNGARVON	HALFWAY INN	1,540	
04-20-94	DUN	2+PR	AC	S.BR. RENOUS	REDROCK	761	
04-19-94	DUN	2+PR	AC	DUNGARVON	HALFWAY INN	2,741	5,042
09-30-94	BBK	* 0+PR	NM	S.W. MIR.	ROCKY BROOK (6 SITES)	9,140	
09-27-94	BBK	* 0+PR	NM	S.W. MIR.	ROCKY BROOK (3 UPSTR	4,885	
09-23-94	BBK	* 0+PR	NM	S.W. MIR.	SISTERS BROOK (4 SITES	3,200	
10-03-94	BBK	* 0+PR	NM	S.W. MIR.	SALMON BROOK	2,335	
09-27-94	BBK	* 0+PR	NM	S.W. MIR.	ROCKY BEND (4 SITES)	4,388	
10-04-94	BBK	* 0+PR	NM	S.W. MIR.	CLEARWATER (4 SITES)	4,500	
10-03-94	BBK	* 0+PR	NM	S.W. MIR.	SW MIR.	2,500	
10-05-94	BBK	* 0+PR	NM	S.W. MIR.	SW MIR.	1,450	
10-06-94	BBK	* 0+PR	NM	S.W. MIR.	KELLY BROOK	2,410	
10-06-94	BBK	* 0+PR	NM	S.W. MIR.	GREY RAPIDS BROOK	2,410	
10-05-94	BBK	* 0+PR	NM	S.W. MIR.	MacKENZIE BROOK	1,600	
10-05-94	BBK	* 0+PR	NM	CAINS R.	BLACK BROOK (3 SITES)	7,000	
10-05-94	BBK	* 0+PR	NM	S.W. MIR.	SIX MILE BROOK	2,280	
10-05-94	BBK	* 0+PR	NM	S.W. MIR.	CAMP THOMAS BROOK	1,600	
09-27-94	RBK	* 0+PR	NM	S.W. MIR.	GILLMAN BK. (5 SITES)	5,000	
10-03-94	CLR	* 0+PR	NM	S.W. MIR.	BURNTHILL BROOK	2,400	
10-03-94	RBK	* 0+PR	NM	S.W. MIR.	BUTTERMILK BROOK	1,200	
10-03-94	RBK	* 0+PR	NM	S.W. MIR.	DEADMAN BROOK	1,216	59,514
07-29-94	BBK	FF	NM	MORSE BROOK	PROV.PRK RT. 8	5,367	5,367
06-10-94	CLR	NFF	NM	CLEARWATER	CLRWTR BDG	12,000	
06-10-94	BBK	NFF	NM	MORSE BRK	RT. 8 CROSSING	17,000	
06-10-94	RBK	NFF	NM	SISTERS	UPPER SITE RD XING	17,000	
06-10-94	CLR	NFF	NM	SISTERS	UPPER SITE RD XING	12,000	58,000
Northwest Miramichi System							
04-22-94	NWM	2+SM	AC	N.W.MIR.	GILL BROOK	21,147	
05-16-94	NWM	2+SM	AC	LITTLE RIVER	UPP. SITE	1,469	
04-21-94	NWM	2+SM	AC	N.W.MIR.	GILL BROOK	15,315	
05-20-94	JUN	2+SM	AC	MILLSTREAM	CHAPLIN ISL RD	1,264	39,195
04-27-94	NWM	1+SM	AC	N.W.MIR.	MINERS BRIDGE	2,236	2,236
04-22-94	NWM	2+PR	AC	N.W.MIR.	GILL BROOK	4,180	
04-21-94	NWM	2+PR	AC	N.W.MIR.	GILL BROOK	4,102	
05-16-94	NWM	2+PR	AC	LITTLE RIVER	UPP. SITE	261	
05-20-94	JUN	2+PR	AC	MILLSTREAM	CHAPLIN ISL RD	206	8,749
10-03-94	NWM	* 0+PR	NM	N.W. MIR.	NW MIR.	3,900	
10-??-94	SEV	* 0+PR	NM	S.BR.SEVOGLE	S.B. SEVOGLE	7,200	11,100
06-11-94	SEV	NFF	NM	N.BR.SEVOGLE		15,000	
06-11-94	SEV	NFF	NM	S.BR.SEVOGLE		10,000	
06-11-94	LSW	NFF	NM	LSW MIR.	PARKS BROOK	10,000	
06-11-94	SEV	NFF	NM	N.BR.SEVOGLE		5,000	
06-11-94	SEV	NFF	NM	S.BR.SEVOGLE	SOUTH BRANCH	20,000	
06-11-94	SEV	NFF	NM	S.BR.SEVOGLE	HEADWATERS OF THE	20,000	
06-11-94	SEV	NFF	NM	S.BR.SEVOGLE		10,000	
06-11-94	SEV	NFF	NM	S.BR.SEVOGLE	SEVOGLE RIVER.	20,000	
06-12-94	LSW	NFF	NM	LSW MIR.	DEVILS BROOK	5,000	
06-12-94	LSW	NFF	NM	LSW MIR.	L. NRTH POLE BK	10,000	
06-12-94	LSW	NFF	NM	LSW MIR.	UP NRT POLE WST RD	15,000	
06-12-94	LSW	NFF	NM	LSW MIR.	WARDENS CMP, CORNEI	10,000	
06-12-94	LSW	NFF	NM	LSW MIR.	INDIAN BROOK	5,000	
06-12-94	LSW	NFF	NM	LSW MIR.	MAIN LIBBIES BRK	5,000	
06-12-94	LSW	NFF	NM	LSW MIR.	LWR LIBBIES BRK	5,000	
06-12-94	LSW	NFF	NM	LSW MIR.	UP NRT POLE EST RD	10,000	
06-12-94	LSW	NFF	NM	LSW MIR.	WEST BRK	10,000	
06-11-94	SEV	NFF	NM	S.BR.SEVOGLE		5,000	
06-11-94	SEV	NFF	NM	S.BR.SEVOGLE		25,000	
06-11-94	LSW	NFF	NM	LSW MIR.	TUADOOCK R.	20,000	
06-11-94	SEV	NFF	NM	S.BR.SEVOGLE	FISH WERE DISTRIBUTEI	10,000	
06-11-94	SEV	NFF	NM	S.BR.SEVOGLE	STREAM TO THE	20,000	
06-11-94	SEV	NFF	NM	S.BR.SEVOGLE	MOUTH OF CLEARWATEI	10,000	
06-11-94	SEV	NFF	NM	S.BR.SEVOGLE	TO SITES FROM	15,000	290,000
Transfers to rearing facilities in 1994							
07-14-94	DUN	1+PR	Southwest	RENOUS PONDS		81,000	81,000
07-19-94	NWM	1+PR	Northwest	RENOUS PONDS		66,700	66,700
06-29-94	NW92C	1+PR	Northwest	McCormack LK	Heath Steele	3,000	3,000
	DUN	0+PR	Southwest	ATLANTIC INSTITUTION		35,000	35,000
	NWM	0+PR	Northwest	ATLANTIC INSTITUTION		85,000	85,000

* fall stocking from transfers in the spring of 80,000 feeding fry to the 20 satellite rearing facilities.

Table 7. Broodstock collections from the Southwest and Northwest Miramichi in 1994.

Stock	Date	Large Female	Large Male	Small Female	Small Male	Collection location
Southwest Miramichi						
Dungarvon	Sept.14/94	26	9	0	18	Dunarvon Barrier
Cains	Sept.07/94	1	0	0	3	Brophy's Pool
Cains	Oct.4/94	2	0	0	2	Angled @ mouth of Caines R.
Cains	Oct.5/94	2	0	0	0	Angled @ mouth of Caines R.
Clearwater	Sept.08/94	7	1	0	6	Clearwater bridge pool
Rocky Brk	Sept.08/94	5	0	0	5	Cold spring pool
Subtotal		43	10	0	34	
Northwest Miramichi						
LSW Mir.	Sept.10/94	12	1	0	2	Moose Landing
LSW Mir.	Sept.10/94	3	0	12	12	Smith Forks
LSW Mir.	Sept.22/94	2	0	0	14	Moose Landing
LSW Mir.	Sept.22/94	3	0	1	4	Smith Forks
LSW Mir.	Oct.8/95	11	0	0	4	Moose Landing
LSW Mir.	Oct.8/95	14	1	0	13	Smith Forks
Sevogle	Sept.18/94	0	2	0	8	Cruick shank pool
NW Mir	Sept.06/94	2	0	0	2	NW Barrier
Subtotal		47	4	13	46 *	
Total for 1994		90	14	13	80	

	Large Female	Large Male	Small Female	Small Male
Southwest Miramichi				
Dungarvon	26	9	0	18
Cains	5	0	0	5
Rocky Brook	5	0	0	5
Clearwater	7	1	0	6
Subtotal	43	10	0	34
Northwest Miramichi				
L.S.W.Mir.	45	2	13	49
Sevogle	0	2	0	8
N.W.Mir.	2	0	0	2
Subtotal	47	4	13	46
Total	90	14	13	80
	104		**93**	

* 13 small salmon males collected during broodstock seining in the LSW Miramichi were returned to the river before spawning

Table 8. Point estimates of the emigration rates of tagged fish out of the branch in which they were tagged. Only tags placed up to Oct. 15 are used. For Northwest Eel Ground traps, tags placed at food fishery and index trapnets during the early-run are used whereas only tags from the index trap are used for the late-run. Southwest tags were placed at Enclosure and Millerton traps. Recaptures are tag returns from angling in 1994.

Small Salmon

Total

From \ To:	Northwest	Southwest	Total Tags	% residence	% emigration
Northwest	11	13	525	63.3%	36.7%
Southwest	11	176	2940	88.7%	11.3%

(Point Estimates: % residence, % emigration)

Early run

From \ To:	Northwest	Southwest	Total Tags	% residence	% emigration
Northwest	10	5	246	64.5%	35.5%
Southwest	3	63	1148	95.9%	4.1%

Late run

From \ To:	Northwest	Southwest	Total Tags	% residence	% emigration
Northwest	1	8	279	125.7%	.
Southwest	8	113	1792	-56.6%	.

Combined large and small salmon

Total

From \ To:	Northwest	Southwest	Total Tags	% residence	% emigration
Northwest	11	16	717	62.9%	37.1%
Southwest	12	208	3946	87.5%	12.5%

Early

From \ To:	Northwest	Southwest	Total Tags	% residence	% emigration
Northwest	10	7	356	62.6%	37.4%
Southwest	3	67	1340	95.0%	5.0%

Late

From \ To:	Northwest	Southwest	Total Tags	% residence	% emigration
Northwest	1	9	361	126.7%	.
Southwest	9	141	2606	-58.0%	.

Table 9. Robustness of emigration rate estimate and estimate of returns of small and large salmon to each branch and to the whole river in 1994.

Angling		NW	SW				
Residence rate		0.614	0.882				
	Tags	Moved to		Recaptures in		Recapture rates in	
Origin	Small	NW	SW	NW	SW	NW	SW
NW	609	374	235	13	24	0.035	0.102
SW	878	104	774	29	66	0.084	0.085
Millerton	2061	243	1818		**Migrant / resident =**	*2.405*	*1.198*
	Large	NW	SW	NW	SW	NW	SW
NW	297	182	115	8	14	0.044	0.122
SW	268	32	236	3	10	0.025	0.042
Millerton	749	88	661		**Migrant / resident =**	*0.570*	*2.887*

Adjusted		NW	SW			
Residence rates		0.457	0.829			
		Moved to			Recapture rates in	
Origin	Small	NW	SW		NW	SW
NW		278	331		0.047	0.073
SW+Mill		503	728	**Migrant /**	0.058	0.091
				resident =	*1.235*	*0.800*
	Large	NW	SW		NW	SW
NW		136	161		0.059	0.087
SW+Mill		174	222	**Migrant /**	0.017	0.045
				resident =	*0.293*	*1.929*

Peterson estimates of returns

	Small		Large	
	Angling	Adjusted	Angling	Adjusted
Northwest	23578	25546	12589	12892
Southwest	28041	29404	13324	14555
Miramichi	51619	54950	25913	27447

% change (adjusted - angling / angling)

	Small	Large
Northwest	8.3%	2.4%
Southwest	4.9%	9.2%
Miramichi	6.5%	5.9%

Table 10. Removals of Atlantic salmon by size and season from the Northwest Miramichi, Southwest Miramichi and Miramichi River systems in 1994.

	Northwest Miramichi			Southwest Miramichi			Estuary	Miramichi River		
	Early	Late	Total	Early	Late	Total	Early	Early	Late	Total
Small salmon										
Food fisheries	2,447	474	2,921	0	0	0	56	2,503	474	2,977
Angling	3,456	675	4,131	4,375	2,697	7,072	0	7,831	3,372	11,203
Broodstock	46	0	46	34	0	34	0	80	0	80
Scientific sampling and incidental mortalities	9	0	9	130	38	168	0	139	38	177
Total	5,958	1,149	7,107	4,539	2,735	7,274	56	10,553	3,884	14,437
Large salmon										
Food fisheries	80	1	81	0	0	0	43	123	1	124
Angling	42	14	56	55	43	98	0	97	57	154
Broodstock	51	0	51	53	0	53	0	104	0	104
Scientific sampling and incidental mortalities	0	0	0	13	2	15	0	13	2	15
Total	173	15	188	121	45	166	43	337	60	397

Note: 1. Large salmon angling kills are calculated from DNRE angling catches assuming a catch-and-release mortality rate of 0.03.
2. Food fishery harvests are values reported by First Nations.

Table 11. Sex ratio of small salmon (% females) by trap, season, and river system for 1994.

	Early Run	Late Run	X^2	P.value	DF
NW Eel Ground	32.63%	11.90%	61.667	0.000	1
NW Red Bank	33.40%	12.08%	65.750	0.000	1
X^2	0.062	0.008	average	NW Miramichi	
P. value	0.804	0.927	early:	33.05%	
DF	1	1	late:	11.98%	

	Early Run	Late Run	X^2	P.value	DF
SW Enclosure	24.24%	12.02%	4.120	0.042	1
SW Millerton	21.05%	14.35%	1.975	0.160	1
X^2	0.123	1.600	average	SW Miramichi	
P. value	0.726	0.206	early:	22.22%	
DF	1	1	late:	13.77%	

	Early Run	Late Run	X^2	P.value	DF
NW Miramichi	33.05%	11.98%	128.178	0.000	1
SW Miramichi	22.22%	13.77%	5.052	0.025	1
X^2	4.420	1.867	average	Miramichi	
P. value	0.036	0.172	early:	32.11%	
DF	1	1	late:	13.13%	

Table 12. Sex ratios of small and large salmon from broodstock collections and at the Renous partial fence in 1994.

	Small Salmon			Large Salmon		
	total females	total males	% females	total females	total males	% females
Broodstock collection						
LSW (Sept. 10, 94)	73	45	61.9	15	1	93.8
Sevogle (Sept. 18, 94)	72	91	44.2	87	2	97.8
Dungarvon (Sept. 14, 94)	92	113	44.9	75	8	90.4
Counting Fence						
Renous (Aug.17-Nov.2)	74	429	14.7	102	53	65.8

Table 13. Sex ratios of large salmon (% females) by trap, season, and river system for 1994.

	Early Run	Late Run	X^2	P.value	DF
NW Eel Ground	N/A	72.82%	-	-	-
NW Red Bank	N/A	77.64%	-	-	-
X^2	-	1.518	average	NW Miramichi	
P. value	-	0.218	early:	N/A	
DF	-	1	late:	75.79%	

	Early Run	Late Run	X^2	P.value	DF
SW Enclosure	N/A	80.93%	-	-	-
SW Millerton	N/A	81.74%	-	-	-
X^2	-	0.068	average	SW Miramichi	
P. value	-	0.795	early:	N/A	
DF	-	1	late:	81.57%	

	Early Run	Late Run	X^2	P.value	DF
NW Miramichi	N/A	75.79%	-	-	-
SW Miramichi	N/A	81.57%	-	-	1
X^2	-	6.710	average	Miramichi	
P. value	-	0.010	early:	N/A	
DF	-	1	late:	79.51%	

Table 14 . Biological characteristics (fork length, sex ratio and fecundity) of small and large salmon sampled at the Southwest and Northwest Miramichi trapnets.

	Small Salmon		Large Salmon	
	Estimate	Std. Dev.	Estimate	Std. Dev.
Northwest Miramichi				
% Female				
Early	33.05		-	
Late	11.98		75.79	
Total	21.99		75.79	
Fork length				
Early	53.3	2.58	77.7	7.96
Late	56.3	2.75	78.1	7.58
Total	55.3	3.05	77.9	7.71
Fecundity (eggs per fish)*				
Early	1033		5598	
Late	445		5639	
Total	772		5630	
% Previous spawners				
Early			29.3	
Late			31.4	
Total			30.6	
Southwest Miramichi				
% Female				
Early	22.22		-	
Late	13.77		81.57	
Total	14.15		81.57	
Fork length				
Early	54.5	2.85	78.1	8.00
Late	56.8	2.74	77.6	7.23
Total	55.8	2.99	77.7	7.38
Fecundity (eggs per fish)*				
Early	745		-	
Late	527		5588	
Total	671		5609	
% Previous spawners				
Early			29.3	
Late			27.6	
Total			28.0	

* Note: Eggs per fish calculations are based on fecundity length relationship and sex ratios (Randall 1989).
Eggs per spawner (small) = $\%Female * e^{[3.1718 * Ln(FL) - 4.5636]}$
Eggs per spawner (large) = $\%Female * e^{[1.4132 * Ln(FL) + 2.7560]}$

Table 15. Estimated returns and escapement to the Miramichi River (to Millbank 1971 to 1991; to enclosure area 1992 to 1994) of small and large salmon. % change is 1994 minus mean relative to the mean.

Year	Returns to the Estuary		Escapement	
	Small Salmon	Large Salmon	Small Salmon	Large Salmon
1971	35,673	24,407	21,946	4,347
1972	46,275	29,049	27,135	17,671
1973	44,545	27,192	30,688	20,349
1974	73,418	42,592	55,186	34,445
1975	64,902	28,817	48,469	21,448
1976	91,580	22,801	62,380	14,332
1977	27,743	51,842	13,247	32,917
1978	24,287	24,493	14,353	10,829
1979	50,9656	9,054	30,848	4,541
1980	41,588	36,318	26,894	18,873
1981	65,273	16,182	39,929	4,608
1982	80,379	30,758	56,000	13,258
1983	25,184	27,924	14,849	8,458
1984	29,707	15,137	18,929	14,687
1985	60,800	20,738	41,815	20,122
1986	117,549	31,285	89,398	30,216
1987	84,816	19,421	62,777	18,056
1988	121,919	21,745	90,278	20,980
1989	73,231	17,211	48,385	15,540
1990	83,148	28,574	59,524	27,588
1991	60,869	29,949	48,269	29,089
1992	152,647	37,000	129,288	35,927
1993	92,400	35,200	76,416	34,702
1994	56,929	27,544	42,479	27,147
% change 5-year	-39%	-7%	-41%	-5%
historical	-16%	+1%	-12%	+38%

Table 16. Counts of migrant parr, smolts, small salmon and large salmon at Catamaran Brook, Northwest Miramichi 1990 to 1994. Data from Cunjak (1995). 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	850[1]	760	83[1]	28[1]	0.104	0.084
1991	2183	1515	79	48	0.084	0.029
1992	1434	2429	127	64	0.044	0.010
1993	1360	515	107	44	0.109	
1994	2359	1002	56	24		

[1] incomplete count because of damage to counting fence

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

Tributary	Year	Large	Small	Total	Dates Operated	No. of Days
North Branch of SW Miramichi River						
	1981	54	671	725	Jul. 5-Oct. 4	92
	1982	282	621	903	Jun. 30-Oct. 8	101
	1983	219	290	509	Jul. 4-Oct. 10	99
	1984	297	230	527	Jul. 10-Oct. 16	99
	1985	604	492	1096	Jul. 1-Oct. 20	112
	1986	1138	2072	3210	Jun. 30-Oct. 19	110
	1987	1266	1175	2441	Jul. 2-Oct. 19	110
	1988	929	1092	2021	Jun. 30-Oct. 24	117
	1989	731	969	1700	Jul. 1-Oct. 24	116
	1990	994	1646	2640	Jun. 29-Oct. 14	108
	1991	476	495	971	Jun. 30-Oct. 21	107
	1992	1047	1383	2430	Jun. 30-Oct. 20	113
	1993	1145	1349	2494	Jun. 30-Oct. 22	115
	1994	877	1223	2100	June 29-Oct. 30	124
	1989-93 Mean	879	1168	2047		
	Change (94-mean)/mean	0%	+5%	+3%		
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
	1989-93 Mean	249	593	842		
	Change (94-mean)/mean	-39%	-40%	-39%		
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
	1989-93 Mean	255	1050	1305		
	Change (94-mean)/mean	-11%	-36%	-31%		

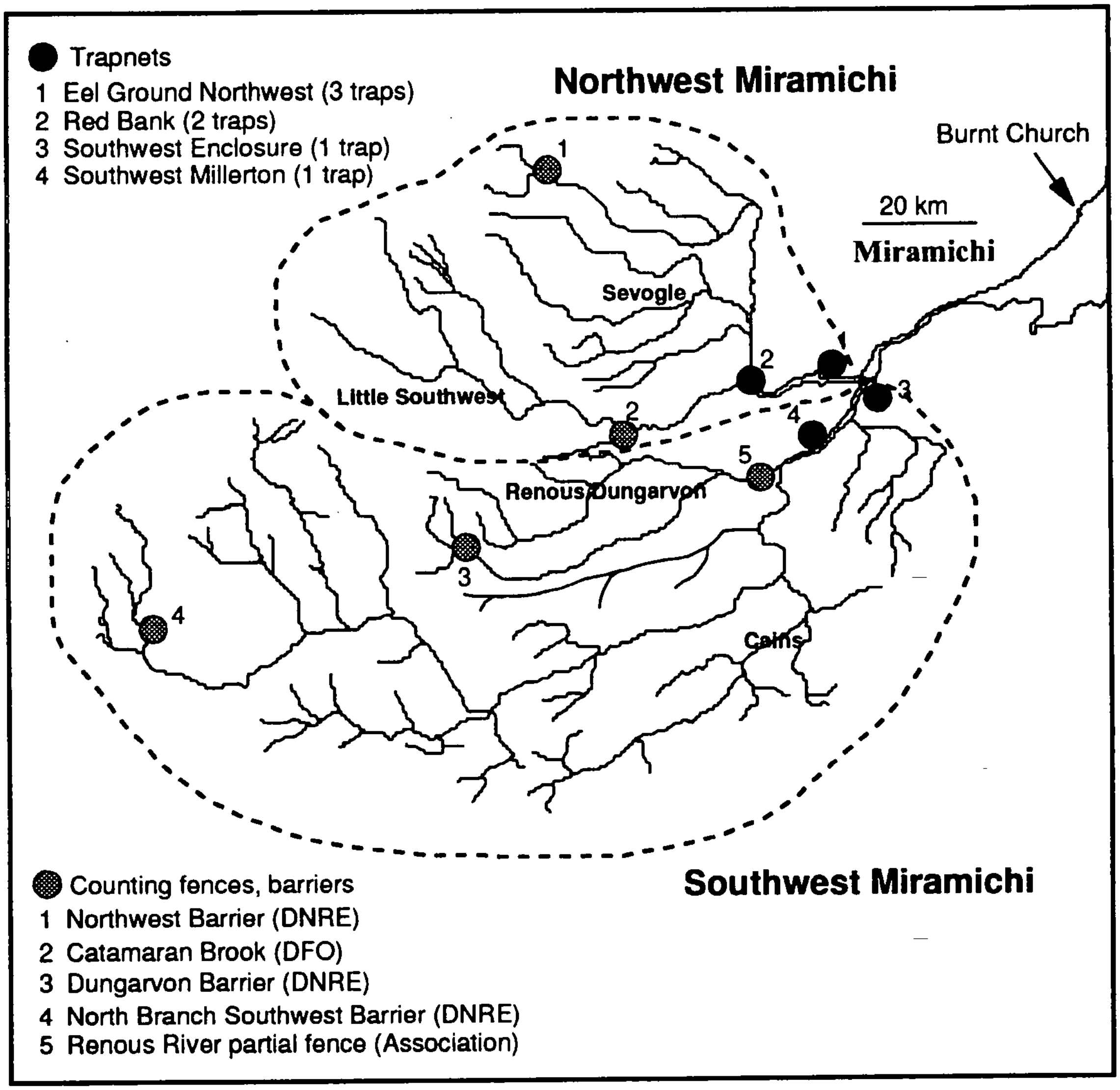
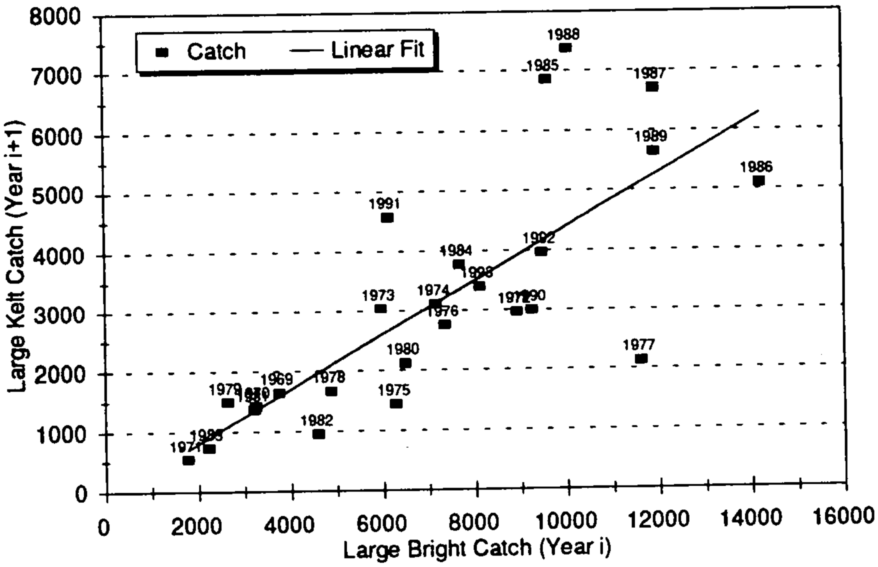


Figure 1. The Miramichi River indicating major branches, major tributaries and location of trapnets and counting fences operated in 1994.



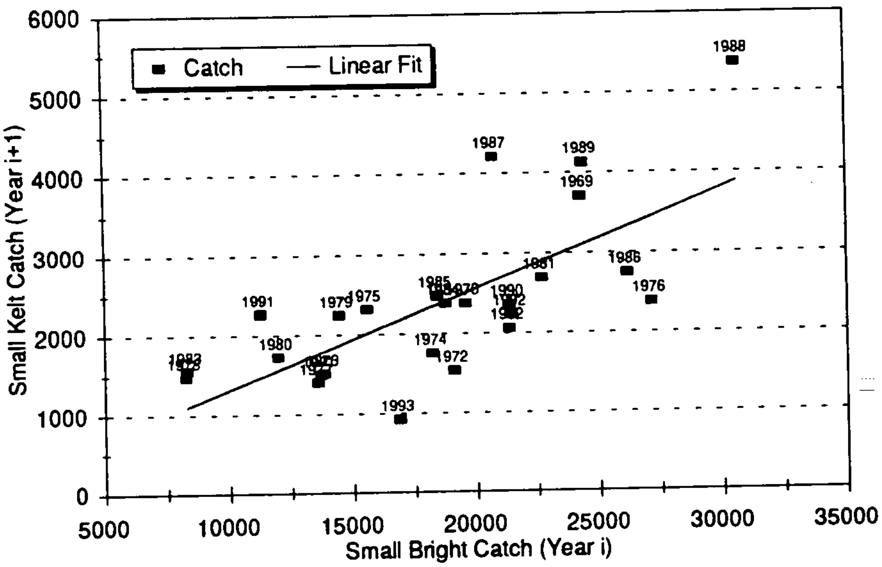


Figure 2. Catch of kelts in year (i+1) relative to catch of bright salmon in year i, for large (upper) and small (lower) salmon, Miramichi River.

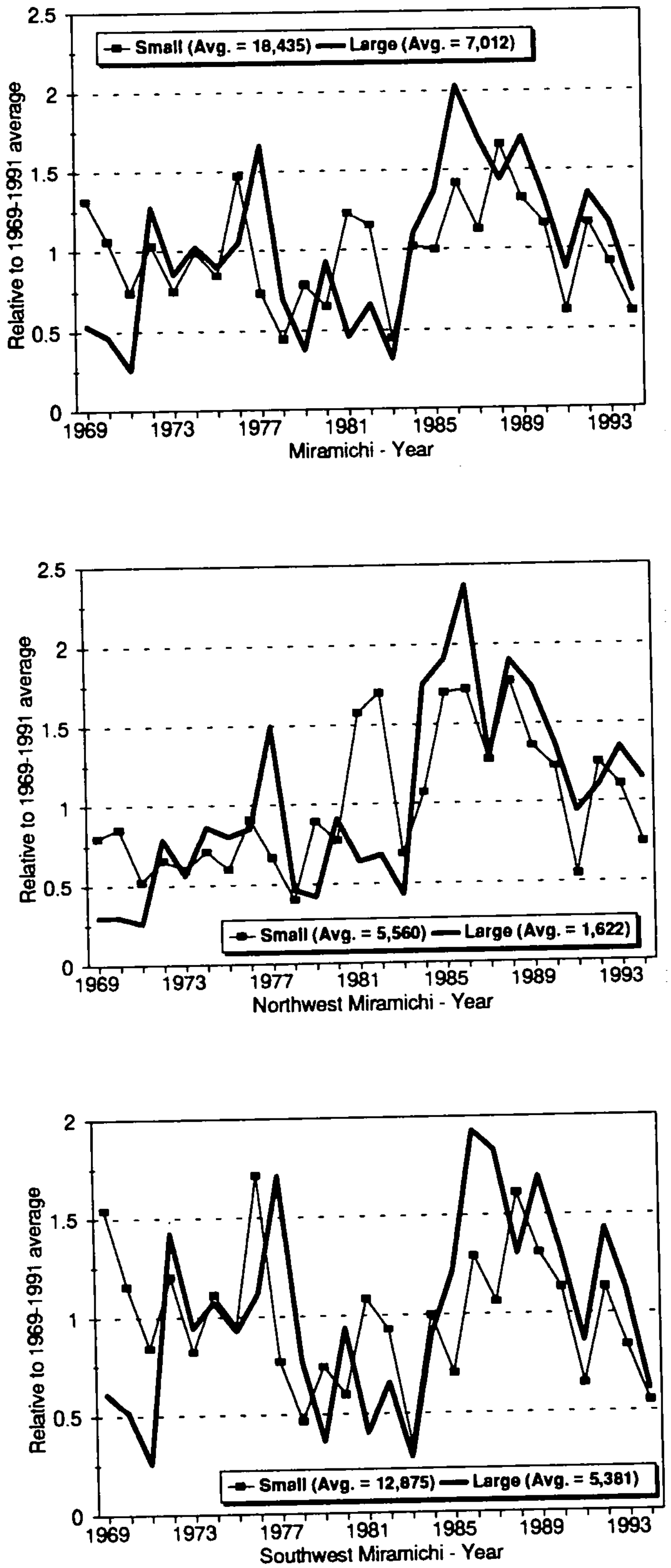


Figure 3. Trends, relative to the long-term mean (1969 to 1991), in angling catches of small and large salmon from the Miramichi River (top), Northwest Miramichi (middle) and Southwest Miramichi (bottom).

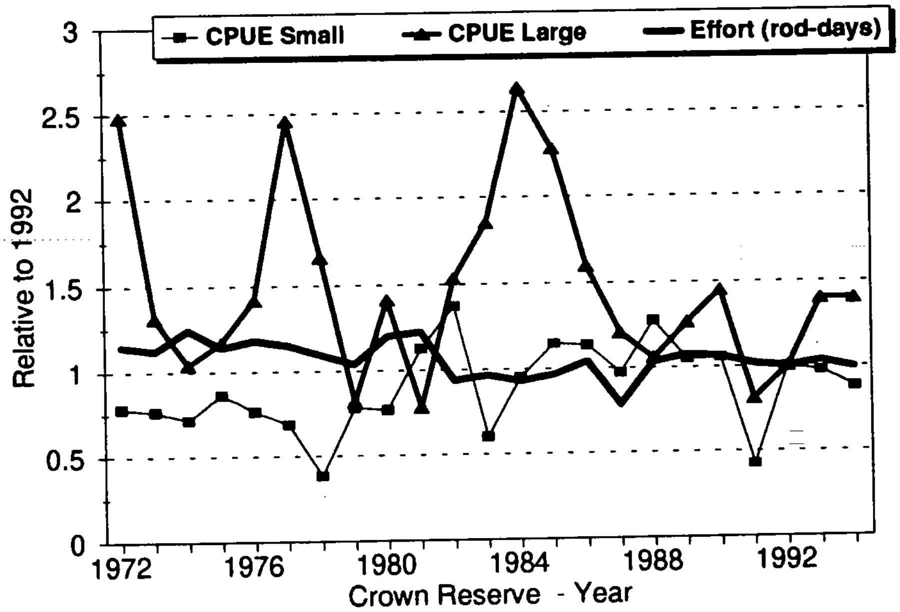


Figure 4. Trends in effort and CPUE of small and large salmon catches from the Crown Reserve waters of the Northwest Miramichi, 1972 to 1994.

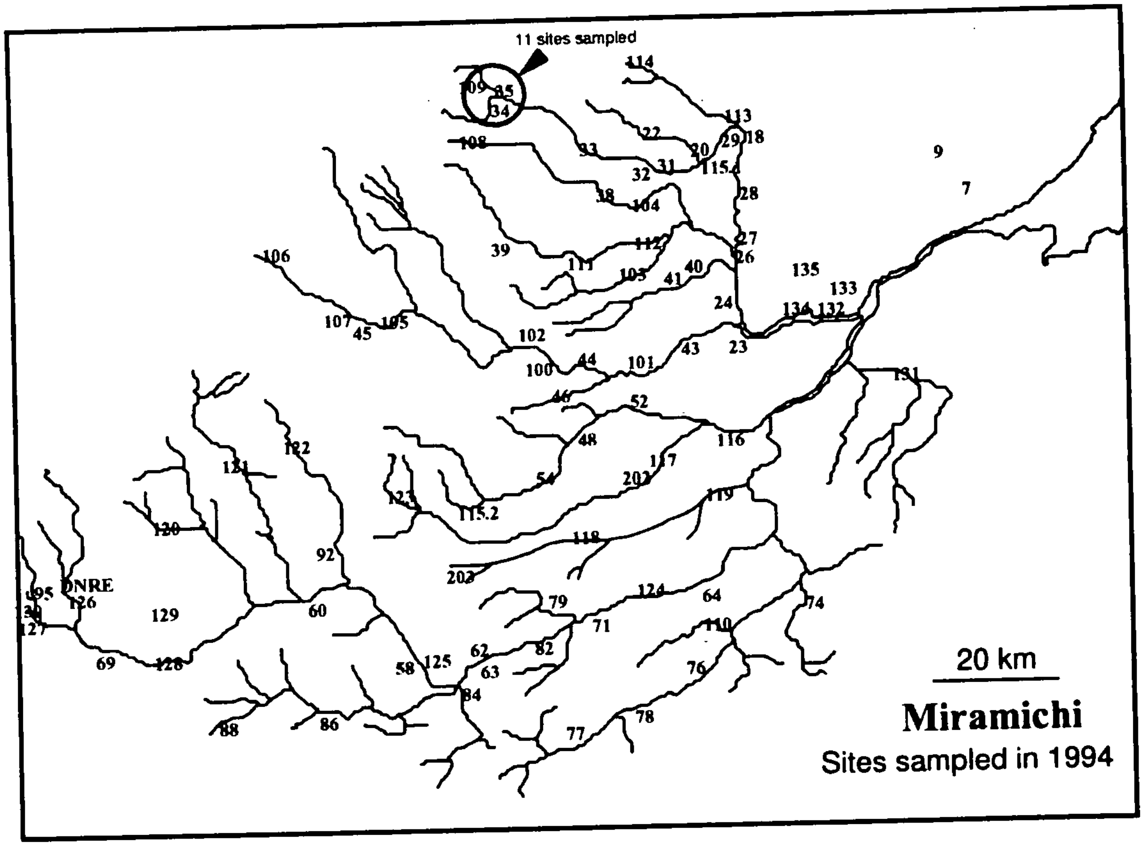


Figure 5. Juvenile salmon electrofishing sites, identified by sequential site number, sampled in 1994.

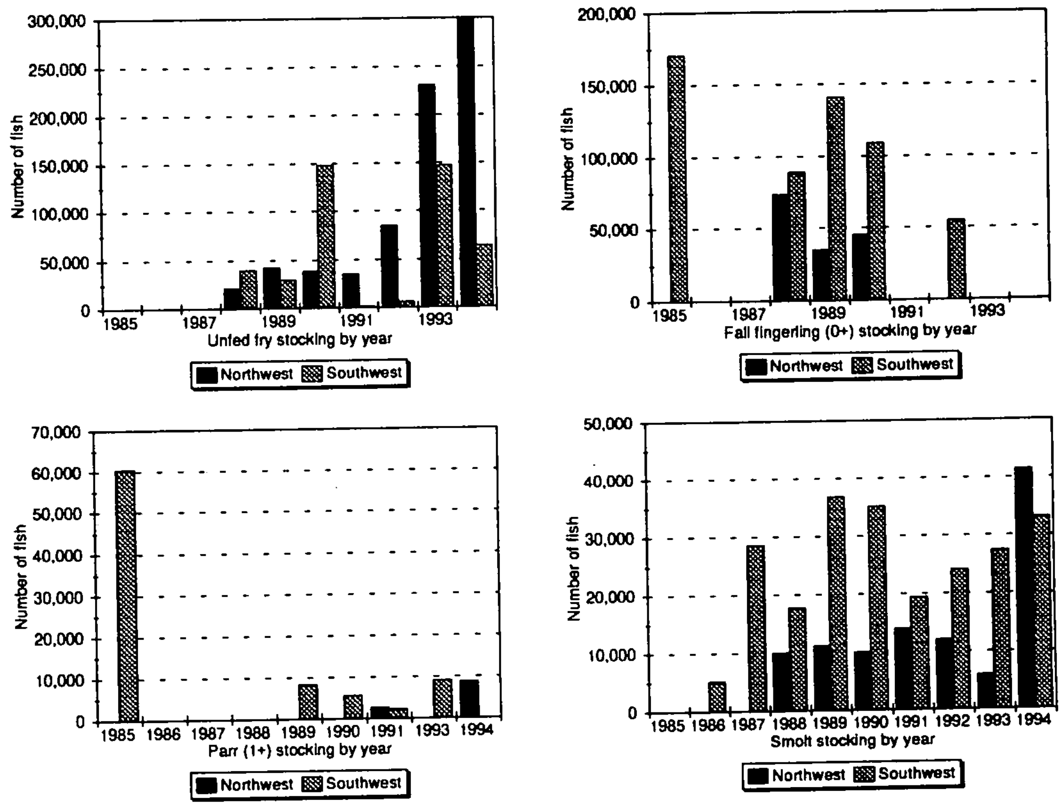


Figure 6. Summary of distributions of Atlantic salmon by life stage to the Northwest and Southwest Miramichi for 1985 to 1994. Summary of fall fingerling stocking excludes satellite rearing projects.

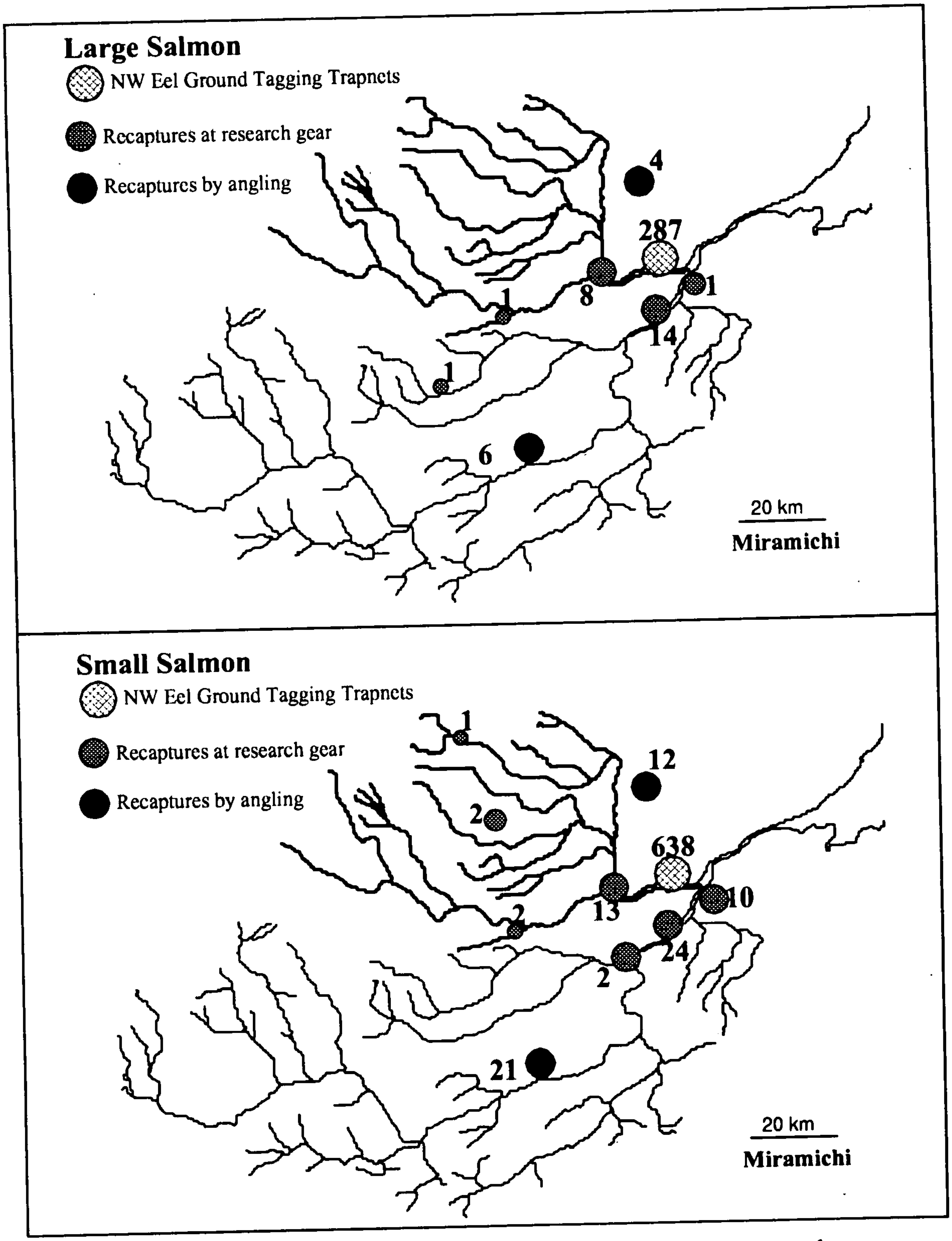


Figure 7. Recovery locations and gears of small and large salmon tagged at Eel Ground trapnets, Northwest Miramichi River, 1994.

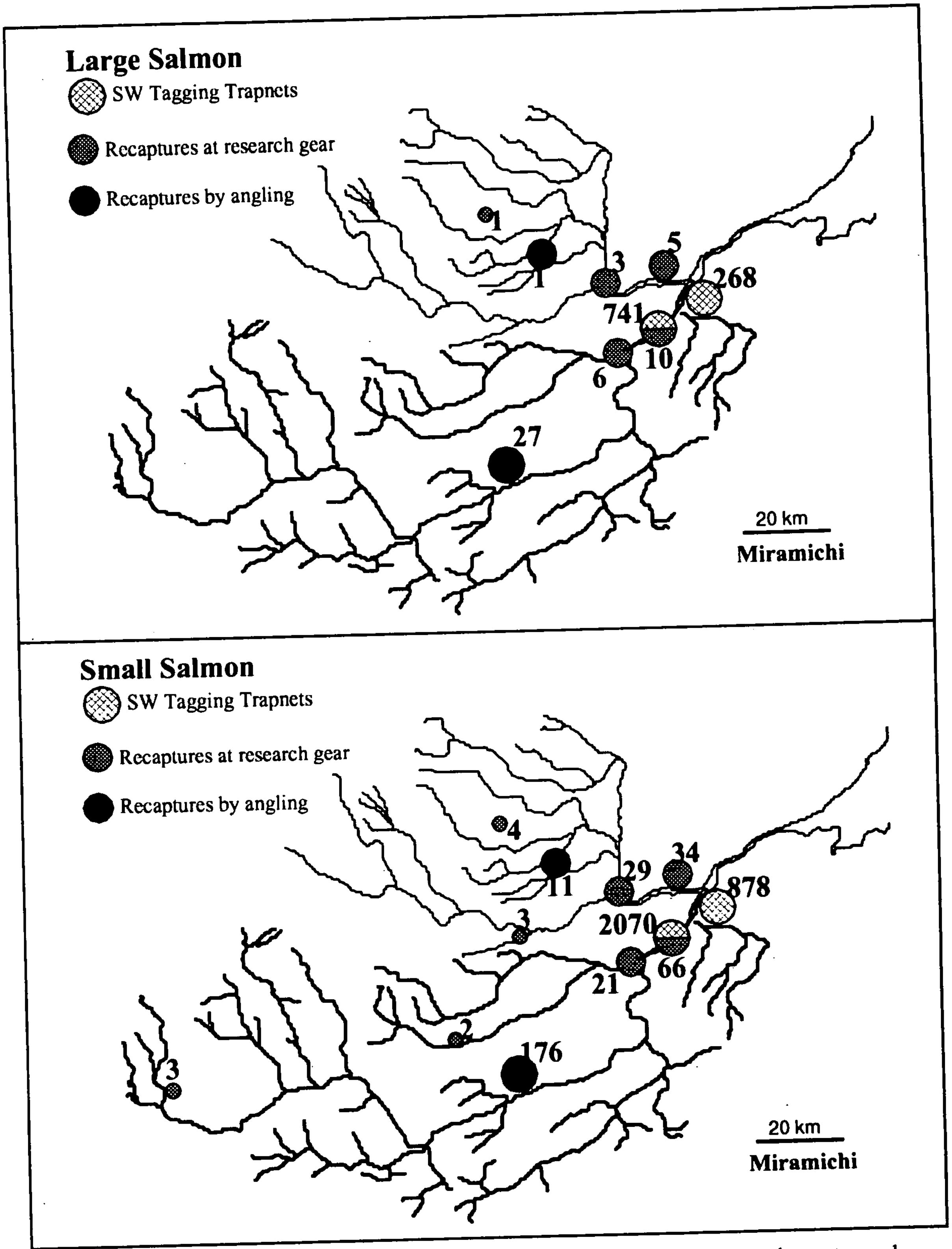


Figure 7 (cont'd). Recovery locations and gears of small and large salmon tagged at the Enclosure and Millerton trapnets in the Southwest Miramichi, 1994.

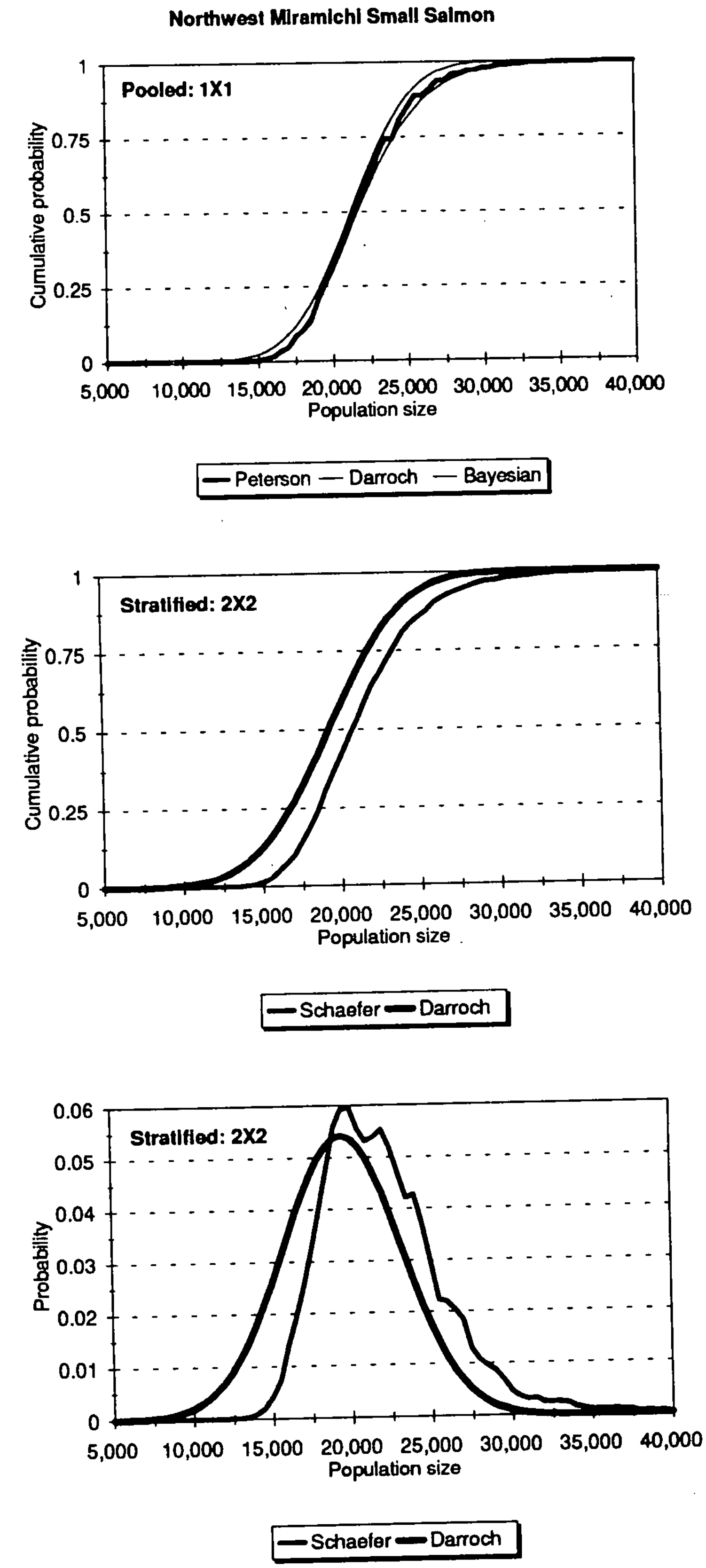
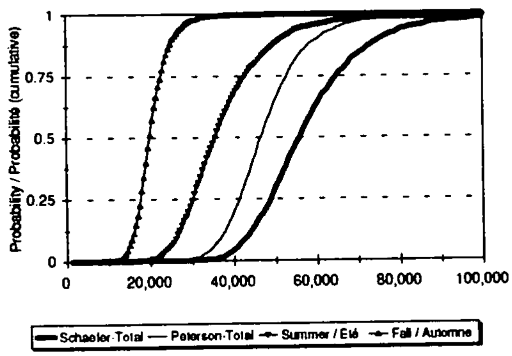


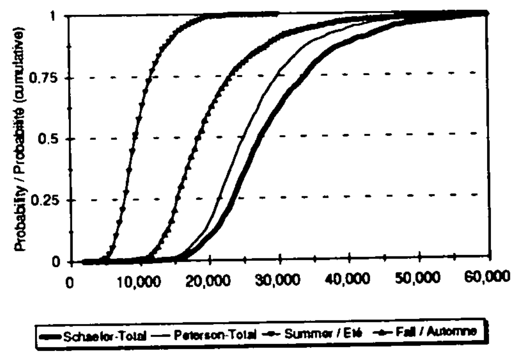
Figure 8. Comparison of the resampling population estimation algorithm used in 1994 to other population estimation procedures. Mark, recapture and catch vectors were for small salmon from the Northwest Miramichi. Marks available were fixed for residence rates of 0.614 for Northwest tags and 0.882 for Southwest tags plus a tag retention rate of 0.90.

Miramichi River - small salmon



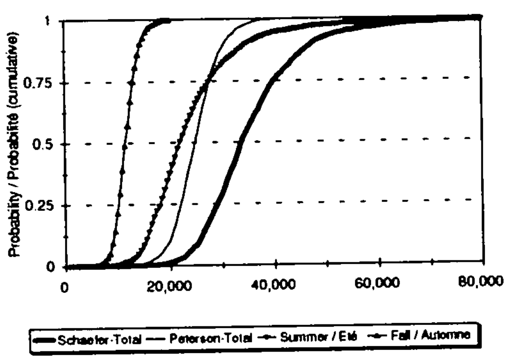
Schaefer	Median	Perc 5	Perc 95
Summer / Eté	35500	24100	57433
Fall / Automne	19900	14700	27850
Total	55925	40545	82950

Miramichi River - large salmon



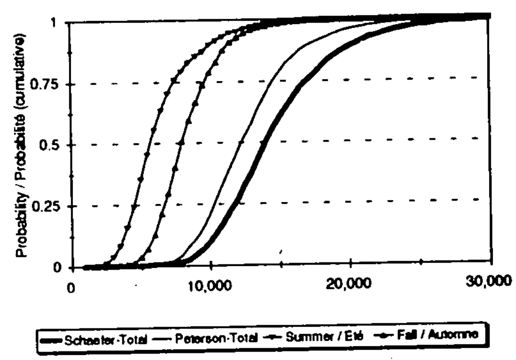
Schaefer	Median	Perc 5	Perc 95
Summer / Eté	8900	5478	16250
Fall / Automne	18025	11900	35195
Total	27450	18278	47023

Southwest Miramichi - small salmon



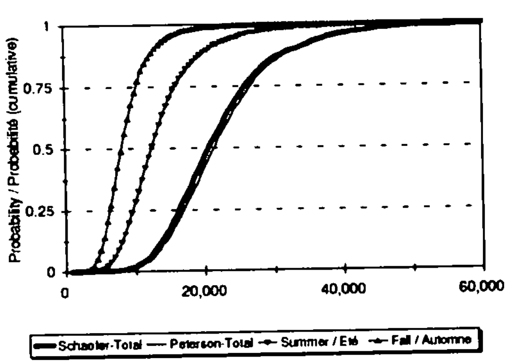
Schaefer	Median	Perc 5	Perc 95
Summer / Eté	21850	13950	41300
Fall / Automne	11600	8500	15550
Total	33775	23450	54150

Southwest Miramichi - large salmon



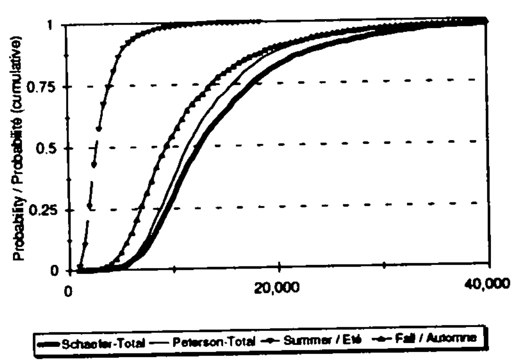
Schaefer	Median	Perc 5	Perc 95
Summer / Eté	5775	3200	11850
Fall / Automne	8000	5300	12700
Total	14000	9100	22850

Northwest Miramichi - small salmon



Schaefer	Median	Perc 5	Perc 95
Summer / Eté	12400	6750	24925
Fall / Automne	8100	4500	14950
Total	20600	11750	38525

Northwest Miramichi - large salmon



Schaefer	Median	Perc 5	Perc 95
Summer / Eté	2750	1250	6950
Fall / Automne	9450	4650	25750
Total	12600	6450	31300

Figure 9. Estimated returns of small and large salmon by branch and season to the Miramichi River, 1994.

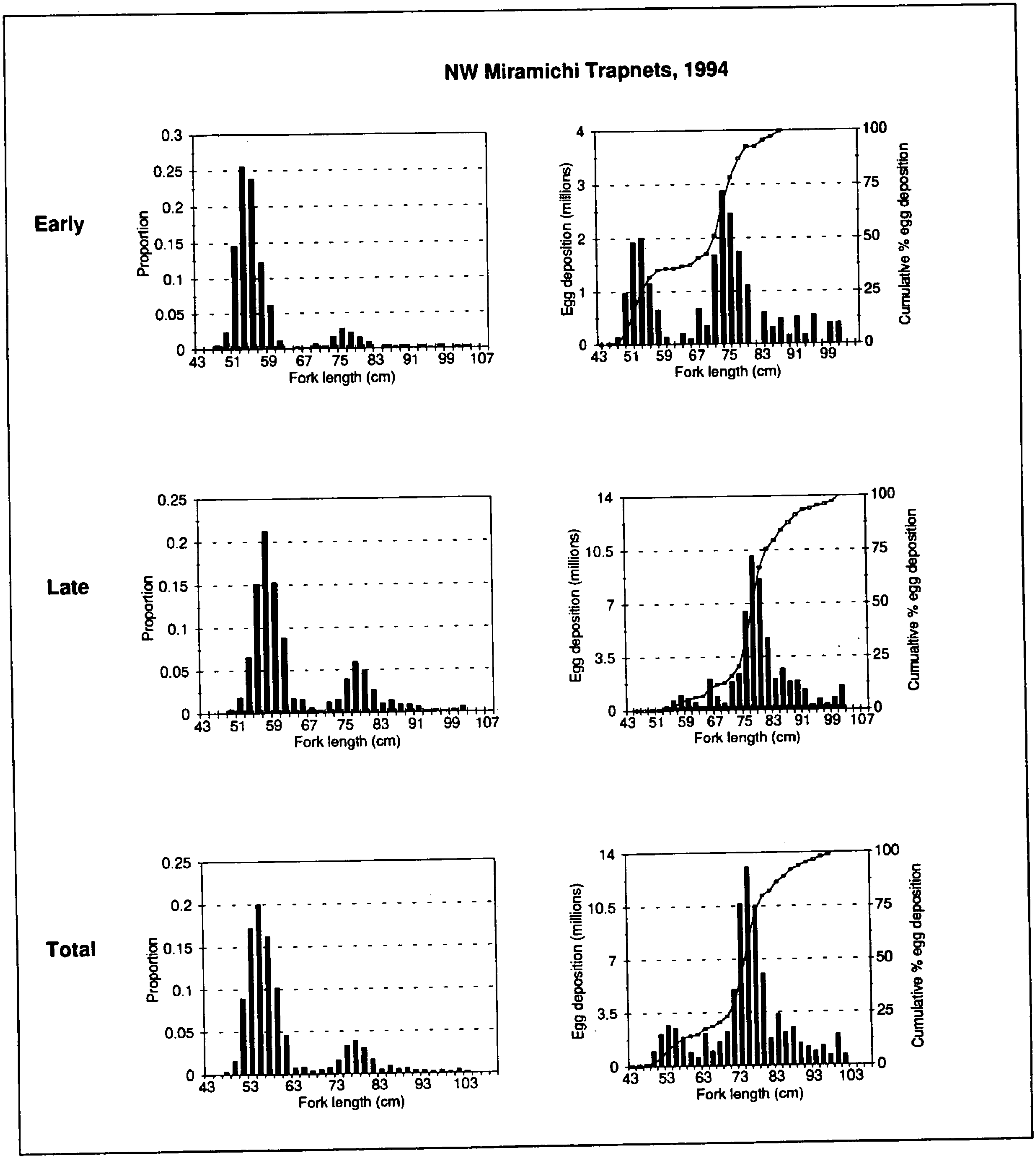


Fig. 10. Proportion at length, egg deposition at length and cumulative egg deposition at length for early, late and total spawners in the NW Miramichi, 1994.

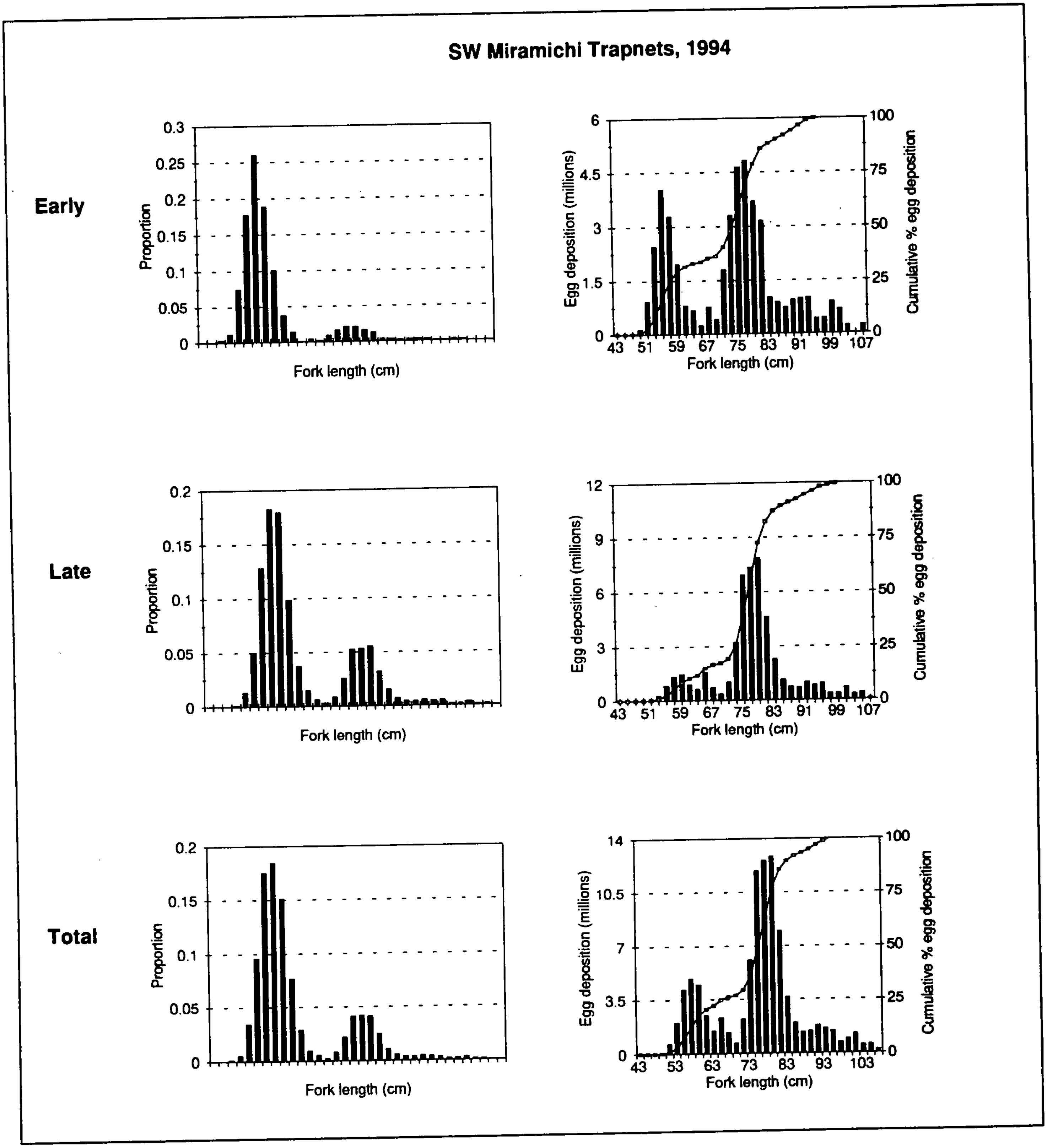


Fig. 11. Proportion at length, egg deposition at length, and cumulative egg deposition at length for early, late and total spawners in the SW Miramichi, 1994.

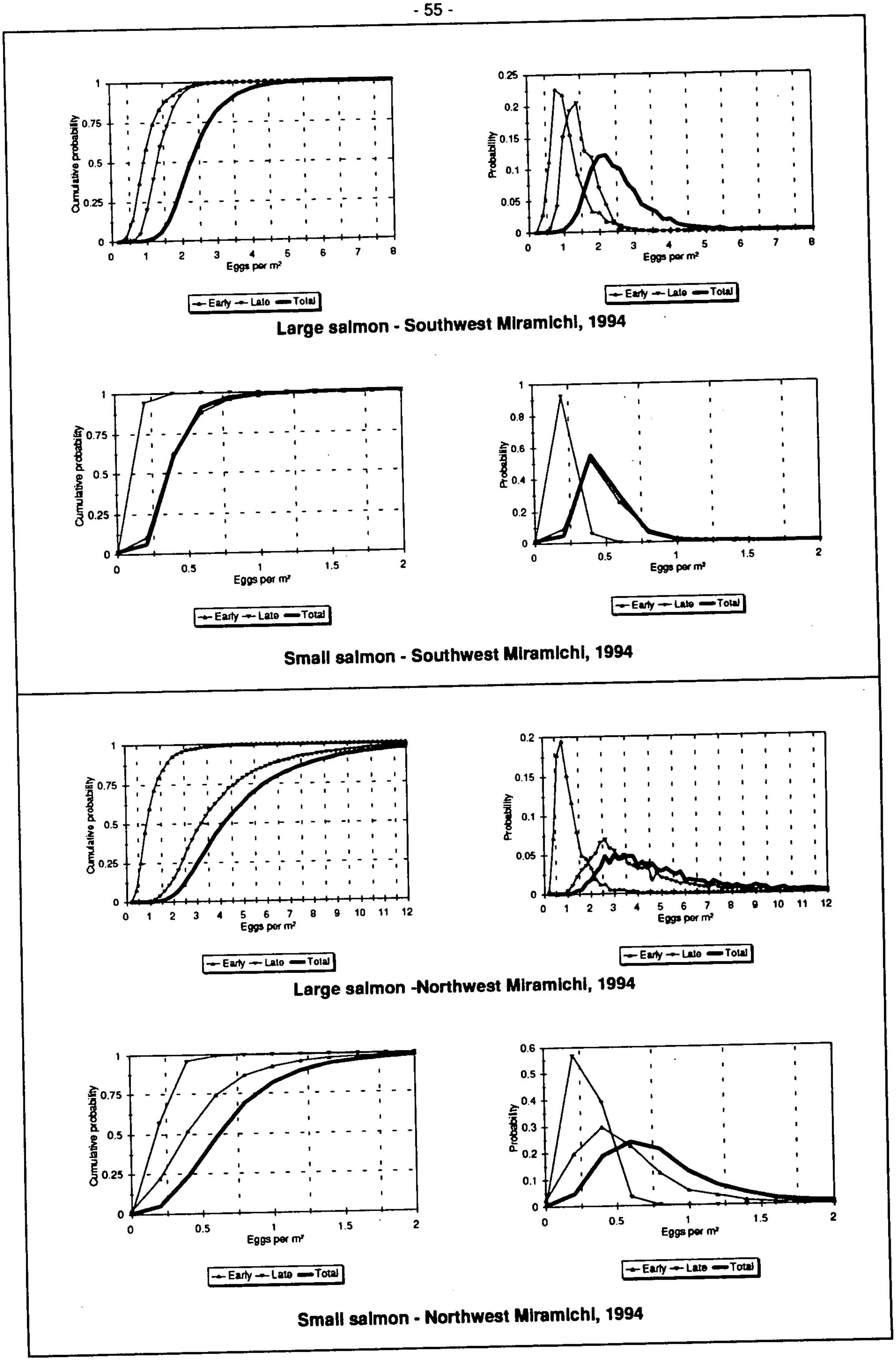


Fig. 12. Probability plots of the estimated egg depositions by size group in the Northwest and Southwest Miramichi in 1994.

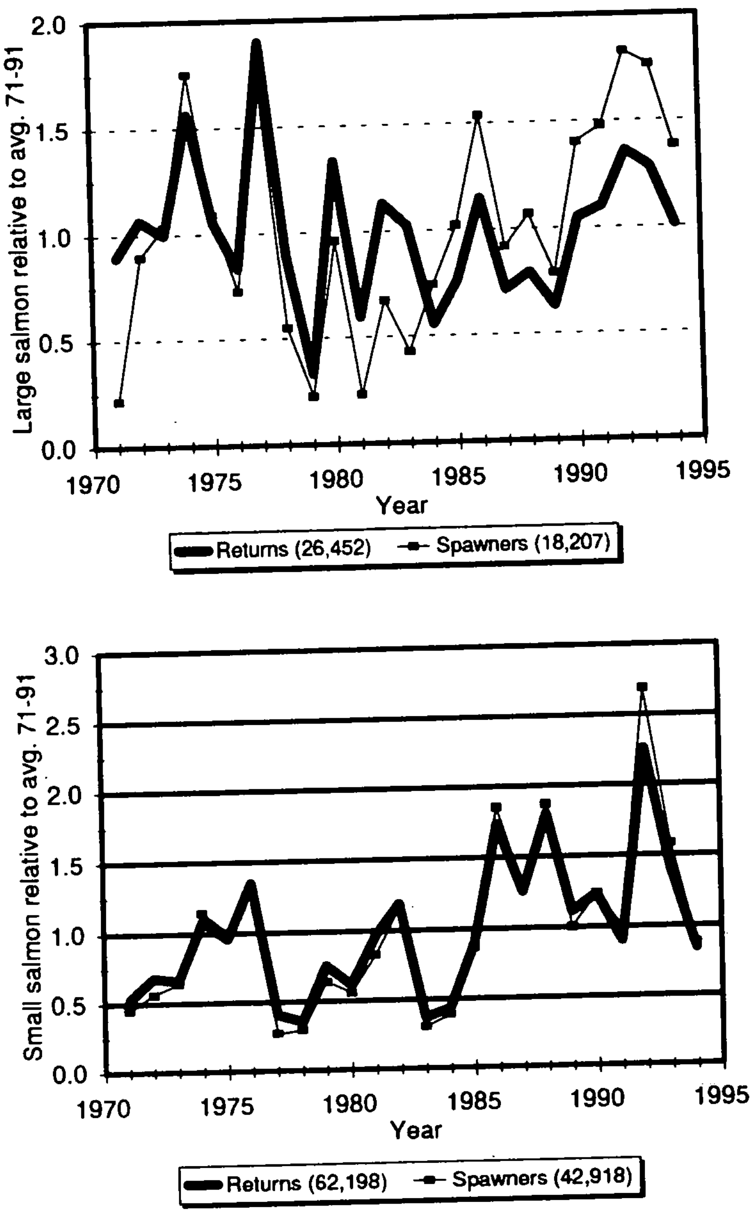


Fig. 13. Total returns to the Miramichi River estuary and number of spawners of large (upper) and small (lower) salmon relative to the 1971 to 1991 averages.

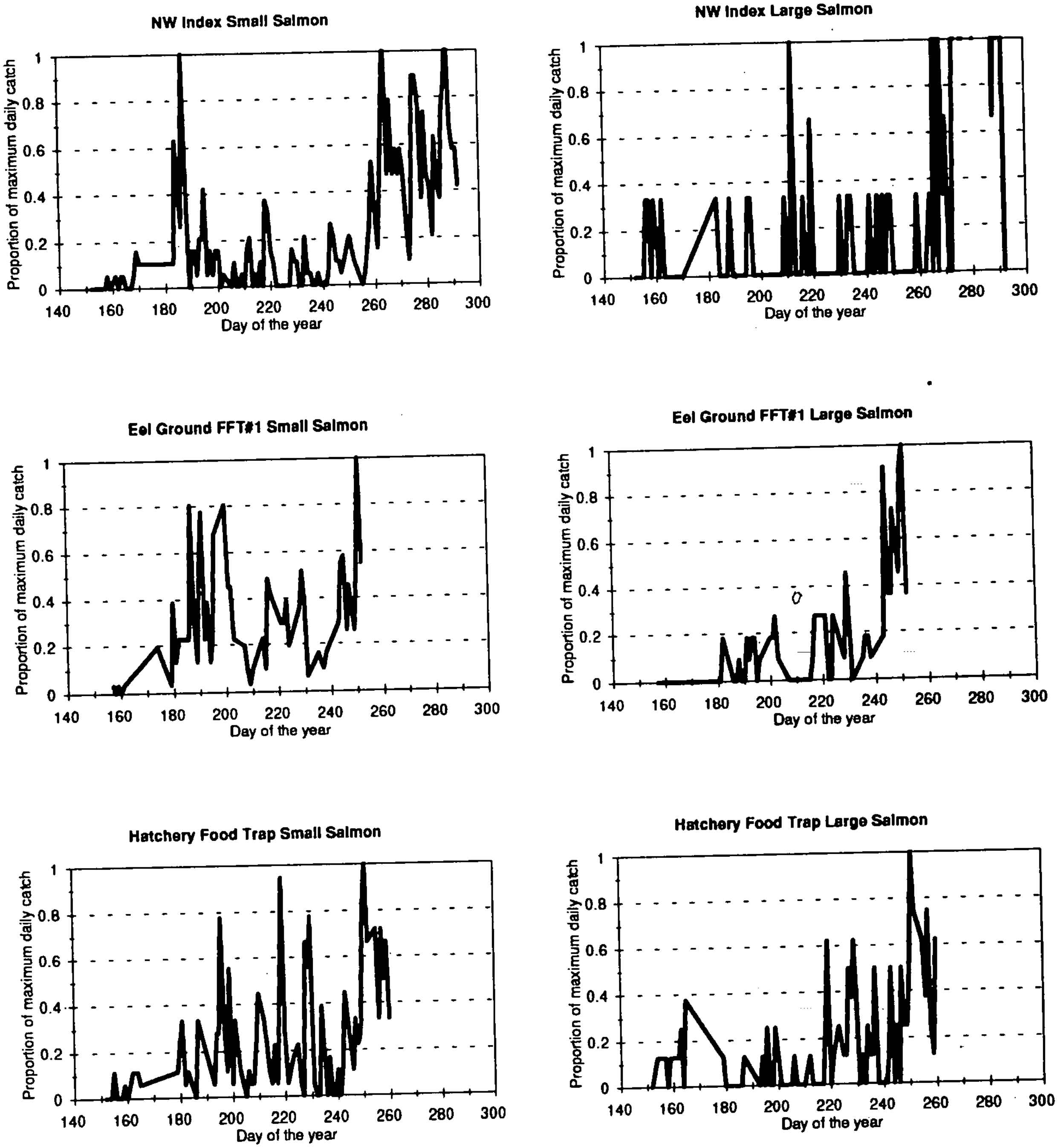
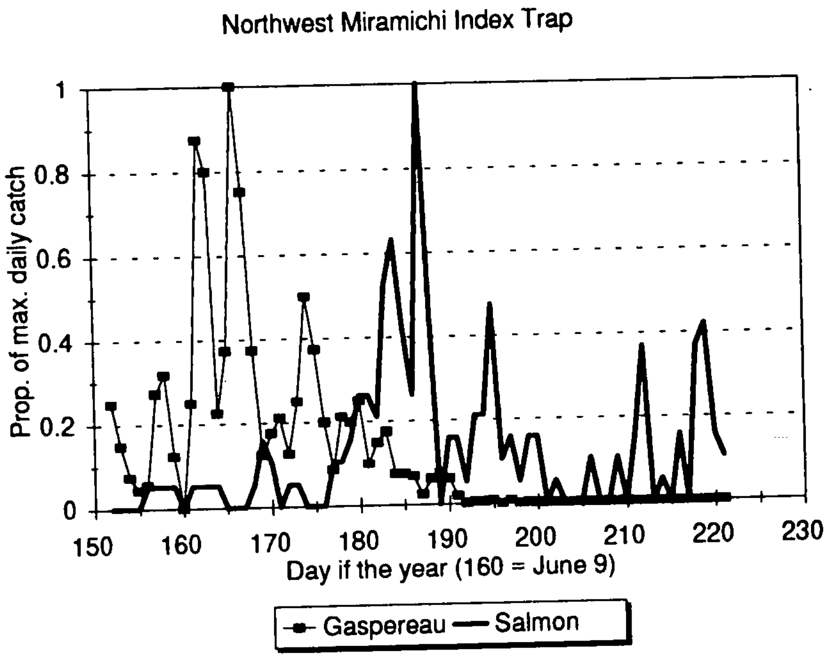


Fig. 14. Relative daily efficiency (as proportion of maximum daily catch observed before Sept. 19 when fooı traps finished fishing) of the Northwest Miramichi index trapnet compared to the two food fishery trapnets at Ground. Eel Ground FFT#1 was installed approximately 500 m downstream of the index trapnet, hatchery fı trap was installed about 500 m upstream and across the river from the index trapnet.



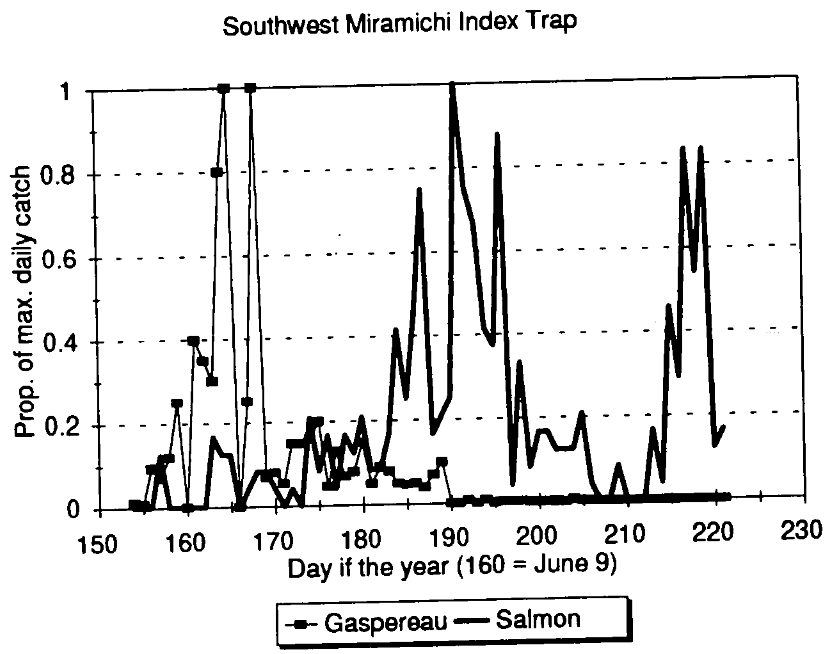


Figure 15. Daily catches of gaspereau and salmon (small + large) as a proportion of the maximum daily catch observed over the period June 1 to Aug. 9, 1994.

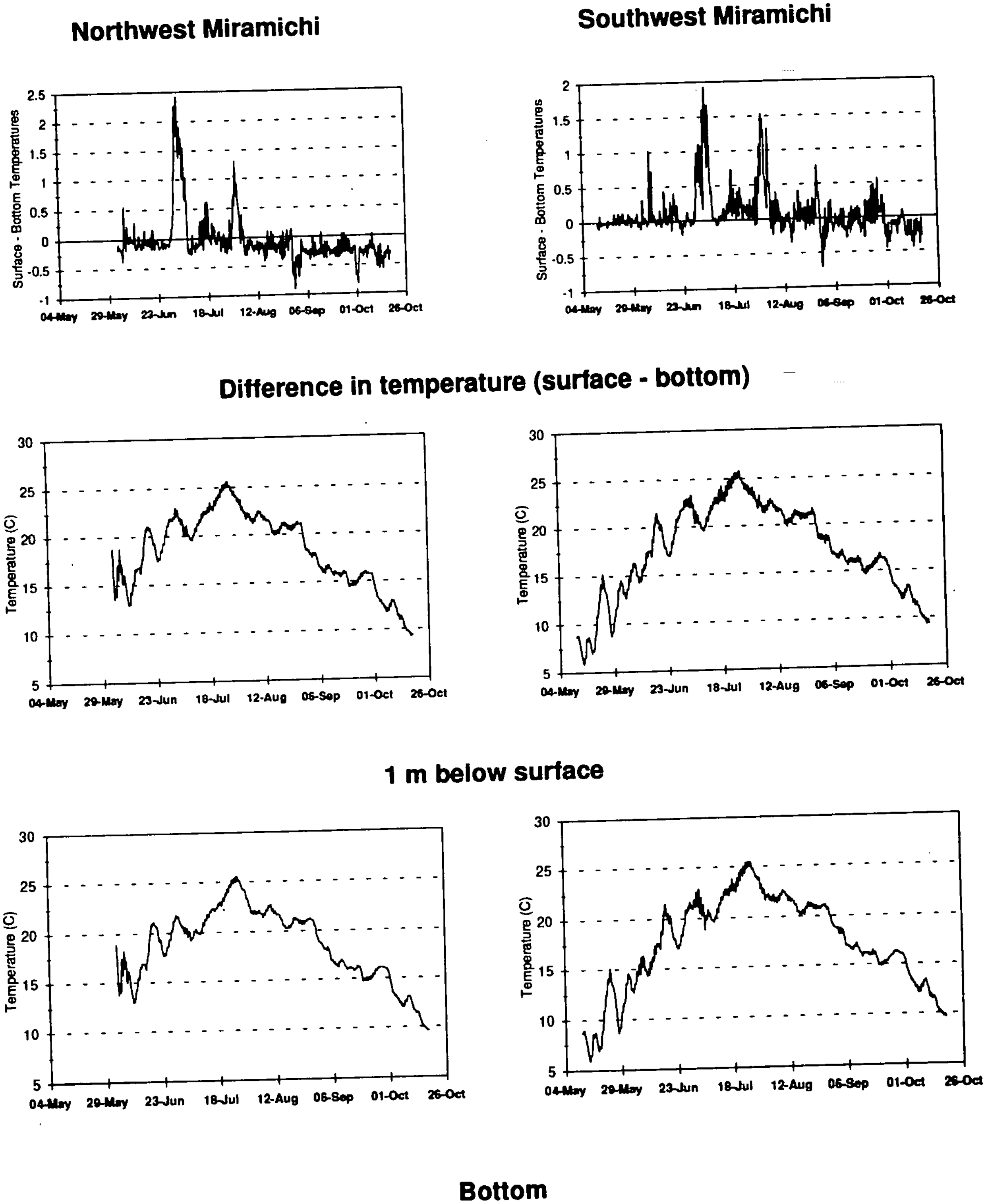


Fig. 16. Surface and bottom water temperatures and measured temperature difference between surface and bottom in tidal waters at the index trapnets in the Northwest and Southwest Miramichi in 1994.

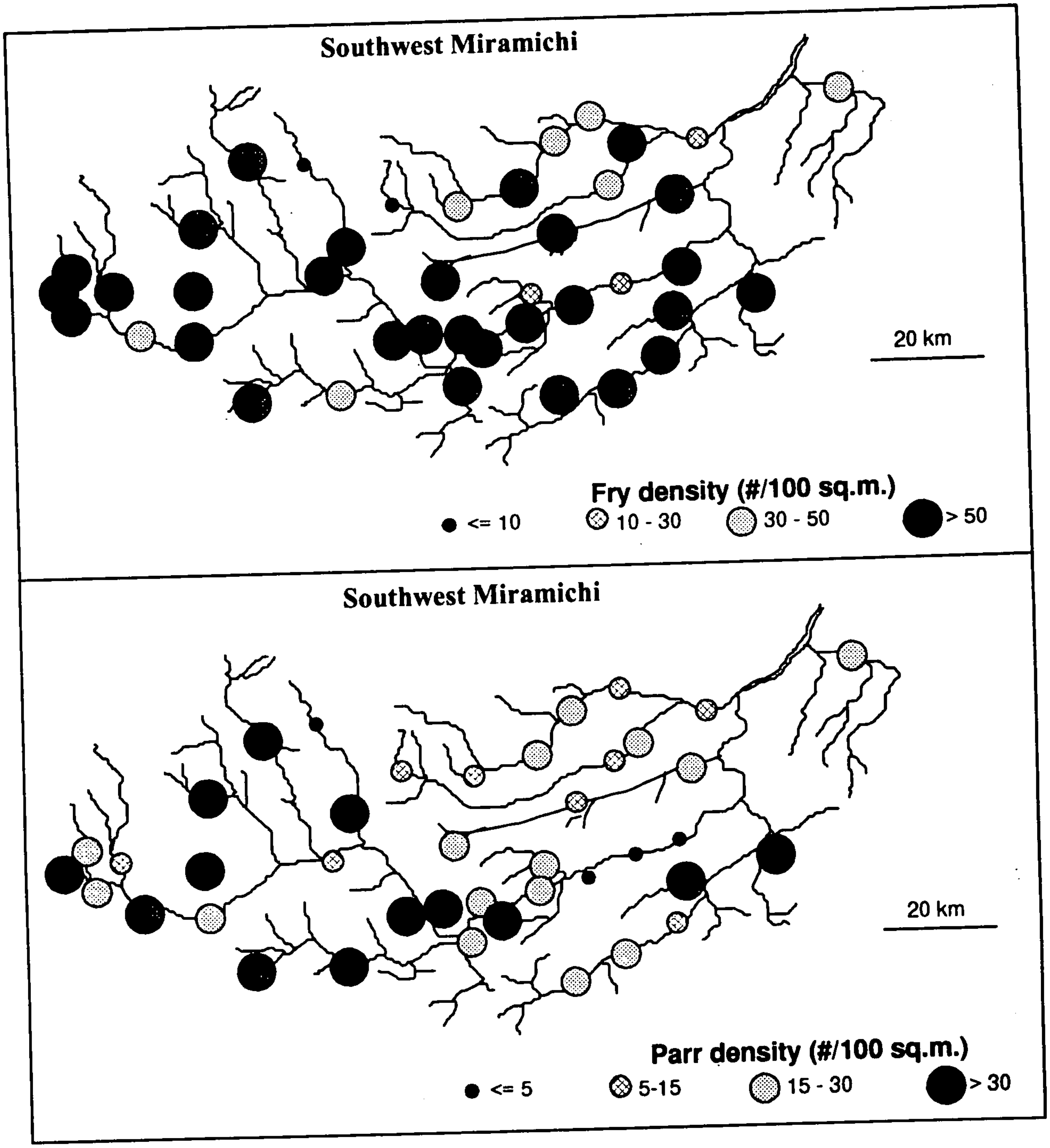


Fig. 17. Observed fry (upper) and parr (lower) densities in the Southwest Miramichi in 1994.

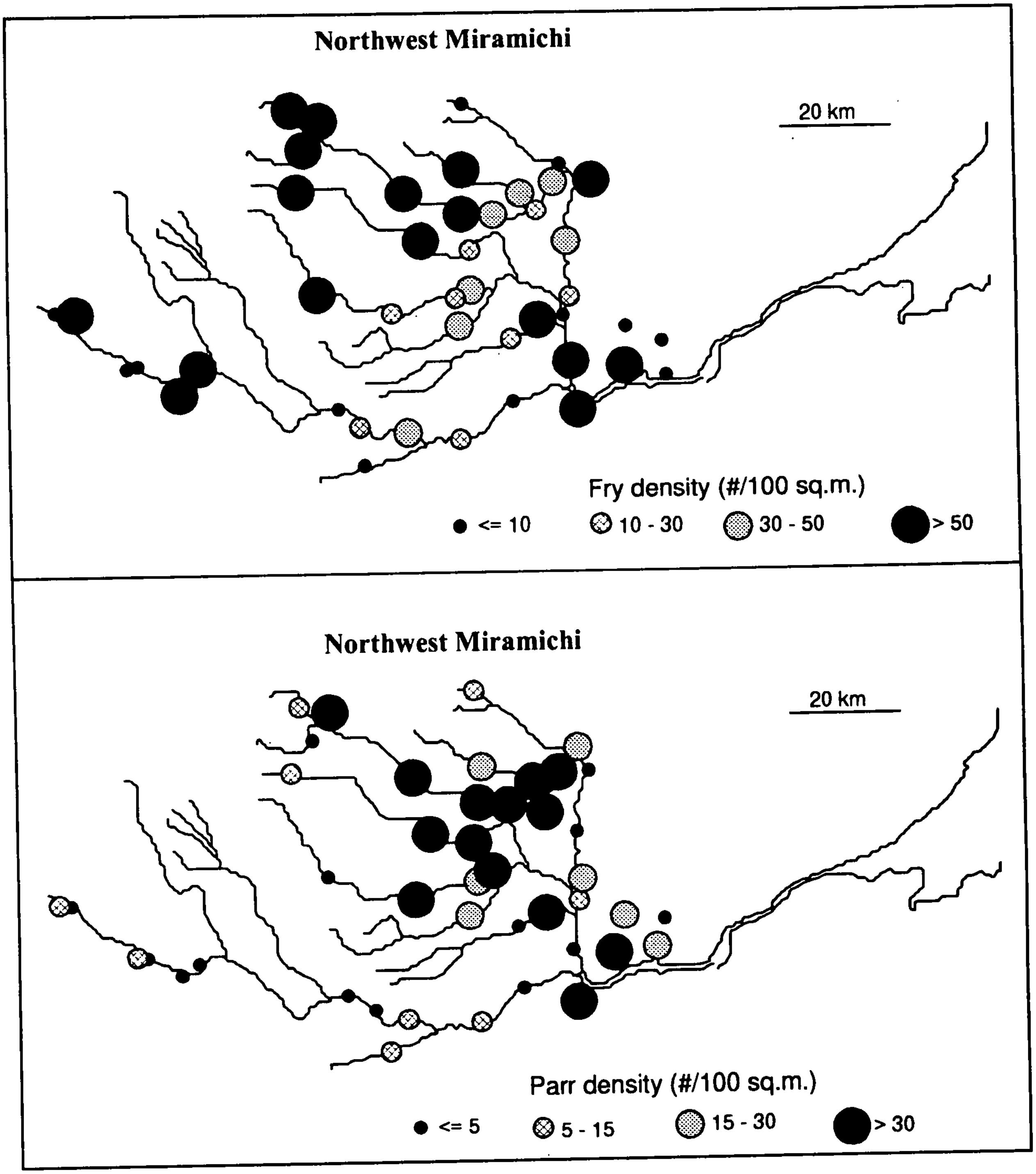
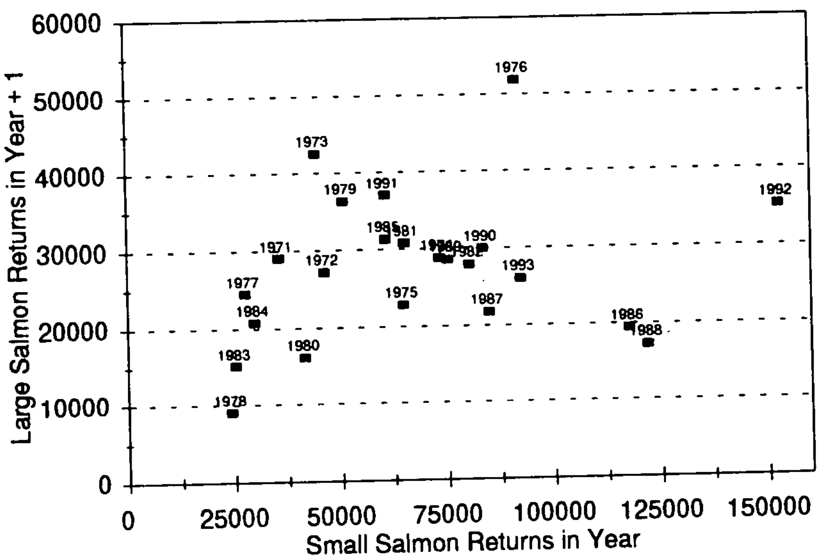


Fig. 18. Observed fry (upper) and parr (lower) densities in the Northwest Miramichi in 1994.



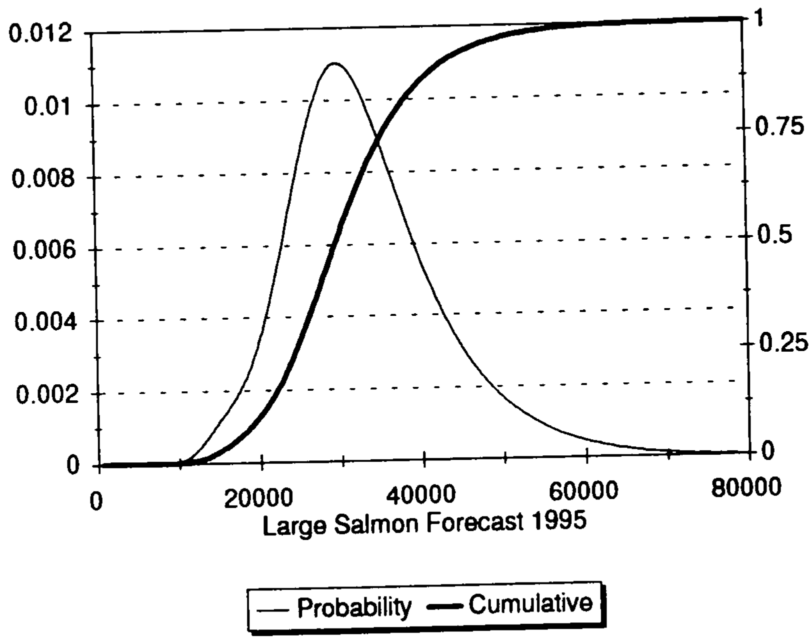
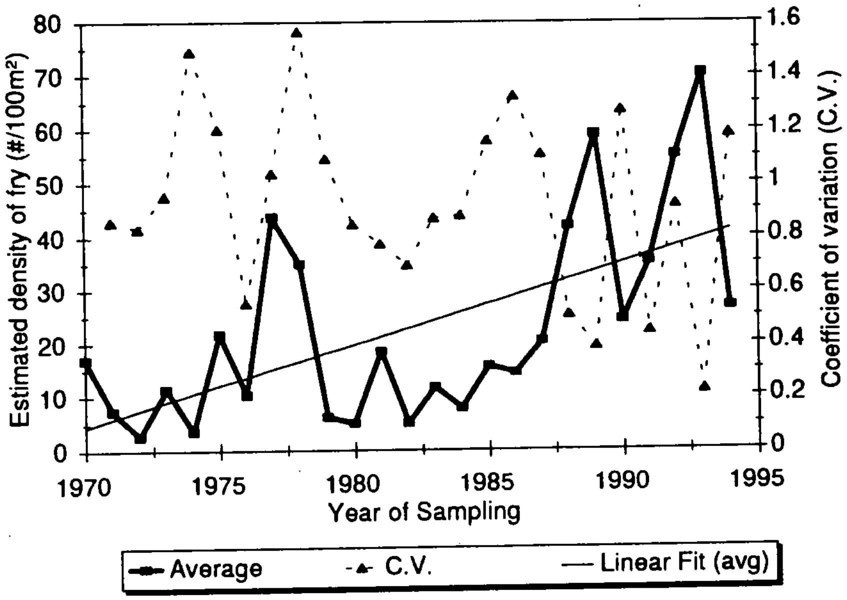


Fig. 19. Preseason forecast model of the large salmon returns to the Miramichi (upper) and the 1995 large salmon return forecast probability (lower).



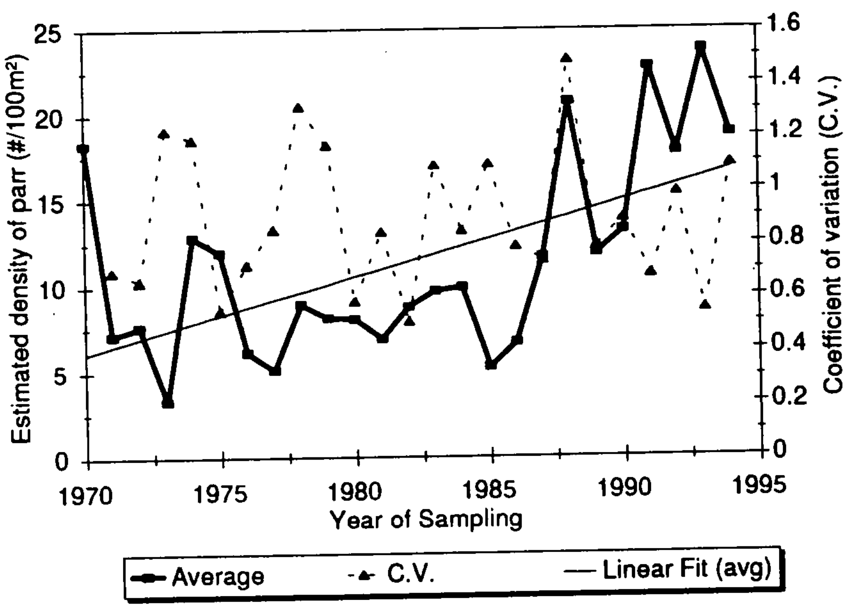


Fig. 20. Average densities and coefficient of variation of fry (upper) and parr (lower) at the index sites of the Northwest Miramichi, 1970 to 1994.

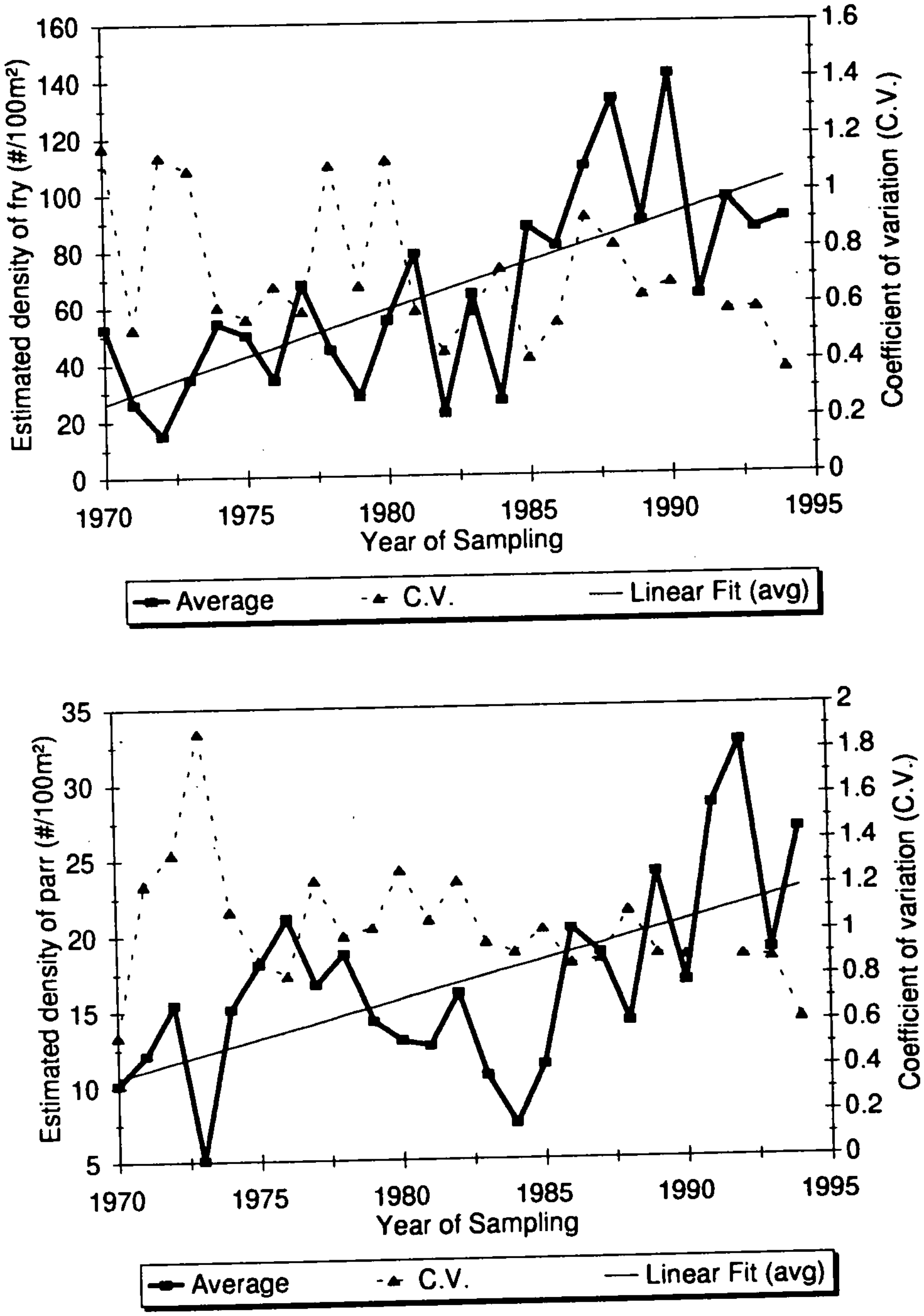


Fig. 21. Average densities and coefficient of variation of fry (upper) and parr (lower) at the index sites of the Southwest Miramichi, 1970 to 1994.

Appendix 1. Minutes of the science workshop on Northwest and Southwest Miramichi salmon, Dec. 15 and 16, 1994.

Chairperson:	
Ross Claytor	DFO, Science, Moncton
Notes:	
John Peppar	DFO, Science, Moncton
Attendees:	
Michael Augustine	Red Bank First Nation
Bernard Duffy	Renous-Dungarvon River Enhancement Association
Don Archibald	Northumberland Salmon Protection Association
Vince Swazey	Miramichi Salmon Association
Alex Mills	NB Outfitters, Doaktown
Danny Surette	Atlantic Salmon Federation
Bill Hooper	NB DNRE, Fredericton
Tasha Robertson	NB DNRE, Fredericton
Bernie Dubee	NB DNRE, Newcastle
Pam Seymour	NB DNRE, Fredericton
Bill Scott	DFO, Newcastle
Mark Hambrook	DFO, Science, Miramichi SEC
John Hayward	DFO, Science, Miramichi SEC
Joe Sheasgreen	DFO, Science, Miramichi SEC
Daniel Caissie	DFO, Science, Moncton
Gerald Chaput	DFO, Science, Moncton
Tim Lutzac	DFO, Science, Moncton
Dave Moore	DFO, Science, Moncton
Michel Biron	DFO, Science, Moncton
John Ritter	DFO, Science, Moncton

1. Introduction.

Ross Claytor provided overviews of the stock assessments procedure, objectives of the meeting, and an outline of the proposed agenda. In outlining the stock assessment procedure, he noted that the ultimate objective of the science workshop in this process was to produce an assessment document for the Northwest and Southwest Miramichi River salmon stock. The order of presentation and discussion was:

1. **Fisheries** -- landings and description.
2. **Target** -- spawning escapement.
3. **Data** -- mark-recapture, logbook summaries, age determinations, juvenile surveys, spawner surveys and hatchery stockings.
4. **Status** -- methods, comparison of results, target met, trends and ecology.
5. **Prospects** -- short-term, long-term and in-season.
6. **Summary** -- improvements.

Points of Discussion

1. Landings

- To assist in clearing some potential misunderstandings, some definitions were provided:
  small salmon = less than 63 cm = grilse = 1SW salmon = what can be retained by angling
  early = up to August 31   late = after August 31
- Recreational fishery landings in 1994 unavailable to date; DNRE's FISHSYS data to be available approx. mid-February and to be included in the assessment and document.
- Results of the Crown Reserve angling survey indicate effort was down about 6%, and the total salmon 'catch' down about 13%, from last year. Most of this decline was recorded on the NW Miramichi reserves, as opposed to others on the Sevogle and Little Southwest Miramichi Rivers. Members felt the data should be broken down by reserve stretches.
- Northwest members thought angling conditions were fair in the early part of the season in the Northwest, but low water conditions experienced by August, likely had a negative effect on subsequent angling quality.
- Southwest members felt that the angling and angling conditions in 1994 were good at some areas early in the season, but they died down somewhat in July, and then stayed rather poor until late in the season. Overall catches were quite similar to last couple of years, but down from what highs have been in the past. Effort was about the same as the previous year.
- Re: violations, jigging was noted as being more numerous in 1994, likely as a result of the low water conditions facilitating such illegal angling activities.
- There was no SW Miramichi harvest by the Eel Ground First Nation in 1994.

2. Target

- Procedure to calculate the spawning requirement was outlined; the value of 2.4 eggs per square metre of habitat was employed, as per calculations done for other river systems.

3. Data

- Mark-recapture was used to estimate returns to the river system; 7 traps (5 in the NW Miramichi) and 5 counting fences or barriers (2 in the NW Miramichi) were employed in the Miramichi River system in 1994.
- DFO increased sampling (spatially) by electrofishing in 1994. DNRE conducted electrofishing on 'closed' sites to compare results with 'open' site data obtained in 1993. More sites can be done with the open site method, and results appear comparable. Combination of closed and open sites needed, to verify results obtained by each (calibration to site characteristics).
- DNRE provided an overview of their electrofishing and redd count survey methods, and results.
- Data from the fishing camps pursuing satellite rearing and fry stocking are available, and should be gathered and presented in the assessment document. Data from other enhancement initiatives have been compiled and were presented.
- Projects were initiated in 1994 to evaluate enhancement efforts, and included: installation of a fish counting fence on the Renous River, and the analysis of March vs May stocking re: return rates; description and results of the latter to be included in the assessment document.

4. Status

- Estimates of returns to the NW Miramichi were made utilizing the mark-recapture results (tags applied at the Eel Ground trap, recaptures throughout whole Miramichi River system).
- More fish marked in the NW Miramichi in 1994 moved out of the NW system than in previous years of tagging (45% of tags stayed in 1994, as opposed to about 78% in previous years).
- More fish marked in the SW Miramichi in 1994 stayed in the SW system than in previous years of tagging (92% of tags stayed in 1994).
- Return rates had to be calculated, using the number of tags recaptured via angling in both the NW and SW systems; angling recaptures likely a better indicator of fish 'staying' in the respective systems (as opposed to other trap recaptures).
- An analysis of whether this movement (in and out of the two systems) is more predominant later in the season than early (with numbers of fish moving and water conditions present at the time, etc.) has not been done.
- The Schaefer method provided the best estimates of early- vs late-run small salmon returns; this method takes early vs late different trap efficiencies into account, the Peterson method does not.
- The Schaefer method provided estimates of early- vs late-run small salmon returns; 60% of the returns to the Northwest were in the early-run period.

- In terms of spawning escapement to the Northwest, most of the eggs come from the large salmon; 140% of target (in terms of eggs).
- Re: fecundity, it was noted that the SEC's could be a good source of fecundity data; data should be analysed and made available for future assessments.
- Estimated egg depositions in 1994 to the Southwest were estimated at 131% of target for small and large salmon combined (106% of target for large salmon only).
- Alternate methods for estimating returns to the Southwest were presented and discussed(Renous fence, Millerton trap, angling camp data).
- Current angling catches about double what they were in the 1970's. This appears to correspond well to returns indicated at the traps (i.e., estimates of returns made by mark-recapture method) and appears to validate the mark-recapture method. Angling catches as an index of present status are very important for the tributaries, where we don't have other assessment means, such as traps, fences, etc.
- DNRE juvenile density data indicated that the areas sampled were well-seeded; fry densities were about the same as those recorded last year, and parr densities down somewhat from those observed in 1993; PHS values were mostly above 27, and thus, considered good (i.e., that good use was being made of the habitat).
- Juvenile densities being observed in the 1990's are almost double the densities observed back in the 1970's.
- Fry/parr numbers appear to be much lower in the Little SW Miramichi than in the main NW Miramichi.
- DNRE presented data from their barriers, redd and electrofishing surveys. Is there a relationship between number of redds and subsequent juvenile (fry) densities observed? This should be examined.
- Electrofishing surveys have indicated an increasing trend in juvenile densities since 1984.
- A list of stocking sites, numbers stocked, etc., is needed, to ensure that stocked fish are not being included in the densities estimates made by the electrofishing operations.
- DNRE's counts at the barrier pools were down in 1994 from last year and the 5-year means (down 31% at North Brook Pool, and down 39% at Frying Pan Pool). It was suggested that targets for escapement are needed for these two areas, so that numbers being observed could be related to what's needed.
- An overview of some of the physical conditions of the Miramichi River system was presented by Daniel Caissie; his presentation provided overviews of the meterological (temperatures and precipitation) and hydrological (discharge, pH and conductivity, suspended sediments) conditions as measured in Catamaran Brook in 1994. He noted that 1994 was characterized by high flow events, sediment loads, low pH, high stream temperatures, some warm summer night air temperatures and low flows later in the season. He noted that measurements on the Little SW Miramichi River showed lower pH's and higher water temperatures than Catamaran Brook. In addition, alkalinity was much lower on this river (i.e., indicating a poorer buffering capability); likely a habitat (i.e., environmental) problem, as opposed to a man-related problem.

5. Prospects

- Pre-season (1995, i.e., short-term) forecast made for the whole of the Miramichi River system; based on small salmon to large salmon relationship (utilizing probability density function). Returns of small salmon in 1995 are expected to be higher than 1994, but less than returns of 1992 and 1993. Large salmon returns are predicted from the small salmon returns the year before.
- Long-term prospects based on juvenile densities (increasing trend since 1984).
- In-season forecasting capabilities need to be developed. Some testing of pre-season vs in-season predictions has been done. Results indicate that if we predict too soon, we achieve a prediction worse than the pre-season forecast; if we wait too late to predict, the opportunity for an improved forecast is lost. From July 15 onwards, in-season predicting is an improvement over the pre-season prediction. In-season forecasting would help to prevent overharvesting (if pre-season forecast alone was used).

6. Summary

- Highlights of Northwest assessment -- estimated returns, egg deposition met (140% of target), and forecast for 1995 to meet target.
- Highlights of Southwest assessment -- estimated returns, egg deposition met (131% of target), and forecast for 1995 to meet target.
- Plans re: workshop next year: NW and SW Branches to be discussed at one meeting. The meeting will be divided into two sessions -- an afternoon session for the presentation and discussion of methods, and an evening session for the presentation and discussion of results.
- Improvements for future assessments noted:

- Little SW Miramichi: extent of problem requires definition and work. Need to access - Crown Reserve data, FISHSYS data, historical habitat data, DOE water chemistry data, 'old' electrofishing/conductivity data.
- More electrofishing sites should be added to program.
- Adults - tagged to untagged - add more assessment through seining of pools (September).
- Traps - more needed - need more tags. In addition, traps must be installed as early as possible; need more tags applied early in the season (need to overcome potential problem with gaspereau).
- Creel surveys would be beneficial.
- The need for a sonic tagging study should be assessed.

Appendix 2. Tag and recapture histories for small salmon in the Southwest Miramichi, 1994.

Tagging Area		Southwest Enclosure June	July	August	Sept.	Oct.	Total
Tags Placed		31	149	214	387	97	878
Recapture Data							
Percent reported							
Angling	Total	12.9%	4.7%	6.5%	8.0%	2.1%	6.6%
Traps	NW	0.0%	2.7%	4.7%	4.1%	2.1%	3.6%
	SW	3.2%	3.4%	9.3%	10.9%	15.5%	9.5%
Angling Recaptures							
In Southwest		4	7	14	27	2	54
	Unknown						0
	June						0
	July	4	1				5
	August		2	6			8
	Sept.		4	8	15		27
	Oct.				12	2	14
In Northwest		0	0	0	4	0	4
	Unknown				1		1
	June						0
	July						0
	August				1		1
	Sept.				2		2
	Oct.						
Unknown	Oct.				1		1
Enclosure Trapnet			0	2	5	2	9
	June						0
	July						0
	August						0
	Sept.			2	5		7
	Oct.					2	2
Millerton Trapnet			4	18	33	11	66
	June						0
	July		2				2
	August		1	11			12
	Sept.			5	20		25
	Oct.		1	2	13	11	27
Renous River fence		0	0	0	4	2	6
	August						0
	Sept.				3		3
	Oct.				1	2	3
	Nov.						
Northwest Eel Ground Trap			0	4	9	1	14
	June						0
	July						0
	August			3			3
	Sept.			1	7		8
	Oct.				2	1	3
Red Bank Trapnets			3	4	5	1	13
	June						0
	July		3				3
	August			2			2
	Sept.			2	2		4
	Oct.				3	1	4
Barrier Fences		1	1	0	2	0	4
	Dungarvon	1					1
	SW Miramichi		1				1
	NW Miramichi						0
	Catamaran				2		2
Broodstock Seining		0	1	2	0	0	3
	Dungarvon						0
	Little Southwest						0
	Sevogle						0
	Northwest		1	2			3

Tagging Area		Millerton Trapnet - Southwest Miramichi June	July	August	Sept.	Oct.	Total
Tags Placed		28	318	408	934	382	2070
Recapture Data							
Percent reported							
Angling	Total	3.6%	6.3%	4.9%	8.6%	2.1%	6.2%
Traps	NW	3.6%	2.2%	1.2%	1.9%	1.6%	1.8%
	SW	3.6%	3.1%	8.6%	9.9%	12.3%	8.6%
Angling Recaptures							
In Southwest		0	18	20	78	6	122
	Unknown						0
	June						0
	July		11				11
	August		5	5			10
	Sept.		1	14	52		67
	Oct.		1	1	26	6	34
In Northwest		1	2	0	2	2	7
	Unknown						0
	June	1					1
	July		2				2
	August						0
	Sept.						0
	Oct.				2	2	4
Unknown	Oct.		1				1
Enclosure Trapnet		0	0	4	11	8	23
	June						0
	July						0
	August			1			1
	Sept.			2	5		7
	Oct.			1	6	8	15
Millerton Trapnet		1	9	22	71	38	139
	June	1					1
	July		6				6
	August		2	9			11
	Sept.		1	8	43		52
	Oct.			5	28	38	69
Renous River fence		0	1	1	10	3	15
	August						0
	Sept.		1		7		8
	Oct.			1	3	3	7
	Nov.						
Northwest Eel Ground Trap		0	3	1	11	5	20
	June						0
	July		2				2
	August						0
	Sept.				5		5
	Oct.		1	1	6	5	13
Red Bank Trapnets		1	4	3	7	1	16
	June						0
	July	1	1				2
	August		2				2
	Sept.		1	3	6		10
	Oct.				1	1	2
Barrier Fences		1	1	1	1	0	4
	Dungarvon	1					1
	SW Miramichi		1	1			2
	NW Miramichi						0
	Catamaran				1		1
Broodstock Seining		0	0	1	0	0	1
	Dungarvon						0
	Little Southwest						0
	Sevogle						0
	Northwest			1			1

Tagging Area		Renous River - Partial Fence - August	Sept.	Oct.	Total
Tags Placed		80	272	94	446
Recapture Data					
Percent reported					
Angling	Total	2.5%	5.1%	1.1%	3.8%
Traps	NW	0.0%	2.6%	0.0%	1.8%
	SW	3.8%	7.7%	8.5%	7.2%
Angling Recaptures					
In Southwest		2	14	1	17
	Unknown				0
	June				0
	July				0
	August	2			2
	Sept.		10		10
	Oct.		4	1	5
In Northwest		0	0	0	0
	Unknown				0
	June				0
	July				0
	August				0
	Sept.				0
	Oct.				0
Unknown	Oct.				
Enclosure Trapnet		0	0	0	0
	June				0
	July				0
	August				0
	Sept.				0
	Oct.				0
Millerton Trapnet		2	17	0	19
	June				0
	July				0
	August				0
	Sept.	1	12		13
	Oct.	1	5		6
Renous River fence		1	4	8	13
	August				0
	Sept.	1			1
	Oct.		4	7	11
	Nov.			1	1
Northwest Eel Ground Trap		0	3	0	3
	June				0
	July				0
	August				0
	Sept.				0
	Oct.		3		3
Red Bank Trapnets		0	4	0	4
	June				0
	July				0
	August				0
	Sept.		1		1
	Oct.		3		3
Barrier Fences		0	0	0	0
	Dungarvon				0
	SW Miramichi				0
	NW Miramichi				0
	Catamaran				0
Broodstock Seining		0	0	0	0
	Dungarvon				0
	Little Southwest				0
	Sevogle				0
	Northwest				0

Appendix 2 (continued). Tag and recapture histories for large salmon from the Southwest Miramichi River, 1994.

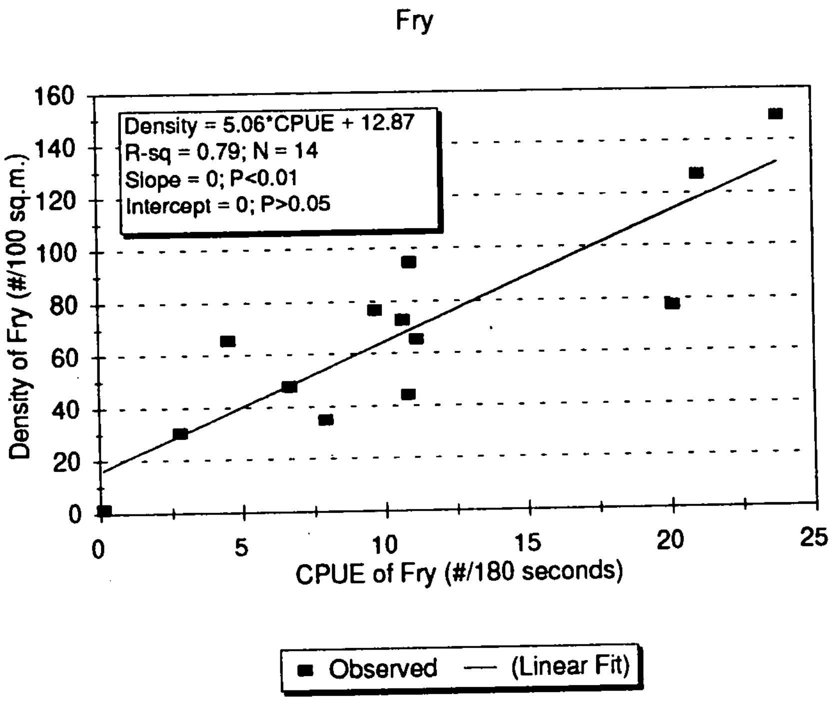
Tagging Area	Southwest Enclosure						Millerton Trapnet - Southwest Miramichi						Renous River - Partial Fence -			
	June	July	August	Sept.	Oct.	Total	June	July	August	Sept.	Oct.	Total	August	Sept.	Oct.	Total
Tags Placed	7	21	46	143	51	268	1	29	88	370	253	741	1	69	78	148
Recapture Data																
Percent reported																
Angling Total	0.0%	0.0%	0.0%	2.1%	0.0%	1.1%	0.0%	3.4%	2.3%	4.9%	1.6%	3.4%	0.0%	1.4%	0.0%	0.7%
Traps NW	0.0%	9.5%	2.2%	0.7%	2.0%	1.9%	0.0%	0.0%	0.0%	0.5%	0.8%	0.5%	0.0%	0.0%	0.0%	0.0%
SW	0.0%	0.0%	2.2%	4.9%	3.9%	3.7%	100.0%	0.0%	0.0%	5.4%	11.1%	6.6%	0.0%	8.7%	6.4%	7.4%
Angling Recaptures																
In Southwest	0	0	0	2	0	2	0	1	2	18	4	25	0	1	0	1
Unknown	.	.	.	.	.	0	.	.	.	.	.	0	.	.	.	0
June	.	.	.	.	.	0	.	.	.	.	.	0	.	.	.	0
July	.	.	.	.	.	0	.	1	.	.	.	1	.	.	.	0
August	.	.	.	.	.	0	.	.	.	.	.	0	.	.	.	0
Sept.	.	.	.	.	.	0	.	.	.	8	.	8	.	.	.	0
Oct.	.	.	.	2	.	2	.	.	2	10	4	16	.	1	.	1
In Northwest	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0
Unknown	.	.	.	.	.	0	.	.	.	.	.	0	.	.	.	0
June	.	.	.	.	.	0	.	.	.	.	.	0	.	.	.	0
July	.	.	.	.	.	0	.	.	.	.	.	0	.	.	.	0
August	.	.	.	.	.	0	.	.	.	.	.	0	.	.	.	0
Sept.	.	.	.	.	.	0	.	.	.	.	.	0	.	.	.	0
Oct.	.	.	.	1	.	1	.	.	.	.	.	0	.	.	.	0
							.	.	.	1	.	1				
Enclosure Trapnet	.	0	0	0	0	0	0	0	0	1	2	3	0	1	0	1
June	.	.	.	.	.	0	.	.	.	.	.	0	.	.	.	0
July	.	.	.	.	.	0	.	.	.	.	.	0	.	.	.	0
August	.	.	.	.	.	0	.	.	.	.	.	0	.	.	.	0
Sept.	.	.	.	.	.	0	.	.	.	1	.	1	.	.	.	0
Oct.	.	.	.	.	.	0	.	.	.	.	2	2	.	1	.	1
Millerton Trapnet	.	0	1	7	2	10	0	0	0	19	23	42	0	2	0	2
June	.	.	.	.	.	0	.	.	.	.	.	0	.	.	.	0
July	.	.	.	.	.	0	.	.	.	.	.	0	.	.	.	0
August	.	.	1	.	.	1	.	.	.	.	.	0	.	.	.	0
Sept.	.	.	.	4	.	4	.	.	.	11	.	11	.	1	.	1
Oct.	.	.	.	3	2	5	.	.	.	8	23	31	.	1	.	1
Renous River fence	0	0	1	0	1	2	1	0	0	0	3	4	0	3	5	8
August	.	.	.	.	.	0	.	.	.	.	.	0	.	.	.	0
Sept.	.	.	1	.	.	1	1	.	.	.	.	1	.	2	.	2
Oct.	.	.	.	.	1	1	.	.	.	.	2	2	.	1	4	5
Nov.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	1	1
Northwest Eel Ground Tr	.	1	0	0	1	2	0	0	0	1	2	3	0	0	0	0
June	.	.	.	.	.	0	.	.	.	.	.	0	.	.	.	0
July	.	.	.	.	.	0	.	.	.	.	.	0	.	.	.	0
August	.	1	.	.	.	1	.	.	.	.	.	0	.	.	.	0
Sept.	.	.	.	.	.	0	.	.	.	.	.	0	.	.	.	0
Oct.	.	.	.	.	1	1	.	.	.	1	2	3	.	.	.	0
Red Bank Trapnets	.	0	1	1	0	2	0	0	0	1	0	1	0	0	0	0
June	.	.	.	.	.	0	.	.	.	.	.	0	.	.	.	0
July	.	.	.	.	.	0	.	.	.	.	.	0	.	.	.	0
August	.	.	1	.	.	1	.	.	.	.	.	0	.	.	.	0
Sept.	.	.	.	1	.	1	.	.	.	.	.	0	.	.	.	0
Oct.	.	.	.	.	.	0	.	.	.	1	.	1	.	.	.	0
Barrier Fences	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dungarvon	.	.	.	.	.	0	.	.	.	.	.	0	.	.	.	0
SW Miramichi	.	.	.	.	.	0	.	.	.	.	.	0	.	.	.	0
NW Miramichi	.	.	.	.	.	0	.	.	.	.	.	0	.	.	.	0
Catamaran	.	.	.	.	.	0	.	.	.	.	.	0	.	.	.	0
Broodstock Seining	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Dungarvon	.	.	.	.	.	0	.	.	.	.	.	0	.	.	.	0
Little Southwest	.	.	.	.	.	0	.	.	.	.	.	0	.	.	.	0
Sevogle	.	.	.	.	.	0	.	.	.	.	.	0	.	.	.	0
Northwest	.	1	.	.	.	1	.	.	.	.	.	0	.	.	.	0

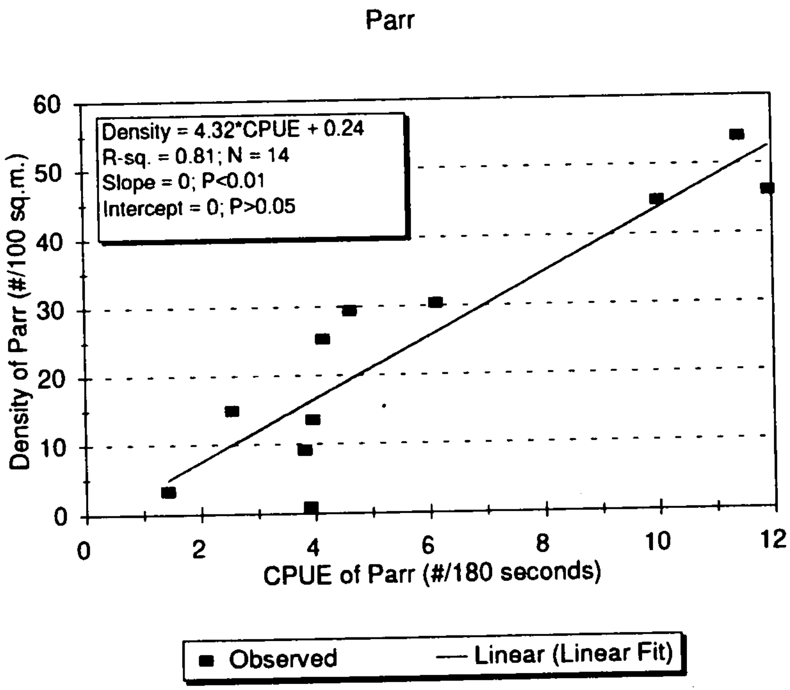
Appendix 2 (continued). Tag and recapture histories for small salmon from the Northwest Miramichi River, 1994.

Tagging Area	Northwest Eel Ground Trapnets June	July	August	Sept.	Oct.	Total	Red Bank Trapnets - Northwest Miramichi June	July	August	Sept.	Oct.	Total
Tags Placed	25	153	68	251	141	638	0	0	63	28	67	158
Recapture Data												
Percent reported												
Angling Total	0.0%	5.2%	10.3%	5.6%	2.8%	5.2%	.	.	0.0%	7.1%	0.0%	1.3%
Traps NW	0.0%	3.3%	13.2%	8.0%	5.0%	6.4%	.	.	17.5%	14.3%	4.5%	11.4%
SW	4.0%	2.0%	5.9%	6.0%	11.3%	6.1%	.	.	1.6%	0.0%	0.0%	0.6%
Angling Recaptures												
In Southwest	0	1	4	13	3	21	0	0	0	1	0	1
Unknown	.	.	.	.	.	0	.	.	.	.	.	0
June	.	.	.	.	.	0	.	.	.	.	.	0
July	.	1	.	.	.	1	.	.	.	.	.	0
August	.	.	1	.	.	1	.	.	.	.	.	0
Sept.	.	.	3	8	.	11	.	.	.	1	.	1
Oct.	.	.	.	5	3	8	.	.	.	.	.	0
In Northwest	0	7	3	1	1	12	0	0	0	1	0	1
Unknown	.	.	.	.	.	0	.	.	.	.	.	0
June	.	.	.	.	.	0	.	.	.	.	.	0
July	.	2	.	.	.	2	.	.	.	.	.	0
August	.	4	1	.	.	5	.	.	.	.	.	0
Sept.	.	1	2	1	.	4	.	.	.	.	.	0
Oct.	.	.	.	.	1	1	.	.	.	1	.	1
Unknown July	.	.	.	.	.	.	.	.	.	.	.	.
Enclosure Trap	0	1	1	4	4	10	0	0	0	0	0	0
June	.	.	.	.	.	0	.	.	.	.	.	0
July	.	1	.	.	.	1	.	.	.	.	.	0
August	.	.	1	.	.	1	.	.	.	.	.	0
Sept.	.	.	.	3	.	3	.	.	.	.	.	0
Oct.	.	.	.	1	4	5	.	.	.	.	.	0
Millerton Trap	0	2	2	10	10	24	0	0	0	0	0	0
June	.	.	.	.	.	0	.	.	.	.	.	0
July	.	2	.	.	.	2	.	.	.	.	.	0
August	.	.	2	.	.	2	.	.	.	.	.	0
Sept.	.	.	.	5	.	5	.	.	.	.	.	0
Oct.	.	.	.	5	10	15	.	.	.	.	.	0
Renous River fence	0	0	1	1	0	2	0	0	1	0	0	1
August	.	.	.	.	.	0	.	.	.	.	.	0
Sept.	.	.	1	1	.	2	.	.	1	.	.	1
Oct.	.	.	.	.	.	0	.	.	.	.	.	0
Nov.	.	.	.	.	.		.	.	.	.	.	
NW Eel Ground Traps	0	3	6	10	7	26	0	0	2	1	2	5
June	.	.	.	.	.	0	.	.	.	.	.	0
July	.	3	.	.	.	3	.	.	.	.	.	0
August	.	.	3	.	.	3	.	.	.	.	.	0
Sept.	.	.	2	6	.	8	.	.	2	1	.	3
Oct.	.	.	1	4	7	12	.	.	.	.	2	2
Red Bank Traps	0	1	2	10	0	13	0	0	8	3	1	12
June	.	.	.	.	.	0	.	.	.	.	.	0
July	.	.	.	.	.	0	.	.	.	.	.	0
August	.	1	2	.	.	3	.	.	7	.	.	7
Sept.	.	.	.	7	.	7	.	.	1	2	.	3
Oct.	.	.	.	3	.	3	.	.	.	1	1	2
Barrier Fences	1	0	0	0	2	3	0	0	0	0	2	2
Dungarvon	.	.	.	.	.	0	.	.	.	.	.	0
SW Miramichi	.	.	.	.	.	0	.	.	.	.	.	0
NW Miramichi	1	.	.	.	.	1	.	.	.	.	.	0
Catamaran	.	.	.	.	2	2	.	.	.	.	2	2
Broodstock Seining	0	1	1	0	0	2	0	0	1	0	0	1
Dungarvon	.	.	.	.	.	0	.	.	.	.	.	0
Little Southwest	.	.	.	.	.	0	.	.	.	.	.	0
Sevogle	.	.	.	.	.	0	.	.	.	.	.	0
Northwest	.	1	1	.	.	2	.	.	1	.	.	1

Appendix 2 (continued). Tag and recapture histories for large salmon from the Northwest Miramichi River, 1994.

Tagging Area	Northwest Eel Ground Trapnets June	July	August	Sept.	Oct.	Total	Red Bank Trapnets - Northwest Miramichi June	July	August	Sept.	Oct.	Total
Tags Placed	16	34	60	107	70	287	0	4	66	238	85	393
Recapture Data												
Percent reported												
Angling Total	6.3%	0.0%	3.3%	6.5%	0.0%	3.5%	.	.	0.0%	1.3%	0.0%	0.8%
Traps NW	6.3%	2.9%	10.0%	4.7%	4.3%	5.6%	.	.	12.1%	8.8%	0.0%	7.4%
Traps SW	0.0%	0.0%	3.3%	4.7%	12.9%	5.6%	.	.	1.5%	1.3%	1.2%	1.3%
Angling Recaptures												
In Southwest	1	0	2	3	0	6	0	0	0	2	0	2
Unknown	.	.	.	.	.	0	.	.	.	.	.	0
June	.	.	.	.	.	0	.	.	.	.	.	0
July	.	.	.	.	.	0	.	.	.	.	.	0
August	.	.	.	.	.	0	.	.	.	.	.	0
Sept.	.	.	1	1	.	2	.	.	.	1	.	1
Oct.	1	.	1	2	.	4	.	.	.	1	.	1
In Northwest	0	0	0	4	0	4	0	0	0	1	0	1
Unknown	.	.	.	.	.	0	.	.	.	.	.	0
June	.	.	.	.	.	0	.	.	.	.	.	0
July	.	.	.	.	.	0	.	.	.	.	.	0
August	.	.	.	.	.	0	.	.	.	.	.	0
Sept.	.	.	.	1	.	1	.	.	.	.	.	0
Oct.	.	.	.	3	.	3	.	.	.	1	.	1
Unknown July	.	.	.	.	.		.	.	.	.	.	.
Enclosure Trap	0	0	0	1	0	1	0	0	0	1	0	1
June	.	.	.	.	.	0	.	.	.	.	.	0
July	.	.	.	.	.	0	.	.	.	.	.	0
August	.	.	.	.	.	0	.	.	.	.	.	0
Sept.	.	.	.	1	.	1	.	.	.	.	.	0
Oct.	.	.	.	.	.	0	.	.	.	1	.	1
Millerton Trap	0	0	2	4	8	14	0	0	1	2	1	4
June	.	.	.	.	.	0	.	.	.	.	.	0
July	.	.	.	.	.	0	.	.	.	.	.	0
August	.	.	.	.	.	0	.	.	.	.	.	0
Sept.	.	.	1	2	.	3	.	.	1	.	.	1
Oct.	.	.	1	2	8	11	.	.	.	2	1	3
Renous River fence	0	0	0	0	0	0	0	0	0	0	0	0
August	.	.	.	.	.	0	.	.	.	.	.	0
Sept.	.	.	.	.	.	0	.	.	.	.	.	0
Oct.	.	.	.	.	.	0	.	.	.	.	.	0
Nov.	.	.	.	.	.	0	.	.	.	.	.	0
NW Eel Ground Traps	0	0	3	1	3	7	0	0	0	6	0	6
June	.	.	.	.	.	0	.	.	.	.	.	0
July	.	.	.	.	.	0	.	.	.	.	.	0
August	.	.	1	.	.	1	.	.	.	.	.	0
Sept.	.	.	2	1	.	3	.	.	.	4	.	4
Oct.	.	.	.	.	3	3	.	.	.	2	.	2
Red Bank Traps	0	1	3	4	0	8	0	0	8	15	0	23
June	.	.	.	.	.	0	.	.	.	.	.	0
July	.	1	.	.	.	1	.	.	.	.	.	0
August	.	.	2	.	.	2	.	.	5	.	.	5
Sept.	.	.	1	3	.	4	.	.	3	11	.	14
Oct.	.	.	.	1	.	1	.	.	.	4	.	4
Barrier Fences	1	0	0	0	1	2	0	0	0	0	0	0
Dungarvon	1	.	.	.	.	1	.	.	.	.	.	0
SW Miramichi	.	.	.	.	.	0	.	.	.	.	.	0
NW Miramichi	.	.	.	.	.	0	.	.	.	.	.	0
Catamaran	.	.	.	.	1	1	.	.	.	.	.	0
Broodstock Seining	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





Appendix 3. Calibration results of the CPUE open site sampling to the density of fry (upper) and parr (lower) witin the closed sites on the Miramichi River, 1994.

Appendix 4. Sample site characteristics form used for describing sites electrofished in 1994.

Year [ ] **Month** [ ] **Day** [ ]

Major Watershed [ ] **Site Number** [ ]

Physical Characteristics of the Site

Type of Site (percent of each type based on surface area)

%	**Riffle** - fast current, shallow depth (<23 cm), turbulent usually broken flow
%	**Run** - fast current, depth > 23 cm, turbulent and sometimes broken flow
%	**Flats** - slow current, depth < 46 cm, smooth surface
%	**Pool** - slow current, depth > 46 cm, smooth surface

Note: Left and right banks are determined by looking upstream

Length Left [m] Right [m]

Width Lower [m] Middle [m] Upper [m]

Water Temperature

Time		Temp	
Time		Temp	
Time		Temp	

Water Conductivity [ ]

Average Gradient

Upstream - cm to water surface	cm
Downstream - cm to water surface	cm
Distance (m)	m

Average Surface Velocity

Time (seconds)	s
Distance (m)	m

Max. Depth [cm]

Substrate Type (approx. percentage as visible area)

Fine Silt or Clay	%
Sand (<2 mm)	%
Gravel (2 to 16 mm)	%
Pebble (16 to 60 mm)	%
Cobble (60 to 250 mm)	%
Rocks (250 to 500 mm)	%
Boulder (> 500 mm)	%
Bedrock	%

Overhanging vegetation

Percent of Left Bank with Overhang	%
Percent of Right Bank with Overhang	%
Max. Metres of Overhang on Right bank	m
Max. Metres of Overhang on Left bank	m

Electrofishing Information

Reading on Smith Root Counter

Sweep	*Start*	*Finish*
5-minute		
1		
2		
3		
4		
5		

Voltage Used [ ]
Freq. Used [ ]

Crew [ ]

Determined from Topographic Maps

Elevation	Lower	
	Upper	
	Length	

Latitude [ ]
Longitude [ ]

Appendix 5. Sample SAS resampling program for estimating the emigration rate of tagged salmon in 1994 and the Schaefer stratified estimate of returns. Example given if for Northwest Miramichi small salmon, 1994.

```
** nw94smal.SAS   ESTIMATING RETURNS FROM MARK/RECAPTURE;

OPTIONS LINESIZE = 160 PAGESIZE = 90 NOCENTER;
LIBNAME A '[CHAPUT.miramich.asses94]';

*******************************************************
  this is the simulation step
*******************************************************;
proc iml;
********* angling recapture matrix for 1994 as NW SW Total for rows
                                          and NW SW columns
          - using recaptures and tags of small and large salmon;

angling = {11 16, 12 208, 23 224};
tags = {694, 3945}; * tag vector;

*** this is the point estimate of the residency rate;
angle = angling[{1 2}, {1 2}];
prop = solve(angle,tags);
resnw = angle[1,1]*prop[1,1]/tags[1,];
ressw = angle[2,2]*prop[2,1]/tags[2,];

print resnw ressw;

**** point estimate of the schaeffer calculation
   observ matrix has tag periods as columns, recap periods as rows and
   contains the number of recaptures in each tag-recap cell from Redbank
   for NW small in 1994, use two strata, June-Aug. and Sept.-Oct;

observ   = {12 0,
             6 24};
r = nrow(observ); c = ncol(observ); *** determines row and column sizes;

**** catch vector is column vector of catches at recapture trap by
**** recapture period - must be of same row dimension as observ;

catch = {782, 592};

***** tags.... are row vectors of tags placed by tagging period at
      various tagging facilities which could be recaptured at recapture trap
      must be of same column dimension as observ;

tagsnw = {219 390};
tagsswen = {394 484};
tagsswmi = {754 1307};

rij = j(r, c, 0);
CR = j(r, 1, 0);
MR = j(1, c, 0);

nwavail = tagsnw*resnw;
swavail = tagsswen*(1-ressw) + tagsswmi*(1-ressw);
tagavail = (nwavail+swavail)*0.9;*** 0.9 is tag loss & mortality factor;

crprime = (catch/observ[,+])`;
cr = shape(crprime, r, c);
mr = shape(tagavail/observ[+,], r, c);

rij = observ#cr`#mr;** population estimates by individual periods;
print rij;

totalp = rij[+,]; total = rij[+,+];
print totalp total;
```

Appendix 5 (continued).

```
******************************************************************************
simulation steps for residency rate, tag loss, schaefer estimates
*******************************************************************************;
a1 = 1:7;
perm = 2000;* number of simulations;
miramich = j(perm,7,0);* dimensions the results matrix, all 0s;
***************************************************************;

do nperm = 1 to perm;* loop for the NPERM bootstrap replications;

*******************************************************************************

**** calculating emigration rates and tags available in each branch;

angling2 = {0 0, 0 0};
do h = 1 to angling[3,1]; * calculate origin of recaptured tags in NW;
  if uniform(-1) <= angling[1,1]/angling[3,1] then
         angling2[1,1] = angling2[1,1]+1;
  else angling2[2,1] = angling2[2,1]+1;
  end;
do h = 1 to angling[3,2]; * calculate origin of recaptured tags in SW;
  if uniform(-1) <= angling[1,2]/angling[3,2] then
         angling2[1,2] = angling2[1,2]+1;
  else angling2[2,2] = angling2[2,2]+1;
  end;
prop = solve(angling2,tags);
resnw = angling2[1,1]*prop[1,1]/tags[1,];
ressw = angling2[2,2]*prop[2,1]/tags[2,];
if resnw <= 0 | resnw >= 1 then resnw = . & ressw = .;
if ressw <= 0 | ressw >= 1 then ressw = . & resnw = .;

nwavail = tagsnw*resnw;
swavail = (tagsswen+tagsswmi)*(1-ressw);
tagavail = (nwavail+swavail)*(0.8+uniform(-1)*0.2);
    *** tag loss & mortality factor varies between 0 & 20%;

**********creates a cumulative matrix of observed recaptures for resampling;
rijcum = j(r, c, 0);
do l = 1 to r;
  a = 1:l;
  temp = observ[a,];
  rijcum[l,] = temp[+,]/tagavail[1,];
end;

********** generates a cumulative bootstrapped matrix of recaptures;
bootrij = j(r, c, 0);
do m = 1 to c;
  do k = 1 to tagavail[1,m];
    x = uniform(-1);
    do n = 1 to r;
    bootrij[n,m] = bootrij[n,m]+(rijcum[n,m] >= x);
    end;
  end;
end;

***** generates bootstrapped matrix of recaptures;
temp = j(r, c, 0);
do i = 2 to r;
  temp[i,] = bootrij[i,]-bootrij[(i-1),];
  end;
r2 = 2:r;
brij = bootrij[1,]//temp[r2,];
brij2 = brij[,+]; brij3 = brij[+,];
```

Appendix 5 (continued).

```
*** traps strata where recaps = 0;
do i = 1 to r;
  if brij2[i,1] = 0 then brij[,1]={0, 0};
  end;
do j = 1 to c;
  if brij3[1,j] = 0 then brij[1,] = {0 0};
  end;
***** calculates bootstrapped schaeffer;
crprime = (catch/brij[,+])`;
cr = shape(crprime, r, c);
mr = shape(tagavail/brij[+,], r, c);
rij = brij#cr`#mr;** population estimates by individual periods;

totalp = rij[+,]; total = rij[+,+];

totalrec = brij[+,+];
totalcat = catch[+,];
totaltag = tagavail[,+];

carrier = resnw||ressw||totalp||totalrec||totalcat||totaltag;

miramich[nperm,a1] = carrier[1,a1];
end;

headers = {resnw ressw totala totalb totalrec totalcat totaltag};
create boot1 from miramich [colname=headers];
append from miramich;
close boot1;
quit;
run;

data nw94smal; set boot1;
  schaefer = round((totala + totalb ),50);
  summer = round((totala),50);
  fall = round((totalb),50);
  if totala = 0 or totalb = 0 then do;
    schaefer = .; summer = .; fall = .;
    totala = .; totalb = .;
    end;
  totala = round(totala,50);  totalb = round(totalb,50);

  if totalrec = 0 then peterson = .;
  else peterson = round((totaltag/totalrec*totalcat),50);

proc univariate data = nw94smal;
 var resnw ressw schaefer peterson summer fall totalrec totaltag;
 run;
data _nul_; set nw94smal;
  file 'nw94smal.prn';
  put schaefer 12. peterson 12. summer 12. fall 12.;
run;
endsas;
```