STATUS OF ATLANTIC SALMON IN THE RESTIGOUCHE RIVER IN 1994

by

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Summary Sheet

Stock: Restigouche River, SFA 15
Target: 71.4 million eggs (12,200 large salmon, 2,600 small salmon)
Rearing area: 29,768,000 m², 76% of SFA 15, 30% of Gulf New Brunswick

	1989	1990	1991	1992	1993	1994	MIN[1]	MAX[1]	MEAN[2]
Angling catch (retained+released)									
Large	4603	3735	3137	4355	2055	3979	1016	6707	3577
Small	3360	4324	2522	4751	3268	4840	896	6873	3645
Angling catch (retained)									
Large	1162	893	956	1004	514	963	514	6707	906
Small	3360	4324	2522	4751	3268	4840	896	6873	3645
First Nations' catch									
Large	1649	1606	1111	1422	1202	1365	129	2950	1398
Small	163	136	19	55	0	76	0	178	75
Spawning escapement (mark-recapture method)[3]									
Large (X 1000)	-	-	-	-	6(4- 9)	16(12- 26)	6	16	6
Small (X 1000)	-	-	-	-	7(5-12)	17(12- 29)	7	17	7
Total returns (mark-recapture method)[3]									
Large (X 1000)	-	-	-	-	9(7-13)	22(18- 34)	9	22	9
Small (X 1000)	-	-	-	-	12(10-18)	26(20- 40)	12	26	12
% egg target met (mark-recapture method)[3]									
	-	-	-	-	48(37-76)	137(105-218)	48	137	48
Spawning escapement (angling exploitation method)[4]									
Large (X 1000)	8- 14	6-11	5- 9	7- 13	3- 6	7- 12	1- 2	11- 19	6-11
Small (X 1000)	3- 8	4-10	3- 6	5- 11	3- 8	5- 11	1- 2	7- 16	4- 9
Total returns (angling exploitation method)[4]									
Large (X 1000)	13- 20	10-16	9-14	12- 19	6- 9	11- 17	6- 9	23- 30	10-16
Small (X 1000)	8- 13	10-17	6-10	11- 18	8-13	11- 19	3- 4	16- 27	9-14
% egg target met (angling exploitation method)[4]									
	65-116	53-95	43-78	62-111	28-51	56-101	9-20	89-159	50-90

[1] MIN MAX for years 1970 to present.
[2] MEAN for years 1989 to 1993.
[3] Most probable value with 95% confidence limits.
[4] Range given reflects uncertainty of angling exploitation rate (assumed to be between 0.3 and 0.5), from which spawning escapement, eggs, and total returns are derived.

Landings: Angling catches of large (including catch and release in N.B.) and small salmon in 1994 were 11 and 33% higher than the five-year means, respectively. Estimated First Nations' harvest was 2% below the five-year mean.

Data and assessment: In 1989-1992 the assessment was based only on angling catch with an assumed exploitation rate of 0.3-0.5. A mark-recapture experiment was used to estimate river population and spawning escapement in 1993 and 1994 and this estimate is presented along with that of the earlier method. In 1994, mark-recapture population estimates are about three times higher than the most conservative angling-based estimates. Visual surveys of spawners provide a minimum estimate of escapement similar to the angling-based estimate with exploitation rate of 0.5. The mark-recapture estimate is probably the most scientifically defensible, but for management purposes the angling-based estimate is more conservative. Calibration and evaluation of the various assessment methods must be a research priority in 1995.

State of the stock: Egg deposition was 137% (C.L. 105-218%) (mark-recapture estimate) or 56-101% (angling-based estimate) of target. According to the mark-recapture estimate, both large and small salmon escapement were met or exceeded. According to the angling-based estimate, large salmon spawning escapement target was not met but the small salmon spawning target was exceeded.

Forecast for 1995: Based on mean returns from 1990-1994 (angling-based method), between 9,600-15,000 large salmon and 9,200-15,300 small salmon are expected to return in 1995. The ranges given reflect upper and lower exploitation rates used in calculating returns.

Abstract

Salmon egg deposition and large salmon spawning escapement in the Restigouche system increased by a factor of two or three in 1994 relative to 1993 levels. The magnitude of the increase, and the absolute abundance of salmon in the Restigouche system relative to target levels were controversial and different assessment methods were not in agreement. A mark-recapture experiment indicated that egg deposition target was met (most probable value was 137% of target, with 95% confidence limits of 105-218%). Large salmon spawning escapement was 16,000 (12,000-26,000) which met or exceeded the target of 12,200 large salmon. Small salmon spawning escapement of 17,000 (12,000-29,000) exceeded the requirement of 2,600 fish. However, more conservative estimates were obtained from an angling-based methodology with assumed exploitation rates of 0.3 and 0.5. Egg deposition by this methodology was 56-101% of target. Large salmon escapement (7,000-12,000) was less than target. Small salmon escapement (5,000-11,000) exceeded target. The mark-recapture estimate is probably more scientifically defensible, but the angling-based estimate is more conservative for management purposes. Minimum population estimates obtained from visual surveys of spawners agreed with the angling-based estimate with exploitation rate of 0.5. Calibration and evaluation of these and other methodologies used to assess salmon in the Restigouche system must be a research priority in 1995.

According to the mark-recapture estimate, returns were in the range of 22,000 (18,000-34,000) large and 26,000 (20,000-40,000) small salmon. The angling-based estimate of returns was 11,000-17,000 large and 11,000-19,000 small salmon. Angling catches (retained+released) were 3,979 large and 4,840 small salmon. Retained large salmon catch (Québec) was 963 fish. Estimated First Nations' harvest was 1,365 large and 76 small salmon. Large and small salmon angling catches increased by 11 and 33%, respectively, relative to the five-year means.

Juvenile densities determined by electrofishing were 12-16% lower than the five-year means, but were typical of four of the previous five years.

Assuming average (1990-1994) returns in 1995, total returns (angling-based estimate) will be 9,600-15,000 large salmon and 9,200-15,300 small salmon.

Résumé

En 1994, la ponte des saumons ainsi que les échappées de grands saumons reproducteurs dans le réseau hydrographique de la Restigouche ont doublé ou triplé par rapport à 1993. L'ordre de grandeur de cet accroissement et l'abondance absolue du saumon dans ce réseau hydrographique par rapport aux cibles prêtaient toutefois à la controverse et les diverses méthodes d'évaluation produisaient des résultats différents. Une expérience de marquage-recapture révélait que la ponte-cible avait été atteinte (la valeur la plus probable était de 137 % de la cible, avec un intervalle de précision de 95 % se situant entre des pôles de 105 et 218 %). Les échappées de grands saumons étaient chiffrées à 16 000 (12 000-26 000), ce qui est égal ou supérieur à la cible de 12 200. Les échappées de petits saumons, soit 17 000 (12 000-29 000), étaient supérieures à la cible, fixée à 2 600. Toutefois, selon des estimations plus prudentes fondées sur la pêche à la ligne et sur des taux d'exploitation présumés de 0,3 et 0,5, la ponte se situait à 56-101 % de la cible. Quant aux échappées de grands saumons (évaluées entre 7 000 et 12 000), elles étaient inférieures à la cible. Les échappées de petits saumons (5 000-11 000) étaient, elles, supérieures à la cible. L'estimation fondée sur l'opération de marquage-recapture est probablement plus défendable sur le plan scientifique, mais celle qui repose sur la pêche à la ligne est plus prudente pour la gestion. Les estimations de population minimale fondées sur des analyses visuelles des reproducteurs concordent avec les estimations fondées sur la pêche à la ligne à un taux d'exploitation de 0,5. L'étalonnage et l'évaluation de ces méthodes et d'autres qui sont utilisées dans l'évaluation du saumon du réseau hydrographique de la Restigouche doivent être une priorité en 1995.

Selon les estimations fondées sur l'opération de marquage-recapture, les montaisons étaient de l'ordre de 22 000 (18 000-34 000) grands et de 26 000 (20 000-40 000) petits saumons. Les mêmes estimations, fondées cette fois sur la pêche à la ligne, se chiffraient à 11 000-17 000 pour les grands saumons et à 11 000-19 000 pour les petits saumons. Les prises des pêcheurs à la ligne (prises gardées + prises remises à l'eau) étaient de 3 979 grands saumons et de 4 840 petits saumons. Les prises de grands saumons gardées (Québec) se chiffraient à 963 poissons. On estimait la récolte des Premières nations à 1 365 grands saumons et à 76 petits saumons. Les prises de grands et de petits saumons par les pêcheurs à la ligne ont augmenté de 11 et de 33 % respectivement par rapport à la moyenne sur cinq ans.

Les densités de juvéniles établies par électropêche étaient inférieures de 12 à 16 % à la moyenne sur cinq ans, mais conformes à celles de quatre des cinq dernières années.

En tablant sur des résultats moyens par rapport à 1990-1994, les montaisons de 1995 devraient être de l'ordre de 9 600 à 15 000 grands saumons et de 9 200 à 15 300 petits saumons.

1 - Introduction

The objective of this report is to evaluate the status of Atlantic salmon in the Restigouche River in 1994. Numbers of spawners are estimated from (1) a mark-recapture experiment, (2) angling data and exploitation rates believed to represent lower and upper limits (the true rate is unknown), and (3) visual surveys of spawners. The advantages and disadvantages of each of these methods of stock assessment are discussed. This report also summarizes angling and First Nations' harvest statistics, juvenile salmon densities at 11 standard electrofishing sites, hatchery stocking and broodstock collection, and forecasts of adult salmon returns in 1995.

In the terminology of this report, small salmon (grilse) are adults less than 63 cm in fork length, which are comprised mainly of 1SW (one-sea-winter) maiden salmon. Large salmon (also known as salmon, MSW or multi-sea-winter salmon) are adults greater than or equal to 63 cm in fork length. This category contains mainly maiden 2SW and 3SW fish and previous spawners.

2 - Description of fisheries

During 1994, two user groups exploited Atlantic salmon in the Restigouche River: anglers and First Nation communities.

Regulations controlling angling of salmon in 1994 were similar to regulations in 1993. Angling was permitted from June 1 to August 31. Anglers in New Brunswick tributaries were obliged to release all large salmon back into the river; catches of small salmon were restricted by seasonal and daily bag limits to eight and two fish, respectively. In Québec tributaries, anglers were allowed to retain both small and large salmon with daily and seasonal bag limits of one and seven fish, respectively; if the first fish caught in a day was a small salmon, a second salmon could be caught and retained irrespective of size. Unlike 1993, when Québec anglers could not retain large salmon after August 9, large salmon retention was permitted for the full season. Québec/New Brunswick boundary waters were regulated by the New Brunswick catch and release policy for large salmon.

Most salmon captured by First Nation fisheries were gill-netted in the estuary, although some angling also took place in freshwater portions of the river. First Nation gill-net fisheries mainly occurred at Listuguj First Nation at Ristigouche, Québec, and at Eel River Bar First Nation near Dalhousie, N.B. (Fig. 1). First Nations did not operate food-fishery trapnets in 1994. The target harvest at Eel River Bar was initially set at 200 large and 0 small salmon following discussions between the band council and DFO. Catches at the Morrissey Rock research trapnet (Fig. 1) were monitored as an in-season index of stock status. Since catches at Morrissey Rock were high relative to 1993, the final harvest target at Eel River Bar was increased to 500 large and 50 small salmon. There was no quota or harvest target for Listuguj First Nation. Dates of the fisheries, where known, are shown in Table 1.

Commercial salmon fisheries in Chaleur Bay have been closed in Québec since 1984, and in New Brunswick since 1985. Commercial fishermen in both provinces were prohibited from landing salmon caught in non-

salmon fishing gear (by-catch).

Harvests of large salmon in 1994 were 963 by anglers (Québec only) and 1365 in First Nation fisheries (Table 2). Harvests of small salmon (New Brunswick and Québec) were 4840 by anglers and 76 in First Nation fisheries.

3 - Target

Egg deposition requirements for the Restigouche River, to provide 2.4 eggs per square meter, are 71,443,200 eggs (Randall 1984). About 12,200 large salmon are required to produce these eggs. An additional 2,600 small salmon are required to ensure a 1:1 sex ratio at spawning, based on past sex ratios of large and small salmon (Randall 1984). Total egg deposition is calculated as follows:

Egg deposition = (large spawners x eggs/large fish)+(small spawners x eggs/small fish)

where: eggs/large fish=5,933
eggs/small fish= 86

Eggs/fish is a mean value for the entire spawning population (males and females combined), calculated by Randall (1984) from egg counts made on fish harvested in 1983 by the freshwater, commercial, and First Nation fisheries, and sex ratios of salmon sampled at the Dalhousie trap, 1972-1980.

The above spawning target is based on Dept. of Fisheries & Oceans estimate of rearing area, 29.8 x 10^6 m^2. N.B. Dept. of Natural Resources & Energy considers the rearing area in the system to be 32.3 x 10^6 m^2 (A. Madden, unpubl. data). At the time when the current target egg deposition was determined, the DNRE estimate of rearing area was only 24 x 10^6 m^2 and consequently the larger estimate was used (Randall, 1984).

Research Recommendation: Target egg deposition for the Restigouche system should be re-evaluated. As well as rearing area, eggs/fish, sex ratio, and age structure of the population may have to be updated; they may have changed in response to management and regulatory changes since 1984. Biological sampling of salmon killed in angling or gill-netting fisheries would be necessary to determine sex ratios and eggs/fish, since all fish trapped by DFO for research purposes are released alive.

4 - Fishery data

Fishery data were obtained from the sources listed in Appendix 6 of Claytor et al. (1994). As in 1993, First Nations harvest statistics for Eel River Bar and Listuguj were obtained from T. Lutzac, DFO. E. LeBlanc, DNRE, provided harvest statistics (1992-1994) for St. Basile First Nation.

In 1994, angling catches of large and small salmon increased by 11 and 33%, respectively, relative to the 1989-1993 means (Table 3, Fig. 2). Catches increased relative to the five-year mean in virtually every tributary (Table 4). The majority of the catch (76% of large salmon, 81% of small salmon) was taken in New Brunswick or provincial boundary waters

(Table 3). In 1994, 45% of the angled salmon were large (Table 3).

Catch per unit effort (CPUE) has been consistently two to three-fold higher in New Brunswick or boundary waters than in Québec tributaries (Table 5). In 1994, CPUE increased for small salmon in both provinces, but there was no consistent trend in CPUE of large salmon.

Landings by New Brunswick First Nations members decreased by 8% (large salmon) and increased by 2% (small salmon) in 1994 relative to the five year mean (Table 6). Landings were not reported by Listuguj First Nation in 1994. The mean landings of 1989-1993 (the most recent years for which landings were reported) were used as a substitute for 1994 data.

Relative to the five-year mean, total landings in 1994 (angling and First Nations) in the Restigouche system increased by 20% (Table 7).

5 - Research data

5.1 - Morrissey Rock trapnet

As in 1992 and 1993, a tagging trapnet was operated jointly at Morrissey Rock Pool (Fig. 1) by Eel River Bar First Nation and DFO. Design and dimensions of the trapnet were similar to those described by Claytor et al. (1994), except for a steeper angle on the outside leader, which was extended by 20 m to maintain river coverage similar to previous years. High water prevented early installation of the trapnet, which became operational on June 16 and was fished until September 20 for a total of 96 days.

During the season 136 large and 455 small salmon were counted (Table 8, Fig. 3), an increase of 167% for large and 33% for small salmon relative to 1993 captures. Of the counted fish, 116 large and 430 small salmon were tagged with blue Carlin tags and released. Fish which were visibly diseased or injured were released untagged. Fork length and presence of disease or of ectoparasitic copepods ("sea lice") were recorded and a scale sample was collected for ageing.

Run timing of small salmon was similar to that observed in 1993, with a large peak in abundance during the first three weeks of July and a smaller peak from July 26 to mid-August (Fig. 3). Very few small salmon were captured before July and even fewer after mid-August.

Much of the large salmon run was probably not sampled because of the late installation date of the trap. Large salmon were not abundant after the third week of July (Fig. 3).

The occurrence of disease, parasites, and net-marked fish was similar in large vs small salmon (Table 9). In 1994, 2% of salmon had reddish fins or areas of the body, consistent with furunculosis (Table 9). As in 1993, these fish were not autopsied to confirm furunculosis and we were unable to visually distinguish this condition from others such as vibriosis or even abrasion of the skin or fins by parasites. The occurance of furunculosis-like signs was similar in 1993 and 1994. A higher proportion of both large and small salmon were reported as carrying sea lice in 1994 compared to 1993, but these may have been more consistently recorded in 1994. Net marks, which were recorded in both

years, were more common on both large and small salmon in 1994 (17-22% of fish) than in 1993 (10-12% of fish).

"Catches" of dead salmon on the upstream side of the trapnet and leaders were also recorded as an index of in-river mortality. These fish probably died as a result of disease or hook-and-release mortality and were carried downriver by the current. They were not separated into large and small components (many were highly decomposed), but the majority were large salmon, and, especially in 1993, many had red marks on the fins or ventral surface consistent with furunculosis. Approximately equal numbers of salmon washed up in 1993 and 1994, but in 1993 they would have represented a larger proportion of the smaller run. Dead salmon "catches" in 1993 were concentrated in the early part of the season, whereas in 1994 they occurred throughout the summer (Table 10).

In both years, 2-3% of tags recovered from small salmon were collected from dead fish found on shore (Table 11).

5.2 - Adams' Shore trapnet

A tagging trapnet was installed for the first time on the Adams' Shore side of Smith Island (Fig. 1) and operated jointly by Listuguj First Nation and DFO. Design and dimensions were similar to those of the Morrissey Rock trapnet. Operating dates were June 20 to September 11, a total of 83 days.

In total, 23 large and 141 small salmon were captured (Table 8, Fig. 4), of which 21 large and 137 small salmon were tagged and released. Data collection was similar to that at Morrissey Rock.

Catches at the trap were sporadic and are not representative of run timing. Maximum daily catch was 39 small and 5 large salmon on July 21 (Fig. 4).

5.3 - Upsalquitch fish barrier

A barrier fence has been operated by DNRE at 10 Mile Pool on the Northwest Upsalquitch River (Fig. 1) since 1980 (Table 12). Returns to the fence in 1994 were 1329 small and 740 large salmon. These returns represent an increase of 12% relative to the 5-year mean for small salmon, and a decrease of 9% for large salmon. Large salmon comprised 36% of the total run to the fence.

5.4 - Causapscal fish barrier

MEF has operated a barrier fence on the Causapscal River (a tributary of the Matapedia River; Fig. 1) since 1988. In 1994, 3 small salmon and 349 large salmon returned to the fence (Table 12). Both small and large salmon numbers have decreased relative to the five-year means (by 80% and 18%, respectively). Large salmon comprised 99% of the total run to the fence.

5.5 - Spawner surveys (canoe)

Spawner surveys were carried out by DNRE, MEF and DFO Conservation & Protection personnel in autumn (usually October-November) of 1982-1994

(no survey was done in 1990 due to high water). In New Brunswick waters, DNRE and DFO personnel visually surveyed spawners from canoes. On waters >20 m in width, two canoes on opposite sides of the stream were poled downstream, each carrying one or two persons, with the observer standing. On narrower streams, one canoe was used. Areas which were inaccessible by canoe were walked. In Québec waters, MEF personnel surveyed spawners by snorkelling (1993-1994; see section 5.6) or canoe (previous years). The intent of these spawner surveys has been to directly observe spawners in 80-85% of the Restigouche River system, including all the main spawning areas but excluding some smaller tributaries (e.g. Tom's, Christopher, Hailes and Berry brooks) which generally contain few spawners. However, the proportion of the Restigouche system directly surveyed for spawners has sometimes been much less than 80-85% (Table 13). When spawner counts could not be carried out in a particular tributary, redd counts conducted later in the season were often substituted, and the number of spawners estimated from the ratio of redds/fish in previous years. Historical relationships between parts of the system were sometimes utilized to estimate spawner numbers in areas which were not surveyed. Barrier fence counts were added to the totals for the Northwest Upsalquitch and Causapscal rivers. DNRE collated the data from the various sources and generated abundance estimates for each tributary.

The estimated abundance of spawners in the entire system in 1994 was 6,871 large and 4,390 small salmon (Table 14a). Almost one-third of the spawners were reported in the Upsalquitch River, and the remainder were more-or-less equally distributed (about 15% per tributary) in the Matapedia, Kedgwick, Little Main and Main Restigouche rivers (Table 15a). Only half as many spawners (8.5%) were reported in the Patapedia River.

5.6 - Spawner surveys (snorkel)

Snorkelling was used by MEF to survey the entire system for the first time in 1994. Between September 27 and October 22, the Causapscal, Kedgwick, Little Main Restigouche, Gounamitz, Upsalquitch, Main Restigouche, Matapedia and Patapedia rivers were surveyed (D'Amours 1994). Mid-season surveys of selected areas were also carried out from August 2 to 18. The method used varied with river size and water clarity. When conditions allowed (clear water, weak current), canoe counts were carried out during the spawning season when salmon were concentrated in the head and foot of pools. However, in most tributaries, salmon were counted by divers. In small tributaries such as the upper Patapedia, Causapscal and Gounamitz rivers, one diver drifted downriver counting all salmon. In intermediate-size tributaries (e.g. the lower reaches of the Patapedia, the Little Main, and the upper reaches of the Kedgwick River), the team included a diver and a canoeist. The canoe preceded the diver downriver, so as to form a 45° angle with the bank, and funnel salmon towards the diver, who was responsible for counting. In large and deep rivers (Main Restigouche, Matapedia, Kedgwick, Upsalquitch rivers) two divers and a canoe formed a 45° angle with the bank. As they drifted downriver, the first diver was responsible for counting fish passing between himself and the canoe. The second diver counted all other fish.

Abundance of spawners observed by this method in 1994 was 4,631 large salmon and 3,169 small salmon. Fish counted at the Upsalquitch (735 large, 1322 small salmon) and Causapscal (327 large, 2 small salmon)

barrier fences up to the date of the diver survey were added to the observed count for a total of 5,693 large and 4,493 small salmon (Table 14b). The area covered was approximately 75% of the spawning habitat. The distribution of salmon among tributaries (Table 15b) was approximately similar to that of the canoe counts.

The MEF diver counts covered a smaller portion of the Little Main and Kedgwick systems than the DNRE spawner counts. DNRE suggested the addition of spawners from the Little Main Restigouche upstream from the mouth of the Gounamitz River (126 small and 189 large salmon) and the North Branch of the Kedgwick River (101 small and 223 large salmon) to the MEF diver counts to standardize the coverage of the two visual surveys. With this addition, 6,105 large and 4,720 small salmon would have been present (Table 14b).

5.7 - Hatchery stocking and broodstock collection

In total, 275,000 eyed eggs, 577,000 unfed fry and 56,000 feeding fry were distributed to satellite rearing facilities or to the Kedgwick, Little Main Restigouche, Main Restigouche and Upsalquitch rivers by the Charlo Salmonid Enhancement Centre (Table 16).

Adults to be used as broodstock were collected from Forks Pool in the Kedgwick River (40 females, 31 males) and Junction Pool at the confluence of the Kedgwick and Little Main Restigouche rivers (31 females, 30 males) for a total of 132 salmon. From these salmon, 397,682 eggs were collected from Kedgwick River stock, and 384,359 eggs from presumed Little Main Restigouche River stock, for a total of 782,041 eggs (1% of the conservation target for the Restigouche system).

5.8 - Electrofishing

Juvenile salmon were electrofished by DFO at 11 standard sites during July and August (Fig. 1). Abundances were calculated by the removal method (Zippin 1956). Ninety-five percent confidence intervals of the mean densities were calculated after individual site counts were transformed to natural logarithms. Densities of salmon fry and parr have been estimated at these sites each year since 1972.

Mean abundances of 58.5 0+, 10.9 1+ and 2.6 2+ parr·100 m^{-2} were lower by 12, 14 and 16%, respectively, than the five-year means (Table 17). However, the five-year mean was inflated by a large cohort spawned in 1990 (Fig. 5) and the 1994 juvenile abundances were typical of four of the previous five years.

6 - Estimation of stock parameters

6.1 - Angling-based estimate

Total returns were considered to be the sum of estuary harvest, river harvest, poaching and disease (PAD) removals, and spawning escapement.

Returns = Estuary harvest + PAD + River harvest + Escapement

headwaters				estuary
spawning escapement	river harvest	poaching & disease (PAD)	estuary harvest	returns
		B	A	

Estuary harvest included the harvests of both the Listuguj and Eel River Bar First Nations.

An adjustment for mortality resulting from poaching and disease is normally excluded from calculations of spawning escapement in other rivers since the target egg deposition level of 2.4 eggs/m^2 takes this source of mortality into account. It has been retained in the assessment for the Restigouche River since in this system poaching and disease occurs prior to or at the same time as in-river removals and thus must be added to these to estimate returns.

Poaching and disease (PAD) mortality rate was assumed to be 0.14 of the population entering the river (i.e. after estuary harvest, but before angling) for small salmon and 0.16 for large salmon, as in previous assessments (Randall et al. 1988). The calculation was made as follows:

For large salmon, **PAD = 0.16[B/0.84]** because,

PAD = 16% of the population at point A and,

The population at point A = B + 0.16 A or, B/0.84

B, the population available to anglers = angling catch/exploitation rate

B = Catch/Exp

Therefore, **PAD = 0.16[(Catch/Exp)/0.84]**

By similar logic, PAD for small salmon was calculated as:

PAD = 0.14[(Catch/Exp)/0.86]

River harvest for small fish is the sum of fish lost to angling, collected for broodstock (Charlo hatchery, N.B.) and removed (in-river) by St. Basile and Eel River Bar First Nations.

River harvest for large fish is the sum of fish lost to angling (Québec), mortality associated with catch and release (N.B.), collected for broodstock and removed (in-river) by St. Basile and Eel River Bar First Nations. The mortality rate associated with catch-and-release of large salmon was assumed to be 6% (from observations summarized in Appendix 1 of Courtenay et al. 1991).

Spawning escapement was calculated as angling catch divided by angling exploitation rate minus river harvest. Angling exploitation rate is unknown for the Restigouche River, but Randall et al. (1990) argued that it is probably somewhere between 0.3 and 0.5. Therefore, spawning escapements were calculated for these limits (but see section 7.2.2 for further comments on probable exploitation rates).

Returns were estimated as 10,807-17,123 large (Tables 18, 19) and 11,303-18,807 small (Tables 20, 21) salmon. The ranges reflect the difference in the estimates when exploitation rate is set to 0.3 or 0.5. Spawning escapement was calculated as 6,650-11,955 large and 4,811-11,264 small salmon.

The probabilities that estimates of spawning escapement were different from targets were assessed through a randomization procedure which used the uncertainty in angling exploitation rate and reported angling catches. The procedure was as follows:

1. Estimate spawners in the current year using an exploitation rate drawn at random from a uniform distribution between 0.3 and 0.5. Estimates of angling catch are assumed to be accurate within 20% of the true catch (catch is drawn at random from a uniform distribution between reported catch/1.2 and reported catch/0.8).

2. Subtract the target from the estimated value to determine the difference in spawners or egg deposition relative to the target.

3. Repeat steps 1 & 2 1000 times and plot the distribution of the differences. The probability that the observed spawning escapement or egg deposition is less than the target level is equal to the percentage of observations of differences less than 0.

A sample SAS program for these randomization tests is shown in Appendix 1.

The probability that spawning escapement is less than target is 0% for small salmon (Fig. 6) and 100% for large salmon (Fig. 7).

6.2 - Mark-recapture experiment

An estimate of the within river returns at (point A in PAD description) in 1994 was determined by mark-recapture using small salmon marked with blue carlin tags at the Morrissey Rock trapnet.

Returns were estimated using a Bayesian estimator as described by Gazey and Staley (1986). The estimator determines the most probable population size given R recaptures out of M marks, in a sampled catch of C. The returns of small salmon to point "A" (Morrissey Rock trapnet) was calculated using (1) Upsalquitch angling returns of tags applied up to August 15 and (2) Upsalquitch barrier fence returns of tags applied throughout the full season. These two estimates were pooled using a multiplicative model to obtain the most probable estimate. Since the angling-based method estimates returns to point "A" up to August 15, and the fence-based method estimates returns to point "A" up to September 20, the pooled estimate is a conservative estimate of the population.

The values of R, M and C required for the Bayesian estimate were obtained as:

M ('Tags applied' at Morrissey Rock): 430 small salmon were tagged and released at Morrissey Rock. Tagging mortality was assumed to be 10% as in the Miramichi River (Chaput et al. 1994). Tag loss was assumed to occur after tagging mortality at a rate of 0.009/day as determined for

the Margaree River (Chaput et al. 1993). Median days to recapture of 17 days was based on Upsalquitch River recaptures. Accordingly, tags applied through the full tagging season were used with Upsalquitch fence recaptures. Tags applied to August 15 were used with Upsalquitch angling recaptures (closing date for angling was August 31).

R ('Tags recaptured'): Only fish recaptured in the Upsalquitch system were utilized in calculating total returns. Tag reporting rates were estimated using a telephone survey. Tagged fish were recaptured at angling camps, on Crown Reserve waters and at the Upsalquitch barrier fence. A telephone survey of Crown Reserve anglers and of angling camp managers determined return rates of angled tags to be 75% by Crown Reserve anglers, 100% by camps. It was assumed that 100% of tagged fish at the Upsalquitch barrier fence were reported.

C ('Total recaptures'): The recapture methods were Upsalquitch angling (sum of camps and Crown Reserves) or Upsalquitch fence counts.

Spawning escapement was obtained by subtracting angling catch, other freshwater removals (e.g. broodstock, hook-and release mortality) and a poaching-and-disease correction. Total returns to the Restigouche system were obtained by adding First Nations harvest (estuary harvest).

The above procedure was used to estimate total returns of small salmon. Since reporting of large salmon tags was less reliable than small salmon tags, the large salmon population estimate was made using the ratio of large:small salmon in the combined New Brunswick and Québec angling catch (45% large salmon, Table 3). The whole-system ratio was considered to be the appropriate correction factor for large salmon abundance, since the mark-recapture estimate obtained for small salmon pertains to abundance in the entire Restigouche system, not just the Upsalquitch. As well, ratios of large:small salmon arriving at the Upsalquitch barrier fence are not representative of the Restigouche as a whole, which precludes using the large:small salmon ratio at the fence. The disadvantage of this ratio method is that it assumes angling exploitation rates of large and small salmon are similar.

The spawning escapement estimates from the 1994 mark-recapture study were 16,218 large (Table 22, Fig. 8) and 17,061 small (Table 23, Fig. 9) salmon. Total returns of large salmon were estimated as 22,197 fish and of small salmon were 25,547 fish.

The 1993 mark-recapture data were re-evaluated in 1994 using the above method. The recalculated 1993 data incorporated tag reporting rates of 77% for Crown Reserve and 100% for camp anglers. In 1993, an adjustment for tag reporting rates of 77% had been applied to all angled tags, not just those from Crown Reserve angling (Claytor et al. 1994). Median days to recapture in 1993 were 15 days. The revised estimates for 1993 are: 5,665 large and 7,032 small salmon spawners, 8,866 large and 12,000 small salmon total returns (Tables 22, 23).

7 - Assessment results

7.1 - Status of stock (all methods)

	Large spawners	Small spawners
Target (71.4 million eggs):	**12,200**	**2,600**
Evidence for 'target met':		
Mark-recapture estimate	16,218	17,061
95% confidence limits	(12,438-25,839)	(12,331-29,101)
Evidence for 'target not met':		
Angling exploitation estimate		
ER=0.3	11,955	11,264
ER=0.5	6,650	4,811
Canoe-based spawner counts	6,871	4,390
Diver spawner counts	5,693	4,493
with DNRE adjustment	6,105	4,720

As summarized above, the estimates of abundance obtained by different methods differed by a factor of three to four. According to the mark-recapture method, both large and small salmon escapement exceeded target; large salmon exceeded target by 33% (approximately 4,000 salmon above target) and there was a surplus of >14,000 small salmon. The lower confidence limit of spawning escapement by this method (12,438 large and 12,331 small salmon) resembled the abundance estimate obtained from the angling exploitation method with ER=0.3, which indicated that large salmon escapement did not quite meet the target, and that there was a surplus of >8,000 small salmon. The remaining three methods were approximately in agreement that large salmon escapement was about 50% of target (5,000-6,000 salmon less than the target) and that there was a surplus of approximately 2,000 small salmon. Egg deposition relative to target is shown in Figure 10. Spawning escapement estimates of the different methods are summarized in Figures 11 and 12.

The most scientifically defensible estimate of population abundance (see discussion in section 7.2.2) was probably the mark-recapture estimate which concluded that the large salmon target was met (133% of required large spawners, with confidence limits of 102-212%). Small spawner escapement by this method was substantially above target.

The other methods, which indicated that target was not met, were perhaps not as scientifically defensible (section 7.2.2) but were more

conservative from a management point of view.

Accepting the ER=0.5 angling-based estimate, which approximated 'minimum' escapement obtained from visual count methods, was the approach supported by participants at the Restigouche Science Workshop meeting of November 22, 1994 (Appendix 2) as the most conservative alternative. Using the ER=0.3-0.5 range as the bottom line, as was done in Restigouche assessments before 1993, would also be a conservative approach for management purposes.

Evaluation of the different assessment methodologies being used on this river must be a research priority for 1995. As a first step in this process, it is important to consider the assumptions, merits and problems of each methodology.

7.2 - Comparison of methods

7.2.1 - General considerations

Basic ecology texts (e.g. Krebs 1985) categorize methods for determining abundance of a population as:

(1) Total counts of the population (census): This is the most direct way to determine the size of a population. Absolute abundance is obtained without sampling error.

(2) Sampling methods to estimate absolute abundance:

(a) Quadrat sampling: Count all individuals on quadrats of known size and extrapolate the average to the whole area.

(b) Capture-recapture methods: Mark a known number of individuals, utilize the ratio of marked:unmarked individuals in a random sample to extrapolate population size.

(3) Measures of relative density (Index methods): Samples are collected that represent some relatively constant but unknown relationship to the total population size.

With the exception of MEF's spawner counts (a partial census), all methods currently used to assess the status of the Restigouche salmon stock fall into categories (2) and (3). DNRE's spawner counts, often represented as a total census of the population, are a quadrat sampling method since less than 100% of the system is surveyed and extrapolations are made to the unsurveyed portion. The methods, summarized by category, are:

(1) Census:
- Spawner surveys (by divers). This is a partial census since portions of some tributaries are not censused. However, no attempt is made to extrapolate abundance of salmon in areas which are not censused, so this is not a quadrat sampling technique.

(2) (a) Quadrat sampling:
- Spawner surveys (from canoes). In years where redd counts and historical relationships are used extensively, this is no longer a

quadrat sampling method but a hybrid of quadrat/index methods.

(2) (b) Capture-recapture methods:
- Capture and mark at Morrissey Rock trap, recapture in Upsalquitch River.

(3) Index methods:
- Abundance at Morrissey Rock trap.
- Abundance at Upsalquitch barrier fence.
- Abundance at Causapscal barrier fence.
- Total angling catch.
- Angling catch at specific sites (e.g. at four "index camps").
- Catch per unit effort for whole system.
- Catch per unit effort at specific sites (e.g. Crown Reserve waters).
- Redd counts (an index obtained by quadrat sampling).
- Juvenile abundance (useful as an index for forecasting or hindcasting but not for current year stock status).

(4) Unclassified methods:
- The angling-exploitation based method of calculating spawner abundance, which does not fall into any of the categories listed above, utilizes an index of abundance (angling catch) and extrapolates to absolute abundance using a presumed angling exploitation rate of 30 to 50%.

7.2.2 - Characteristics of assessment methods

1. Estimates of absolute abundance

(a) Mark-recapture method

The advantages of this method are:

1. The assumptions, mathematical basis (e.g. required numbers of marks and recaptures) and methodology are well-established. Recaptures of 25-75 marked fish will provide a population estimate within 25% of the true value, 95% of the time, for populations of 10^2 to 10^9 individuals (Ricker 1975).

2. Confidence limits can be calculated.

3. Standardization of methodology with other major Gulf Region salmon rivers, i.e. Miramichi and Margaree.

The assumptions of this method, along with concerns relating to possible violations in the present experiment (and solutions, where possible) are:

1. **There is no immigration (recruitment) to, or emigration from, the population during the period of capture, marking and recapturing.** There is no recruitment of salmon to the recapture site that have not previously passed the initial capture site, point A. In similar types of studies, mark-recapture methods have been successfully used to estimate the abundance of migratory fish marked at one point and recaptured at another, since the 1940's (Ricker 1975). However, the use of the

Upsalquitch River alone as the recapture site requires a further assumption which may be problematic (B. Dempson, pers. comm.). There are, obviously, fish entering the river that are going to areas other than the Upsalquitch. An assumption is therefore required that the ratio of marked to unmarked fish in the Upsalquitch is the same as that in all other parts of the river system. Tag:catch ratios (see discussion under Scenario (1), below) suggest that this is not necessarily the case. (Solution: Improve tag recoveries from tributaries other than the Upsalquitch so that tags returned from the entire Restigouche system are used in mark-recapture calculations.)

2. **Marked and unmarked animals are captured randomly.** It is possible that the probability of recapture is affected by tagging. Tagged fish may be more visible to anglers due to behavioural changes or because the tag itself shows up well and if so the fish might be more readily targeted. Or, tagging might cause behavioural changes which make the fish less susceptible to angling. For example, tagged fish may drop down into the estuary which makes them unavailable for freshwater angling. (Solution: We used two different means of recapture, the Upsalquitch barrier fence and angling. Both yielded similar proportions of tagged:untagged fish, suggesting that there was no change in probability of capture of fish that had reached the Upsalquitch system. This does not, however, address the possibility that tagged fish might choose to leave the freshwater system altogether.)

3. **Marked animals are subject to the same mortality rate as unmarked animals.** If fish are physiologically stressed from handling during tagging, they may be more susceptible to disease, temperature stress, or other causes of mortality.

4. **Marks are not lost or overlooked.** Tags may fall off fish. (Solution: An experiment should be conducted to empirically evaluate tag loss.) Anglers may not return tags because of lack of interest or knowledge, or may keep tags as a souvenir. (Solution: In 1993 and 1994 we have used telephone surveys of anglers to estimate tag return rates). Anglers often do not remove or report tags from fish which are released, which includes most large salmon in the Restigouche system. (Solution: We estimate abundance using mark-recapture techniques for small salmon only. For large salmon, which must all be released in New Brunswick, we estimate abundance from large:small salmon ratios in the angling catch. But see comments below (point 5) on the validity of this ratio.)

5. **Both the marking and the recapturing technique yield a random sample of the population.** If different spawning stocks (belonging to specific tributaries) behave differently, then marking and recapturing probably do not sample randomly. For example, fish were marked at Morrissey Rock, thus presumably selecting for fish travelling up the south channel of the Restigouche. Fish recaptured in the Upsalquitch belong to the Upsalquitch spawning stock. If the proportion of Upsalquitch fish travelling up the south channel is different from that of stocks from other tributaries, then the assumption of randomness is violated. (Solution: Tag fish at a second trap in the north channel. This was attempted in 1994 with limited success.) See below for a more complete discussion of the possible consequences of selection for Upsalquitch fish.

Given that the mark-recapture population estimate for 1994 was

substantially higher than that of other methods, it is worthwhile to review scenarios by which the mark-recapture estimate could overestimate the population:

(1) The Morrissey Rock trapnet selectively captures salmon destined for tributaries other than the Upsalquitch (the recapture site). i.e. Upsalquitch fish are selected against at the trapnet.
(2) The tag reporting rate is lower than assumed.
(3) Tagged fish are less catchable by anglers than untagged fish.
(4) Tag loss is higher than assumed. Either (a) median days-at-large before recapture is more than the estimate and/or (b) tag loss is greater than 0.009/day.
(5) Mortality of tagged fish is greater than that of untagged fish, and is not sufficiently accounted for by the correction factor of 10%.

Scenarios (1) through (4a) are unlikely. Comparison of tag returns and angling catch by tributary (Table 24) suggests that Morrissey Rock trap may select for Upsalquitch fish, not against them, resulting in an underestimate of the population according to scenario (1). However, higher ratios of tags:catch in the Upsalquitch system relative to other systems (Table 25) may be the result of better tag reporting rates in the Upsalquitch. Tag reporting rate (scenario 2) has been verified by a phone survey of Upsalquitch camps and crown reserve anglers. If tagged fish were less catchable than untagged fish (scenario 3), then the proportion of tagged fish in the captured population should differ between angled fish and the Upsalquitch fence. This is not the case (Table 25). Median days-at-large used in the tag loss estimate (scenario 4a) is derived from tag return data and is probably correct.

Scenarios (4b) and (5) remain. There is no empirical estimate of tag loss rates for the Restigouche. The presently used value of 0.009/day was derived from tagging experiments in the Margaree. Mortality rates of tagged vs. untagged fish are likewise unknown. In the mark-recapture estimate, a mortality rate of 10% has been applied to tagged fish, following the practice used in the Miramichi assessment.

In the 1994 population estimate, the combined effect of applying a 10% tagging mortality rate and then assuming a tag loss of 0.009 tags/day for the median days-at-large is a reduction in tagged fish of 28% relative to those tagged at the trap. To estimate the same spawning escapement as that predicted by ER=0.3, about 47% of tagged fish would have to be lost. To reach the spawning escapement predicted by canoe counts, about 64% of tagged fish would have to be lost. These proportions appear excessive based on estimates used in other systems. In the Margaree assessment, the 0.009 tag loss correction is applied without the additional 10% mortality factor. In the Miramichi, only the 10% mortality factor is applied, with no additional correction for tag loss. Using both the tag loss and the mortality factors is a conservative approach.

The abundance of large salmon was estimated from the calculated abundance of small salmon, using the large:small salmon ratio in angling catches in the entire Restigouche system. The assumption of similar exploitation rates of large and small salmon, required by this method, should be tested.

(b) Angling exploitation rate method

Advantages:

1. Abundance estimates based on this method are available for a number of years for the Restigouche.

2. Angling catches are relatively well documented and recorded with relatively little error in the Restigouche, where most of the angling is regulated in private camps or crown waters.

3. Low cost.

Disadvantages:

1. This method depends on angling exploitation rate, which is unknown. The true value is believed to lie between 0.3 and 0.5. These upper and lower bounds were selected by Randall et al. (1990). The lower bound, ER=0.5, was estimated using spawner abundances from canoe surveys. However, an attempt to evaluate the canoe surveys in 1989 showed them to underestimate abundance by 15-41% (Randall et al. 1990). Consequently, exploitation rates using the results of these surveys would be overestimated. The upper bound, ER=0.3, was selected because early-run salmon in the Miramichi were exploited at 0.34 (Randall et al. 1991). In 1994, early-run small salmon in the Miramichi system were exploited at 0.20 (Southwest Miramichi R.) to 0.28 (Northwest Miramichi R.). The 1994 exploitation rate of small salmon in the Restigouche River based on the mark-recapture estimate was 0.22 (0.14-0.28). This was lower than the 1993 exploitation rate of 0.32 (0.21-0.40). Large salmon angling exploitation rates from the mark-recapture estimates were 0.23 (0.15-0.29) in 1994 and 0.32 (0.21-0.40) in 1993. Higher exploitation rates reported for other Gaspe rivers in 1994 (MEF data) were based on visual spawner counts and therefore probably overestimated.

2. It is not possible to directly establish confidence limits for this estimate.

3. The method assumes that angling success is directly proportional to population size. However, other factors such as catchability (presumably related to environmental factors like temperature and water level) and effort (which is not independent of population size and catchability) also affect angling catch.

(c) Visual spawner counts

Advantages:

1. A minimum estimate of population size is obtained from the MEF diver survey (based only on observed fish, no extrapolations) and the DNRE count when it encompasses all (or almost all) of the drainage.

2. Localized information on spawner status, i.e., by tributary or section of tributary.

Assumptions:

1. Visibility is equivalent among years, as well as among tributaries.

2. All observers are equally skilled.

3. Fish do not move between quadrats during the count.

Disadvantages/Concerns:

1. Weather conditions affect the success of spawner counts. Extreme weather conditions (e.g. flooding) may prevent spawner counts.

2. Observer error (not observing fish, mistaken species identity, inability to distinguish large and small salmon) may cause underestimates or overestimates.

3. It is not possible to determine the error or set confidence limits unless quadrat counts are replicated.

4. Where redds are being used to estimate spawners, the relationship between redds and spawners needs further verification.

5. Different methods are used to estimate the population in different stretches of river (e.g. canoe counts by DNRE, snorkel counts by MEF, redd counts where necessary).

As mentioned above, canoe-based spawner counts were shown by Randall et al. (1990) to underestimate abundance by 15-41%. Diver-based spawner counts were shown in the same study to underestimate abundance by 10-23%.

2. Estimates of relative abundance

(a) Returns to traps and barrier fences

The number of individuals caught per day provides a useful relative index of run timing. The absolute number of fish trapped depends not only on the population density but also on their activity and the researcher's skill in placing traps or barrier fences. Trap efficiency may vary from year to year or even within a season, hence trap counts provide only an approximate indication of abundance.

Trends in abundance of salmon counted at Morrissey Rock trap and the Upsalquitch barrier fence, relative to 1993 values, were similar (Table 26). Weekly trends recorded through the summer were also in general agreement. Trends in returns to the Causapscal River were somewhat different from the Upsalquitch (Table 26). Spawner counts (Table 15) suggest that the proportion of salmon returning to each tributary varies annually. Therefore counts at a barrier fence on a particular tributary may not be representative of the entire system. However, annual variability in the proportion of salmon returning to each tributary does not invalidate the mark-recapture estimate for the entire system as long as the proportion of marked:unmarked fish does not vary among tributaries.

(b) Angling catch

The error associated with compilations of total angling catch on the Restigouche River, where most angling is conducted from private camps, is much less than on most other New Brunswick rivers. For this reason, angling catch on the Restigouche is probably a better index of salmon returns than it is on many other rivers. However, angling catch is often not directly related to salmon abundance, as discussed above with respect to the angling-based abundance estimate.

Angling catch at four index camps is used as an in-season weekly index of fish abundance. In most years, angling catch at these camps is significantly ($P<0.05$) correlated with the total catch in the system. In 1994, trends in index camp catch were different from those in the total angling catch (Table 26). Where possible, it is probably better to utilize the whole-system catch. For in-season index purposes, weekly collection of catches for the whole system is not possible, and use of the four index camps is probably an acceptable compromise.

(c) Catch per unit effort

Catch per unit effort (CPUE) may be a better index of stock status than total catch. However, effort is measured in rod-days, where one rod-day is counted for any portion of a day when an individual has fished. Thus, a rod-day might represent only 30 minutes of fishing, or 12 hours.

CPUE may be calculated for the entire Restigouche system or for subsets of the system, such as Crown Reserve or Crown Lease waters. Crown Reserve and whole-system CPUE were substantially different in 1994 (Table 26). In particular, small salmon CPUE was estimated as 0.72 fish/rod-day for Crown Reserve waters, but was 0.26 for the whole system. Similar to angling catch, whole-system CPUE is probably more representative of relative abundance.

7.2.3 - Comparison of trends

Comparing 1993 and 1994 estimates

According to the small salmon tag/catch ratios presented in Table 25, escapement in 1994 should have been in the order of 1.3 to 2.4 times higher than in 1993. All the small salmon estimates presented in Table 27 approximately correspond to this expected increase. The ratio of 1994:1993 mark-recapture estimates for small salmon is on the high end of this distribution with a value of 2.4. The increases in large salmon estimates in 1994 over 1993 are greater than those for small salmon; 1993 was considered to be a particularly poor year for large salmon abundance in the Restigouche system.

As described in section 7.1, three of the five estimates of absolute abundance were in general agreement (although the two spawner count methods are not independent of one another). The trends in relative abundance from 1993 to 1994 are similar for large salmon abundance estimates and indices based on angling catch (angling exploitation ER=0.3 and 0.5, total angling catch), canoe spawner counts and Upsalquitch fence counts, and indicate an increase ranging from 94% to 110% (Table 26). There was little agreement in trend between methodologies when comparing

1994 values to the five-year means for large salmon.

For small salmon, angling-based measures (angling exploitation ER=0.3 and 0.5, total angling catch) described an increase in abundance of 48% in 1994 relative to 1993 (Table 26). Catch per unit effort, and counts at Morrissey Rock trap and Upsalquitch barrier fence indicated an increase of abundance of 33-39% over the same period. Angling-based measures, canoe spawner counts and catch per unit effort described an increase of 24-33% in 1994 relative to the five-year means.

7.2.4 - Conclusions regarding methodology

1. All the methods discussed above have limitations and require more thorough evaluation.

2. The index techniques are most useful as a supplement to estimates of absolute abundance and as an in-season indicator of large changes in population size.

3. It will be essential to carry out empirical tests in 1995 which evaluate the different estimates of absolute abundance. A proposal for a jointly conducted experiment to evaluate DFO's mark-recapture method, DNRE's visual canoe counts and MEF's visual snorkelling counts in 1995 is currently being developed.

8 - Ecological considerations

Water discharge in the first half of June, 1994 (solid bars) was more than twice the mean value for 1919-1993 (Fig. 13). Values for this time period in both 1993 and 1994 were substantially higher than those recorded in any year since 1919. Early installation of the Morrissey Rock research trap, impossible in 1993 and 1994 due to strong current, should be feasible in a year of "normal" discharge. Above-average rainfall in late May contributed to the high June discharge. Water levels in 1994 continued to be high through June and July but were extremely low through most of August, when rainfall was substantially lower than the average. Water levels and temperature may be linked to annual variation in occurrence of furunculosis.

9 - Forecast/Prospects

Three forms of forecasting were used:

(1) Five-year mean: Returns of large and small salmon in 1995 were predicted to be similar to average returns for the period 1990 to 1994 (based on the angling catch-exploitation rate method with ER of 0.3 to 0.5).

(2) Adult survival: Returns of small fish in 1993 and 1994 were assumed to reflect the relative survival at sea of cohorts contributing to large salmon returns in 1995. The average of returns of small salmon in 1993 and 1994 was compared to the previous 5-year average, as a possible index of sea survival. The predicted return of large salmon in 1995 from this method is expressed as a percent change from the previous 5-year mean returns.

(3) Spawning success: Indices of age 1+ parr were used to predict future returns of both large and small salmon. Forcasting from juvenile densities is based on ages of spawners in the Restigouche River, where most small salmon return to spawn as 3 or 4 year old fish, and most large salmon return to spawn as 4 to 6 year old fish (unpublished data). Thus, small salmon returning to spawn in 1995 originate from eggs laid in 1990 or 1991. Large salmon returning in 1995 probably belong to the cohort of eggs laid in 1988 through 1990. The average of 1+ parr densities for 1990 to 1992 were compared to the previous 5-year average, as a possible index of recruitment strength of large salmon. Similarly, for potential returns of small salmon in 1995, age 1+ parr densities for 1992 and 1993 were compared to the previous 5-year average. Predicted returns based on parr abundance are expressed as a percent change from the previous 5-year mean 1+ parr densities.

Forecasts for 1995 returns are as follows:

	Large salmon	Small salmon
Five-year mean	9,551-15,031	9,217-15,327
Adult survival	-8%	---
Spawning success	+46%	+24%

10 - Management Considerations

The most conservative management strategy is to accept the angling exploitation rate method (ER=0.5). This suggests that about 50% of the large salmon target for spawning escapement was met. By this method, small salmon escapement was met and current harvesting strategies appear to be acceptable. Large salmon escapement could have been enhanced by reducing estuary and river harvests targetted at this component of the stock.

In-season monitoring and forecasting is currently carried out using catches at the Morrissey Rock research trap and at four index angling camps. In 1994, these indices were used to adjust the in-season target harvest level of Eel River Bar First Nation.

11 - Research Recommendations

1. To improve the stock assessment it is essential to calibrate (or validate) the various methods used to estimate spawning escapement (especially the spawner count and mark-recapture methods) because of the discrepancy among the different estimates in 1994.

2. If possible, the number of tags applied and/or recovered should be increased to improve precision of the mark-recapture estimate. Tag recoveries from tributaries other than the Upsalquitch need to be improved. It may be feasible to collect tag information at MEF salmon registration stations.

3. Ratios of tagged:untagged salmon should be collected during spawner surveys by divers and used to determine if fish tagged at research traps preferentially move into different tributaries.

4. Improved harvest data from First Nation netting is essential to the assessment. As well, catch per unit effort data from Listuguj First Nation nets may provide a useful indicator of changes in salmon migration patterns if the Atholville pulp and paper mill reopens in 1996 (salmon are expected to cross to the north shore to avoid the mill effluent, thus increasing the exploitation rates of the First Nation fishery). Collection of 1995 data would provide baseline information.

5. The spawning target for the Restigouche should be re-evaluated, takimg into account updated estimates of spawning area, and the possibility that age/size structure has changed.

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Table 1. Operating dates of First Nations fisheries in Chaleur Bay and Restigouche River, 1979 to 1994.

Year	New Brunswick		Québec
	Gillnet	Trap net[a]	Gillnet
1979	May 14 - October 24		June 6 - August 1
1980	May 19 - July 13		June 2 - July 28
1981	May 15 - August 30		
1982	May 17 - August 1		June 9 - August 2
1983	May 16 - August 28		June 3 - August 7
1984	May 14 - August 27		June 5 - August 10
1985	May 20 - August 25		June 3 - July 31
1986	May 19 - August 10	May 26 - July 20	June 2 - June 26
1987	May 24 - July 27	May 24 - July 15	June 1 - June 30
1988	May 16 - August 26	May 16 - August 14	June 6 - July 6
1989	May 15 - August 20	May 29 - August 20	June 5 - June 30
1990	May 14 - July 22	May 22 - July 25	June 11 - July 6
1991	May 12 - July 27	May 26 - July 27	June 3 - June 28
1992	May 25 - August 23	May 26 - August 2	June 10, 11, 12, 16, 17, 25 & 30 July 1, 6, 9, 10, 14, 15 & 19
1993	May 17 - August 8		May 17 - August 8
1994	May 16 - July 16		N/A

[a] One trap net in 1986. Two trap nets in 1987 to 1992.

Table 2. Preliminary estimates of harvests (numbers) of small and large salmon in Restigouche River, 1994. Harvests of salmon in 1993 are given for comparison.

Fishery	1994		1993		Mean (89-93)		1994 c.f. Mean	
	Small	Large	Small	Large	Small	Large	Small	Large
First Nations								
N.B.	58	380	0	301	57	413	+2%	-8%
P.Q.	18	985	0	901	18	985	0%	0%
Angling								
N.B.	3942		2472		2974		+33%	
P.Q.	898	963	796	514	671	906	+34%	+6%
Total	4916	2328	3268	1716	3720	2304	+32%	+1%

Table 3. Estimated angling catches of salmon in the Restigouche River, 1970 to 1994. Estimates of large salmon (1984 to 1994) include released fish in New Brunswick. New Brunswick catch-and-release data were estimates from angling lodge logbooks, crown reserve angler questionnaires and DFO fishery officers.

	Large			Small			Proportion Large		
Year	PQ	NB	Total	PQ	NB	Total	PQ	NB	Total
1970	326	1716	2042	166	1340	1506	0.66	0.56	0.58
1971	259	757	1016	173	999	1172	0.60	0.43	0.46
1972	1171	3870	5041	111	978	1089	0.91	0.80	0.82
1973	1146	3746	4892	147	1423	1570	0.89	0.72	0.76
1974	1163	4785	5948	129	1038	1167	0.90	0.82	0.84
1975	741	2160	2901	149	1130	1279	0.83	0.66	0.69
1976	1029	4481	5510	377	2345	2722	0.73	0.66	0.67
1977	1579	5128	6707	459	2333	2792	0.77	0.69	0.71
1978	1652	3373	5025	282	1322	1604	0.85	0.72	0.76
1979	826	997	1823	556	1990	2546	0.60	0.33	0.42
1980	2059	4098	6157	409	2833	3242	0.83	0.59	0.66
1981	1408	2832	4240	635	3010	3645	0.69	0.48	0.54
1982	962	1620	2582	402	2449	2851	0.71	0.40	0.48
1983	587	1481	2068	181	715	896	0.76	0.67	0.70
1984	604	1672	2276	314	1474	1788	0.66	0.53	0.56
1985	851	3563	4414	344	3258	3602	0.71	0.52	0.55
1986	1420	4763	6183	502	4915	5417	0.74	0.49	0.53
1987	970	3203	4173	696	4414	5110	0.58	0.42	0.45
1988	1129	4546	5675	789	6084	6873	0.59	0.43	0.45
1989	1162	3441	4603	509	2851	3360	0.70	0.55	0.58
1990	893	2842	3735	765	3559	4324	0.54	0.44	0.46
1991	956	2181	3137	535	1987	2522	0.64	0.52	0.55
1992	1004	3351	4355	752	3999	4751	0.57	0.46	0.48
1993	514	1541	2055	796	2472	3268	0.39	0.38	0.39
1994	963	3016	3979	898	3942	4840	0.52	0.43	0.45
Mean (89-93)	906	2671	3577	671	2974	3645	0.57	0.47	0.49
1994 c.f. Mean	+6%	+13%	+11%	+34%	+33%	+33%	-9%	-9%	-8%

Table 4. Estimated angling salmon catches from Restigouche River, by tributary, 1970 to 1994. Prior to 1982 Little Main catches included in Main Restigouche. Catches of large salmon (1984 to 1994) include released fish in New Brunswick.

	Matapedia		Upsalquitch		Patapedia		Kedgwick		Little Main		Main Restigouche	
Year	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large
1970	162	290	270	122	4	24	323	205			747	1401
1971	153	217	344	90	20	40	128	67			527	602
1972	102	1010	362	984	7	144	165	425			453	2478
1973	147	1098	498	512	0	43	128	548			797	2691
1974	124	1083	433	579	5	63	80	289			525	3934
1975	131	692	462	262	18	31	136	316			532	1600
1976	296	922	767	753	80	88	209	348			1370	3399
1977	278	1312	554	901	181	227	368	684			1411	3583
1978	251	1457	449	507	31	158	143	423			730	2480
1979	466	754	507	135	90	60	316	123			1167	751
1980	311	1784	1178	592	95	229	284	468			1374	3084
1981	485	1176	1234	221	148	175	356	473			1422	2195
1982	259	841	818	214	143	112	322	190	59	50	1250	1175
1983	154	456	203	218	27	103	68	224	14	0	430	1067
1984	285	560	483	346	44	59	149	164	102	27	725	1120
1985	291	807	1175	507	104	84	330	185	163	50	1539	2781
1986	389	1289	1397	630	163	187	566	519	481	155	2421	3403
1987	602	915	819	410	193	77	583	409	407	142	2506	2220
1988	680	1068	1296	659	185	107	807	707	524	74	3381	3060
1989	466	1119	836	515	73	62	208	544	43	31	1734	2332
1990	718	856	905	375	81	45	304	258	152	108	2164	2093
1991	521	940	403	195	30	29	277	403	121	75	1170	1495
1992	693	966	1180	561	122	57	420	320	238	141	2098	2310
1993	735	505	644	221	80	16	231	104	85	42	1493	1167
1994	822	917	1212	508	147	51	455	231	269	106	1935	2166
Mean (89-93)	627	877	794	373	77	42	288	326	128	79	1732	1879
1994 c.f. Mean	+31%	+5%	+53%	+36%	+91%	+21%	+58%	-29%	+110%	+34%	+12%	+15%

Table 5. Preliminary estimates of angling catch, effort and CPUE in New Brunswick and Québec portions of the Restigouche River, 1994. Catch, effort and CPUE in 1993 are given for comparison.

		1994			1993			Mean (89-93)			1994 c.f. Mean		
		Catch	Effort	CPUE	Catch	Effort	CPUE	Catch	Effort	CPUE	Catch	Effort	CPUE
N.B.	Small	3942	10303	0.38	2472	10167	0.24	2974	9980	0.30	+33%	+3%	+27%
	Large[a]	3016	10303	0.29	1541	10167	0.15	2671	9980	0.27	+13%	+3%	+7%
P.Q.	Small	898	8554	0.10	796	6633	0.12	671	7499	0.09	+34%	+14%	+11%
	Large	963	8554	0.11	514	6633	0.08	906	7499	0.12	+6%	+14%	-8%
N.B.+	Small	4840	18857	0.26	3268	16800	0.19	3645	17479	0.21	+33%	+8%	+24%
P.Q.	Large	3979	18857	0.21	2055	16800	0.12	3577	17479	0.20	+11%	+8%	+5%

[a] Estimates of N.B. large salmon are released fish.

Table 6. First Nations salmon landings for Chaleur Bay and Restigouche River, 1975 to 1994.

	New Brunswick									Québec			
	Estuary			River			Total			Estuary			
Year	Small	Large	Total	Small	Large	Total	Small	Large	Total	Small	Large	Total	Total
1975	3	132	135				3	132	135				135
1976	13	124	137				13	124	137	0	1517	1517	1654
1977	19	212	231				19	212	231	0	2738	2738	2969
1978	23	129	152				23	129	152				152
1979	84	148	232				84	148	232	85	748	833	1065
1980	34	264	298				34	264	298	24	1563	1587	1885
1981	20	211	231				20	211	231				231
1982	12	155	167				12	155	167	148	1521	1669	1836
1983	0	260	260				0	260	260	32	1216	1248	1508
1984	1	213	214				1	213	214	177	1070	1247	1461
1985	0	241	241				0	241	241	35	976	1011	1252
1986	26	431	457				26	431	457	4	1145	1149	1606
1987[a]	95	916	1011				95	916	1011	5	986	991	2002
1988	70	509	579				70	509	579	3	921	924	1503
1989	151	568	719				151	568	719	12	1081	1093	1812
1990	120	471	591				120	471	591	16	1135	1151	1742
1991	10	252	262				10	252	262	9	859	868	1130
1992	2	464	466	0	10	10	2	474	476	53	948	1001	1477
1993	0	293	293	0	8	8	0	301	301	0	901	901	1202
1994[b]	29	348	377	29	32	61	58	380	438	18	985	1003	1441
Mean (89-93)	57	410	466	0	9	9	57	413	470	18	985	1003	1473
1994 c.f. Mean	-49%	-15%	-19%	-	+256%	+578%	+2%	-8%	-7%	0%	0%	0%	-2%

[a] Québec First Nation landings from (Randall et al. 1988).
[b] Québec First Nation landings are 1989-93 means.

Table 7. Commercial, angling and First Nations salmon landings from Chaleur Bay and Restigouche River, 1970 to 1994.

	Commercial		Angling		First Nations		
Year	Small	Large	Small	Large	Small	Large	Total
1970		18180	1506	2042			21728
1971		8967	1172	1016			11155
1972	36	23	1089	5041			6189
1973	1272	295	1570	4892			8029
1974	132	68	1167	5948			7315
1975	163	1026	1279	2901	3	132	5504
1976	5107	225	2722	5510	13	1641	15218
1977	1134	168	2792	6707	19	2950	13770
1978	1522	156	1604	5025	23	129	8459
1979	83	671	2546	1823	169	896	6188
1980	1986	9	3242	6157	58	1827	13279
1981	3045	3534	3645	4240	20	211	14695
1982	2202	4437	2851	2582	160	1676	13908
1983	1552	4569	896	2068	32	1476	10593
1984	7161	2026	1788	604	178	1283	13040
1985	0	0	3602	851	35	1217	5705
1986	0	0	5417	1420	30	1576	8443
1987	0	0	5110	970	100	1902	8082
1988	0	0	6873	1129	73	1430	9505
1989	0	0	3360	1162	163	1649	6334
1990	0	0	4324	893	136	1606	6959
1991	0	0	2522	956	19	1111	4608
1992	0	0	4751	1004	55	1422	7232
1993	0	0	3268	514	0	1202	4984
1994	0	0	4840	963	76	1365	7244
Mean (89-93)	0	0	3645	906	75	1398	6023
1994 c.f. Mean	0%	0%	+33%	+6%	+1%	-2%	+20%

Table 8. Salmon catches at Morrissey Rock and Adams' Shore trapnets.

	Morrissey Rock			Adams' Shore		
Year	Small	Large	Operating dates	Small	Large	Operating dates
1992	63	38	Jul. 15 - Oct. 22			
1993	342	51	Jun. 1 - Jun. 2 & Jun. 16 - Aug. 16			
1994	455	136	Jun. 16 - Sep. 20	141	23	Jun. 20 - Sep. 11

Table 9. Percentage of salmon trapped (by date) at Morrissey Rock with presumed furunculosis (i.e. with red fins or blotches on body), ectoparasites (sea lice) or net marks.

Date	1993 Percent of salmon with: Furun-culosis	Sea lice	Net marks	1993 Total catch at trap	1994 Percent of salmon with: Furun-culosis	Sea lice	Net marks	1994 Total catch at trap
(a) Large salmon								
Jun. 16-30	0	7	14	14	0	46	42	43
Jul. 1-15	0	4	18	22	6	49	18	55
Jul. 16-31	11	0	0	9	0	14	0	28
Aug. 1-15	25	0	0	4	0	43	29	7
Aug. 16-31	0	0	0	1	0	100	0	1
Sep. 1-15	0	0	0	0	0	0	0	1
Sep. 16-30	0	0	0	0	0	0	0	1
Jun. 16-Sep. 30	4	4	12	50	2	40	22	136
(b) Small salmon								
Jun. 16-30	0	57	14	14	0	31	23	26
Jul. 1-15	0	9	10	117	2	27	13	199
Jul. 16-31	2	12	8	115	2	45	22	168
Aug. 1-15	6	40	14	91	0	56	15	54
Aug. 16-31	0	0	0	5	0	60	20	5
Sep. 1-15	0	0	0	0	0	100	0	1
Sep. 16-30	0	0	0	0	0	100	0	2
Jun. 16-Sep. 30	2	20	10	342	2	38	17	455

Table 10. Dead salmon (large and small combined) found (by date) against the upstream side of the Morrissey Rock trapnet and leaders.

Date	1993	1994
Jun. 16-30	3	0
Jul. 1-15	13	3
Jul. 16-31	0	5
Aug. 1-15	0	6
Aug. 16-31	0	0
Sep. 1-15	0	1
Total	16	15

Table 11. Means by which tags applied to small salmon at Morrissey Rock trap were recovered in 1993 and 1994.

	Percent of recoveries	
Method of recovery	1993	1994
Angling	55	63
Upsalquitch barrier fence	26	31
Morrissey Rock recaptures	11	4
Broodstock	5	0
Found dead by anglers	3	2
Total number recovered	64	57

Table 12. Counts of salmon at two fish barriers in the Restigouche River system.

Year	Small	Large	Total	Proportion Large	Operating Dates
NW Upsalquitch barrier					
1980	843	887	1730	0.51	Jun. 17 - Oct. 19
1981	789	481	1270	0.38	Jun. 5 - Oct. 29
1982	819	622	1441	0.43	Jun. 4 - Oct. 17
1983	430	301	731	0.41	Jun. 20 - Oct. 30
1984	518	642	1160	0.55	Jun. 8 - Oct. 28
1985	748	517	1265	0.41	Jun. 5 - Oct. 27
1986	1738	1166	2904	0.40	Jun. 6 - Oct. 23
1987	1557	1000	2557	0.39	Jun. 10 - Oct. 29
1988	1121	993	2114	0.47	Jun. 6 - Oct. 25
1989	1051	894	1945	0.46	Jun. 4 - Oct. 22
1990	1324	946	2270	0.42	Jun. 22 - Oct. 14
1991	1267	930	2197	0.42	Jun. 1 - Oct. 16
1992	1351	963	2314	0.42	Jun. 22 - Oct. 22
1993	957	353	1310	0.27	Jun. 27 - Oct. 13
1994	1329	740	2069	0.36	Jun. 26 - Oct. 18
Mean (89-93)	1190	817	2007	0.40	
1994 c.f. Mean	+12%	-9%	+3%	-10%	
Causapscal barrier					
1988	49	505	554	0.91	Jun. 12 - Sep. 6
1989	7	605	612	0.99	Jun. 18 - Sep. 14
1990	37	456	493	0.92	Jun. 12 - Aug. 14
1991	9	451	460	0.98	Jun. 17 - Aug. 26
1992	8	350	358	0.98	Jun. 12 - Aug. 5
1993	12	256	268	0.96	Jun. 18 - Aug. 17
1994	3	349	352	0.99	Jun. 21 - Sep. 21
Mean (89-93)	15	424	438	0.97	
1994 c.f. Mean	-80%	-18%	-20%	+2%	

Table 13. Methods used by DNRE to estimate "spawner counts" in the Restigouche system.

		% of total salmon numbers derived from:				
Year	Salmon	Redd counts (redd:spawner ratios)	Observed & counted spawners	Calc. from historical relationships	Fence counts	Method not described
1986	Large	18	59	8	0	15
	Small	46	38	7	0	9
1991	Large	21	0	38	12	29
	Small	33	0	24	33	10
1993	Large	19	26	37	18	0
	Small	14	15	19	52	0

Table 14. (a) DNRE canoe-based spawner counts, by tributary, of the Restigouche River system, 1985 to 1994.

	Matapedia		Upsalquitch		Patapedia		Kedgwick		Little Main		Main Restigouche		Restigouche System		Restigouche System
Year	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large	Small + Large
1985	321	892	925	1174	61	548	108	968	525	1859	343	2342	2132	7934	10066
1986	336	1114	2632	2451	311	728	281	976	1241	2541	413	1708	5190	9542	14732
1987	622	946	1948	2179	80	953	582	1729	610	1418	357	949	3930	8535	12465
1988	791	1243	1761	2140	317	1117	602	1546	536	2128	238	962	3861	9520	13381
1989	764	1834	1387	2223	178	1012	289	1640	923	2442	803	2837	3970	12362	16332
1990[a]	1080	1289			214	783									
1991	640	1152	2247	1575	162	586	423	1204	332	862	453	1713	4257	7092	11349
1992	711	1023	1986	1434	141	502	161	515	200	665	73	565	3272	4704	7976
1993	628	1010	1183	570	98	442	127	370	175	500	141	620	2352	3512	5864
1994	384	1376	1909	1534	282	670	518	1111	611	1192	686	988	4390	6871	11261
Mean (89-93)	765	1262	1701	1451	159	665	250	932	408	1117	368	1434	3463	6918	10380
1994 c.f. Mean	-50%	+9%	+12%	+6%	+77%	+1%	+107%	+19%	+50%	+7%	+86%	-31%	+27%	-1%	+8%

[a] Count incomplete. High water prevented field spawner count in New Brunswick.

(b) MEF diver-based spawner counts, by tributary, of the Restigouche River system, 1994.

	Matapedia		Upsalquitch		Patapedia		Kedgwick		Little Main		Main Restigouche		Restigouche System		Restigouche System
Year	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large	Small + Large
1994	383	1389	1835	1289	282	670	960	772	575	416	458	1157	4493	5693	10186
1994 with DNRE adjustments (see text section 5.6)	383	1389	1835	1289	282	670	1061	995	701	605	458	1157	4720	6105	10825

Table 15. (a) Distribution of spawners and spawning habitat among tributaries. From DNRE spawner counts.

	Percentage of total spawner numbers by tributary:					
Year	Matapedia	Upsalquitch	Patapedia	Kedgwick	Little Main	Main Restigouche
1985	12.1	20.9	5.9	10.7	23.7	26.7
1986	9.8	34.5	7.1	8.5	25.7	14.4
1987	12.7	33.4	8.2	18.7	16.4	10.6
1988	15.2	29.2	10.6	16.1	19.9	9.0
1989	15.9	22.1	7.3	11.8	20.6	22.3
1991	15.8	33.7	6.6	14.3	10.5	19.1
1992	21.7	42.9	8.1	8.5	10.8	8.0
1993	27.9	29.9	9.2	8.5	11.5	13.0
1994	15.6	30.6	8.5	14.5	16.0	14.9
Mean	16.3	30.8	7.9	12.4	17.2	15.3
Habitat	21.4	13.1	5.8	8.1	5.9	45.8

(b) Distribution of spawners and spawning habitat among tributaries. From MEP spawner counts.

	Percentage of total spawner numbers by tributary:					
Year	Matapedia	Upsalquitch	Patapedia	Kedgwick	Little Main	Main Restigouche
1994	17.4	30.7	9.3	17.0	9.7	15.9
1994 with DNRE adjustments (see text section 5.6)	16.4	28.9	8.8	19.0	12.1	14.9
Habitat	21.4	13.1	5.8	8.1	5.9	45.8

Table 16. Distributions of Atlantic salmon to the Restigouche River system by the Charlo Salmonid Enhancement Centre in 1994.

River	Number	Stage	Destination
Kedgwick	25,000	eyed eggs	MSRT[a] incubation boxes
	360,000	unfed fry	Kedgwick River
	22,000	feeding fry	MSRT[a] satellite site
Little Main	250,000	eyed eggs	NWSA[b] incubation boxes
	115,000	unfed fry	Little Main Restigouche River
	5,500	feeding fry	Boston Brook Lodge satellite site
Main Restigouche	24,000	feeding fry	Runnymede Lodge satellite site
Upsalquitch	102,000	unfed fry	Upsalquitch River
	4,500	feeding fry	Boland Brook Lodge satellite site

[a] Management of Salmon in the Restigouche and tributaries.
[b] Northwest Salmon Association.

Table 17. Juvenile densities of Atlantic salmon in the Restigouche River, 1972 to 1994. Juvenile densities (number per 100m2) are mean densities of 15 (1972-90 & 93), 8 (1991), 10 (1992) and 11 (1994) standard sites, designated by year of spawning.

Year (i)	Juvenile salmon densities 0+ (year i+1)	1+ (year i+2)	2+ (year i+3)
1971	5.2	2.8	0.6
1972	22.0	6.1	1.5
1973	13.1	4.8	1.0
1974	28.6	6.9	1.4
1975	13.3	3.9	1.0
1976	14.7	6.3	1.4
1977	19.5	5.9	2.1
1978	6.1	3.8	0.4
1979	9.3	2.4	0.4
1980	18.9	3.3	3.1
1981	11.2	7.8	2.5
1982	25.4	7.3	1.6
1983	25.1	10.4	2.8
1984	25.2	7.5	4.7
1985	23.9	9.4	2.1
1986	42.0	6.1	1.9
1987	53.2	12.1	3.1
1988	72.1	12.9	2.9
1989	53.2	12.3	2.8
1990	106.5	14.6	4.7
1991	49.6	11.5	2.6
1992	51.4	10.9	-
1993	58.5	-	-
1994	-	-	-
Mean (89-93)	66.6	12.7	3.1
1994 c.f. Mean	-12%	-14%	-16%

Table 18. Estimated spawners (S) and total returns (R) of large salmon in Restigouche River, 1970 to 1994. Spawners were estimated using an angling exploitation rate (u) of 0.3.

Year	Harvest		Catch Including Releases	Poaching and Disease (PAD)	Spawners (S)	Returns (R)
	Estuary	River				
1970	18180	2042		1297	4765	26284
1971	8967	1016		645	2371	12999
1972	23	5041		3201	11762	20027
1973	295	4892		3106	11415	19708
1974	68	5948		3777	13879	23672
1975	1158	2901		1842	6769	12670
1976	1866	5510		3499	12857	23732
1977	3118	6707		4259	15650	29734
1978	285	5025		3191	11725	20226
1979	1567	1823		1158	4254	8802
1980	1836	6157		3910	14366	26269
1981	3745	4240		2692	9893	20570
1982	6113	2582		1640	6025	16360
1983	6045	2068		1313	4825	14251
1984[a]	3309	722	2276	1445	6865	12341
1985	1217	1173	4414	2803	13540	18733
1986	1576	1695	6183	3926	18915	26112
1987	1902	1170	4173	2650	12740	18462
1988	1430	1329	5675	3604	17588	23951
1989	1649	1492	4603	2923	13851	19915
1990	1606	1146	3735	2372	11304	16428
1991	1111	1181	3137	1992	9276	13560
1992	1412	1337	4355	2765	13180	18694
1993	1194	779	2055	1305	6071	9349
1994	1333	1308	3979	2527	11955	17123
Mean (89-93)	1394	1187	3577	2271	10736	15589
1994 c.f. Mean	-4%	+10%	+11%	+11%	+11%	+10%

[a] River harvests (1984 to 1994) may include catch and release mortalities and broodstock and First Nations removals.

Table 19. Estimated spawners (S) and total returns (R) of large salmon in Restigouche River, 1970 to 1994. Spawners were estimated using an angling exploitation rate (u) of 0.5.

Year	Harvest		Catch Including Releases	Poaching and Disease (PAD)	Spawners (S)	Returns (R)
	Estuary	River				
1970	18180	2042		778	2042	23042
1971	8967	1016		387	1016	11386
1972	23	5041		1921	5041	12026
1973	295	4892		1864	4892	11943
1974	68	5948		2266	5948	14230
1975	1158	2901		1105	2901	8065
1976	1866	5510		2099	5510	14985
1977	3118	6707		2555	6707	19087
1978	285	5025		1915	5025	12250
1979	1567	1823		695	1823	5908
1980	1836	6157		2346	6157	16496
1981	3745	4240		1615	4240	13840
1982	6113	2582		984	2582	12261
1983	6045	2068		788	2068	10969
1984[a]	3309	722	2276	867	3830	8728
1985	1217	1173	4414	1682	7655	11727
1986	1576	1695	6183	2356	10671	16298
1987	1902	1170	4173	1590	7176	11838
1988	1430	1329	5675	2162	10021	14942
1989	1649	1492	4603	1754	7714	12609
1990	1606	1146	3735	1423	6324	10499
1991	1111	1181	3137	1195	5093	8580
1992	1412	1337	4355	1659	7373	11781
1993	1194	779	2055	783	3331	6087
1994	1333	1308	3979	1516	6650	10807
Mean (89-93)	1394	1187	3577	1363	5967	9911
1994 c.f. Mean	-4%	+10%	+11%	+11%	+11%	+9%

[a] River harvests (1984 to 1994) may include catch and release mortalities and broodstock and First Nations removals.

Table 20. Estimated spawners (S) and total returns (R) of small salmon in Restigouche River, 1970 to 1994. Spawners were estimated using an angling exploitation rate (u) of 0.3.

Year	Harvest		Catch	Poaching and Disease (PAD)	Spawners (S)	Returns (R)
	Estuary	River				
1970	0	1506		817	3514	5837
1971	0	1172		636	2735	4543
1972	36	1089		591	2541	4257
1973	1272	1570		852	3663	7357
1974	132	1167		633	2723	4655
1975	166	1279		694	2984	5123
1976	5120	2722		1477	6351	15670
1977	1153	2792		1515	6515	11975
1978	1545	1604		870	3743	7762
1979	252	2546		1382	5941	10121
1980	2044	3242		1759	7565	14610
1981	3065	3645		1978	8505	17193
1982	2362	2851		1547	6652	13412
1983	1584	896		486	2091	5057
1984	7339	1788		970	4172	14269
1985	35	3602		1955	8405	13997
1986	30	5417		2940	12640	21027
1987	100	5110		2773	11923	19906
1988	73	6873		3730	16037	26713
1989	163	3360		1823	7840	13186
1990	136	4324		2346	10089	16895
1991	19	2522		1369	5885	9795
1992[a]	55	4755	4751	2578	11082	18470
1993	0	3288	3268	1773	7605	12666
1994	47	4869	4840	2627	11264	18807
Mean (89-93)	75	3650	4010	1978	8500	14202
1994 c.f. Mean	-37%	+33%	+21%	+33%	+33%	+32%

[a] River harvests (1992 to 1994) include broodstock and First Nations removals.

Table 21. Estimated spawners (S) and total returns (R) of small salmon in Restigouche River, 1970 to 1994. Spawners were estimated using an angling exploitation rate (u) of 0.5.

Year	Harvest		Catch	Poaching and Disease (PAD)	Spawners (S)	Returns (R)
	Estuary	River				
1970	0	1506		490	1506	3502
1971	0	1172		382	1172	2726
1972	36	1089		355	1089	2569
1973	1272	1570		511	1570	4923
1974	132	1167		380	1167	2846
1975	166	1279		416	1279	3140
1976	5120	2722		886	2722	11450
1977	1153	2792		909	2792	7646
1978	1545	1604		522	1604	5275
1979	252	2546		829	2546	6173
1980	2044	3242		1056	3242	9584
1981	3065	3645		1187	3645	11542
1982	2362	2851		928	2851	8992
1983	1584	896		292	896	3668
1984	7339	1788		582	1788	11497
1985	35	3602		1173	3602	8412
1986	30	5417		1764	5417	12628
1987	100	5110		1664	5110	11984
1988	73	6873		2238	6873	16057
1989	163	3360		1094	3360	7977
1990	136	4324		1408	4324	10192
1991	19	2522		821	2522	5884
1992[a]	55	4755	4751	1547	4747	11104
1993	0	3288	3268	1064	3248	7600
1994	47	4869	4840	1576	4811	11303
Mean (89-93)	75	3650	4010	1187	3640	8551
1994 c.f. Mean	-37%	+33%	+21%	+33%	+32%	+32%

[a] River harvests (1992 to 1994) include broodstock and First Nations removals.

Table 22. Estimated spawners and total returns of large salmon in Restigouche River, 1993 to 1994, with 95% confidence limits. Spawners were estimated using mark-recapture techniques.

Year	Harvest		River population at point A	Poaching and Disease (PAD)	Spawners		Returns	
	Estuary	River						
1993[a]	1194	779	7672	1228	5665	(4323-9022)	8866	(7268-12862)
1994	1333	1308	20864	3338	16218	(12438-25839)	22197	(17697-33651)
Mean (93-93)	1194	779	7672	1228	5665		8866	
1994 c.f. Mean	+12%	+68%	+172%	+172%	+186%		+150%	

[a] River harvests (1993 to 1994) include catch and release mortalities and broodstock and First Nations removals.

Table 23. Estimated spawners and total returns of small salmon in Restigouche River, 1993 to 1994, with 95% confidence limits. Spawners were estimated using mark-recapture techniques.

Year	Harvest		River population at point A	Poaching and Disease (PAD)	Spawners		Returns	
	Estuary	River						
1993[a]	0	3288	12000	1680	7032	(4882-12407)	12000	(9500-18250)
1994	47	4869	25500	3570	17061	(12331-29101)	25547	(20047-39547)
Mean (93-93)	0	3288	12000	1680	7032		12000	
1994 c.f. Mean	-	+48%	+113%	+113%	+143%		+113%	

[a] River harvests (1993 to 1994) include broodstock and First Nations removals.

Table 24. Comparison of the distribution (%) of tag returns and angling catch by tributary, for traps located in different parts of the Restigouche system. Dalhousie trap, located in the estuary on the New Brunswick shore (1972-1977), Morrissey Rock trap, located in the New Brunswick channel of the Main Restigouche River (1992-1994) and MLCP traps, located on the Québec shore of the estuary and near Adams' Shore on the Québec side of the Main Restigouche River (1985-1989).

		Percent of total tag returns or angling catch											
		Matapedia		Upsalquitch		Patapedia		Kedgwick		Little Main Restigouche		Main Restigouche	
Trap Location	Salmon Size	Tag	Ang.	Tag	Ang.	Tag	Ang.	Tag	Ang.	Tag	Ang.	Tag	Ang.
Dalhousie (1972-77)	Large	20	20	13	13	3	2	8	8	included		56	57
	Small	17	10	25	28	3	3	11	10	with Main		44	49
Morrissey Rock (1992-94)	Large	25	24	0	12	0	1	12	6	0	3	62	54
	Small	7	17	39	24	1	3	1	9	14	5	38	43
Québec estuary & river (1985-89)	Large	50	21	11	11	6	2	6	9	included		28	57
	Small	13	10	23	23	0	3	6	10	with Main		58	54

Table 25. Tag return:catch ratios for small salmon in 1993 and 1994 and comparison of 1993 vs. 1994 tag:catch ratio as an approximation of relative abundance.

	1993			1994			
Return method	Tags	Catch	Tag/Catch	Tags	Catch	Tag/Catch	1993/1994 Tags/Catch
Angling:							
Upsalquitch	14	644	0.022	13	1212	0.011	2.0
Other	22	2624	0.008	22	3628	0.006	1.3
Total	36	3268	0.011	35	4840	0.007	1.6
Angler telephone survey	15	480	0.031	8	630	0.013	2.4
Upsalquitch fence	18	957	0.019	17	1329	0.013	1.5

Table 26. Comparison of estimates of absolute and relative abundance of salmon in the Restigouche River.

Method	Large Salmon 1994	1993	mean 89-93	94 cf. 93	94 cf. mean	Small Salmon 1994	1993	mean 89-93	94 cf. 93	94 cf. mean
Mark-recapture	16218	5665	----	+186%	----	17061	7032	----	+143%	----
Angling (ER=0.3)	11955	6071	10736	+97%	+11%	11264	7605	8500	+48%	+33%
Angling (ER=0.5)	6650	3331	5967	+100%	+11%	4811	3248	3640	+48%	+32%
Spawner (canoe)	6871	3512	6918	+96%	-1%	4390	2352	3463	+87%	+27%
Spawner (snorkel) with DNRE adjustments (see text section 5.6)	6105	----	----	----	----	4720	----	----	----	----
Abundance (Morrissey Rock)	136	51	----	+167%	----	455	342	----	+33%	----
Abundance (Upsalquitch fence)	740	353	817	+110%	-9%	1329	957	1190	+39%	+12%
Abundance (Causapscal fence)	349	256	424	+36%	-18%	3	12	15	-75%	-80%
Total angling catch	3979	2055	3577	+94%	+11%	4840	3268	3645	+48%	+33%
Index camps - angling catch	519	451	608	+15%	-15%	415	186	238	+123%	+74%
CPUE (river)	0.21	0.12	0.20	+75%	+5%	0.26	0.19	0.21	+37%	+24%
CPUE (N.B. crown reserve)	0.31	0.08	0.20	+288%	+55%	0.72	0.23	0.37	+213%	+95%

Table 27. Ratios of 1994:1993 spawning escapement or indices of relative abundance of salmon in the Restigouche River.

Method	Small salmon 1993	1994	1994/1993	Large salmon 1993	1994	1994/1993
Mark-recapture	7,032	17,061	2.4	5,665	16,218	2.9
Exploitation rate: ER 0.3	7,605	11,264	1.5	6,071	11,955	2.0
ER 0.5	3,248	4,811	1.5	3,331	6,650	2.0
Canoe spawner counts	2,352	4,390	1.9	3,512	6,871	2.0
Upsalquitch fence	957	1,329	1.4	353	740	2.1

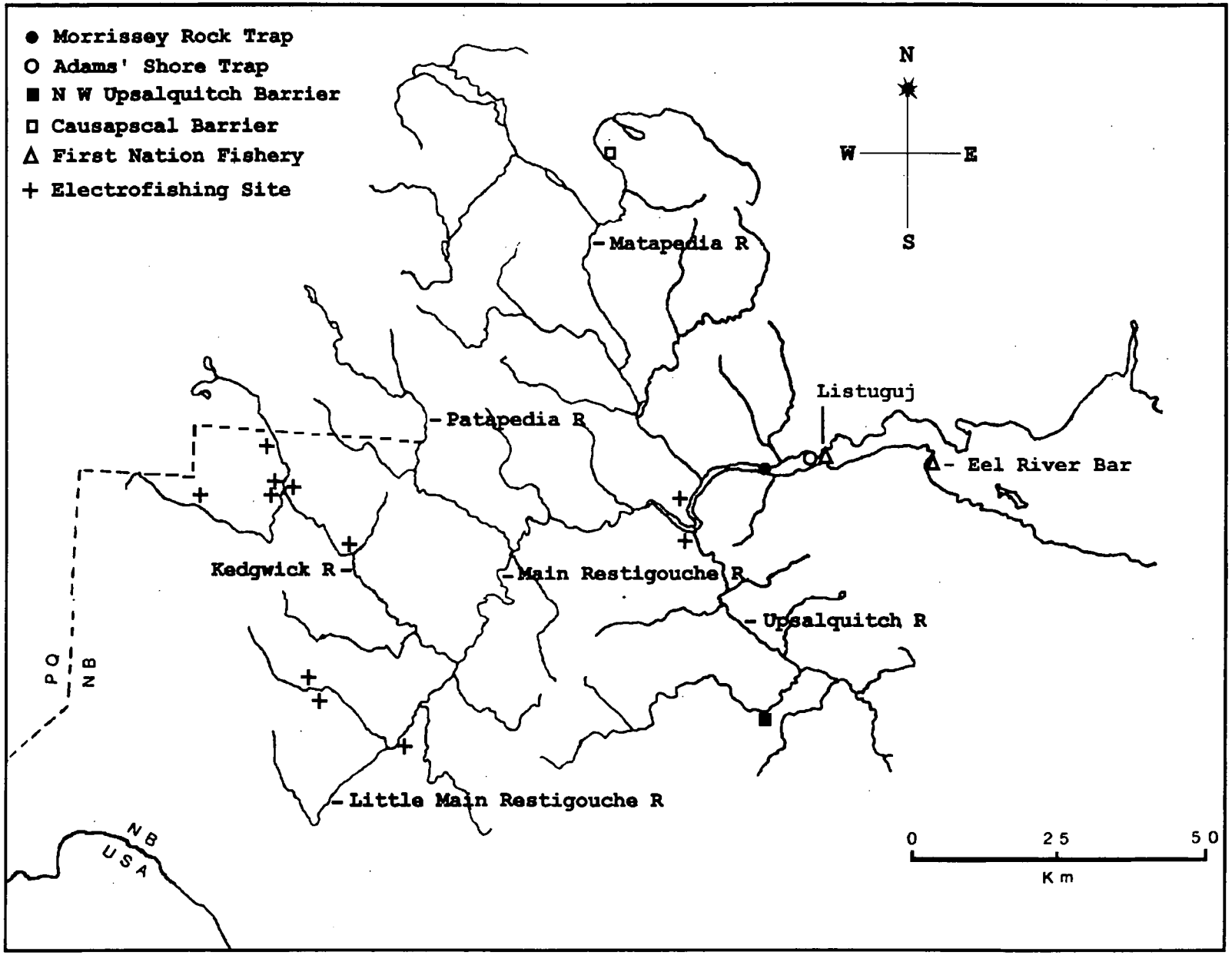


Figure 1. Map of the Restigouche River showing the location of salmon counting facilities, First Nations fisheries and electrofishing sites in 1994.

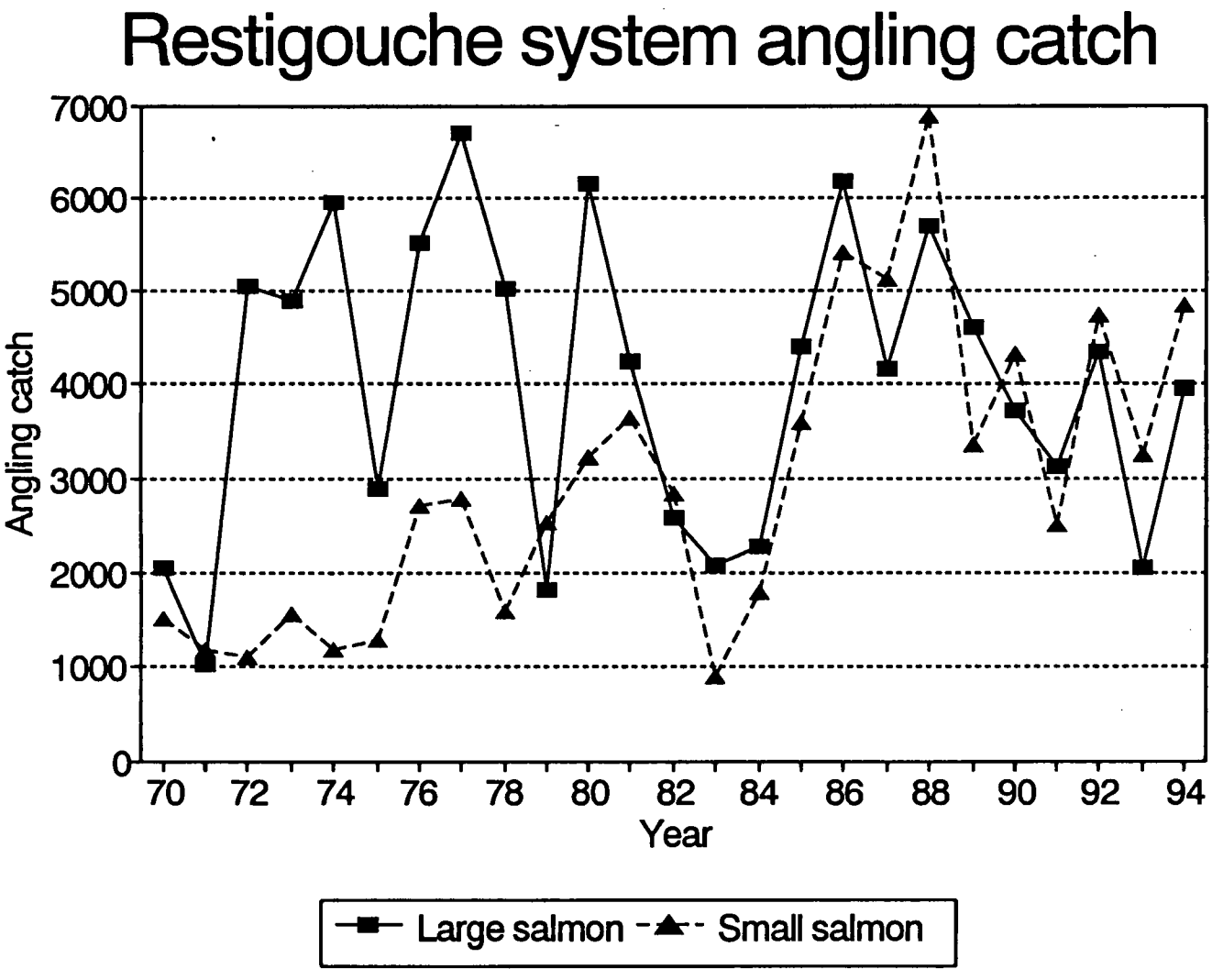
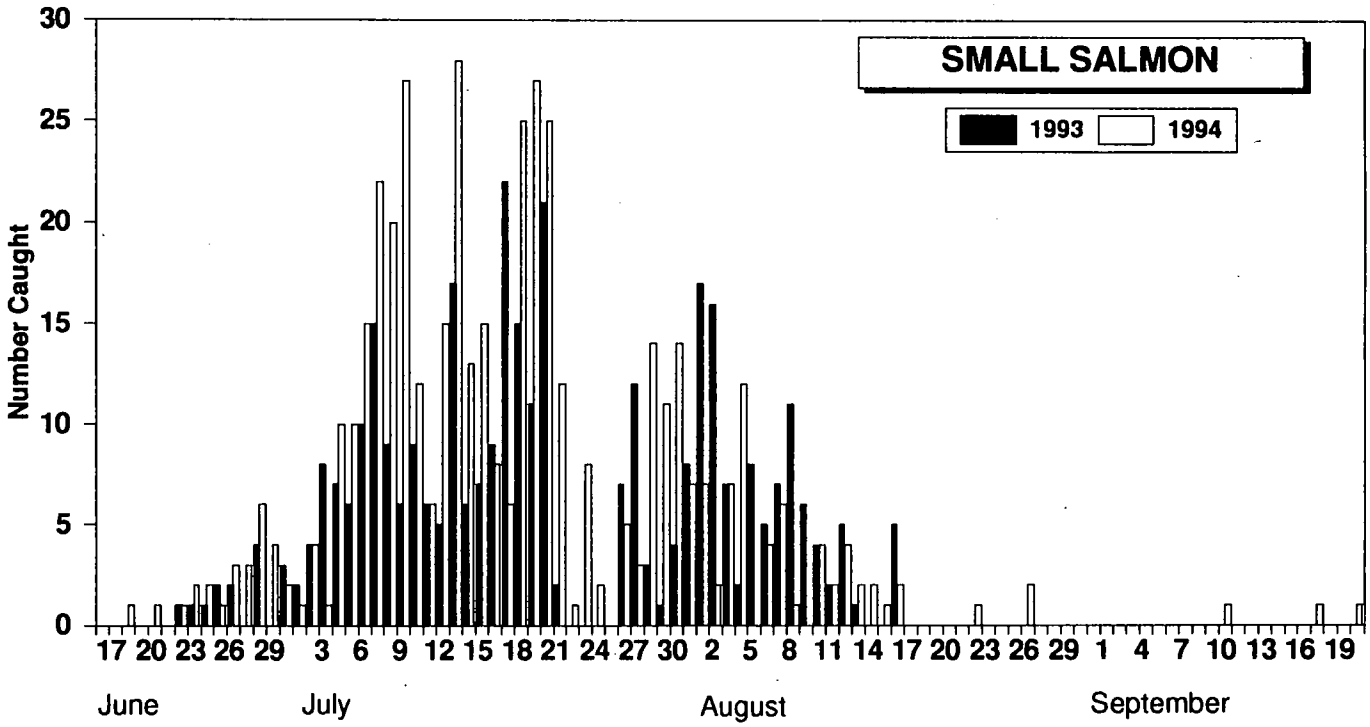


Figure 2. Angling catch of Atlantic salmon in the Restigouche River, 1970-1994.



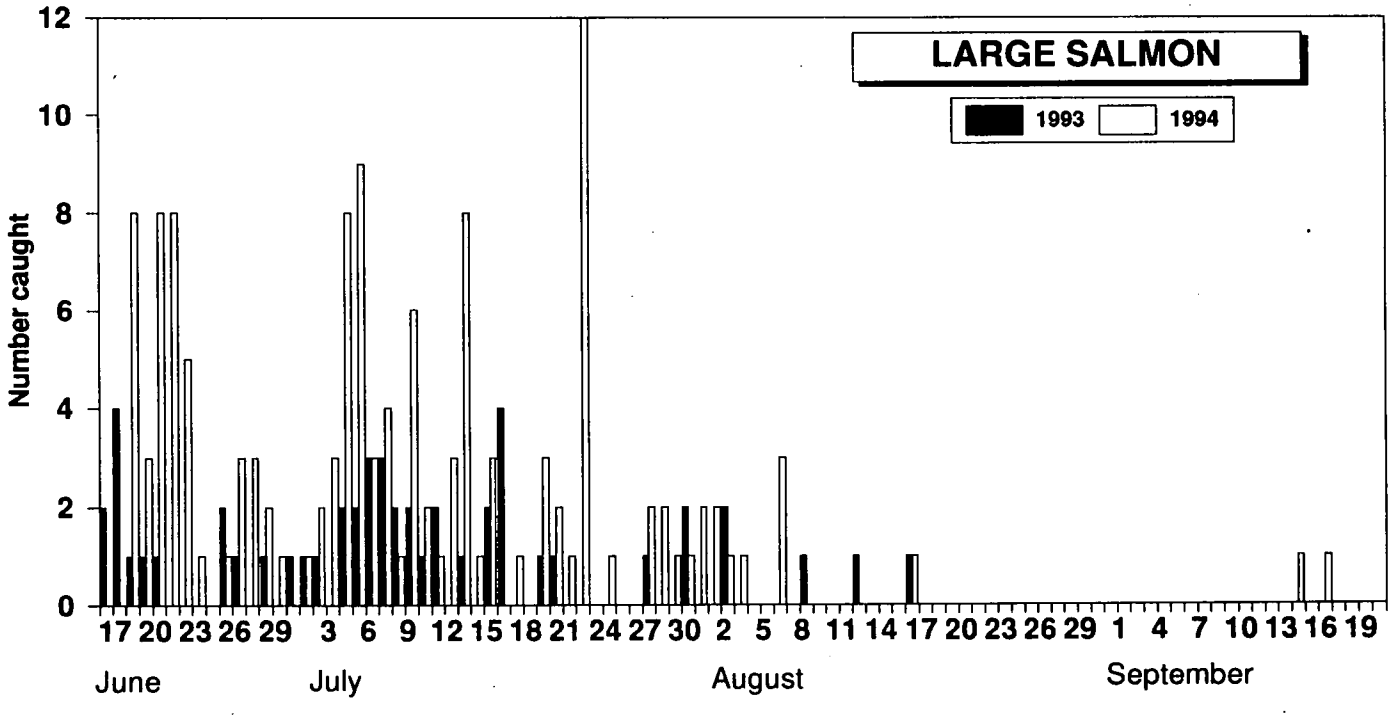


Figure 3. Daily catches of small and large salmon at the Morrissey Rock assessment trap in 1993 and 1994.

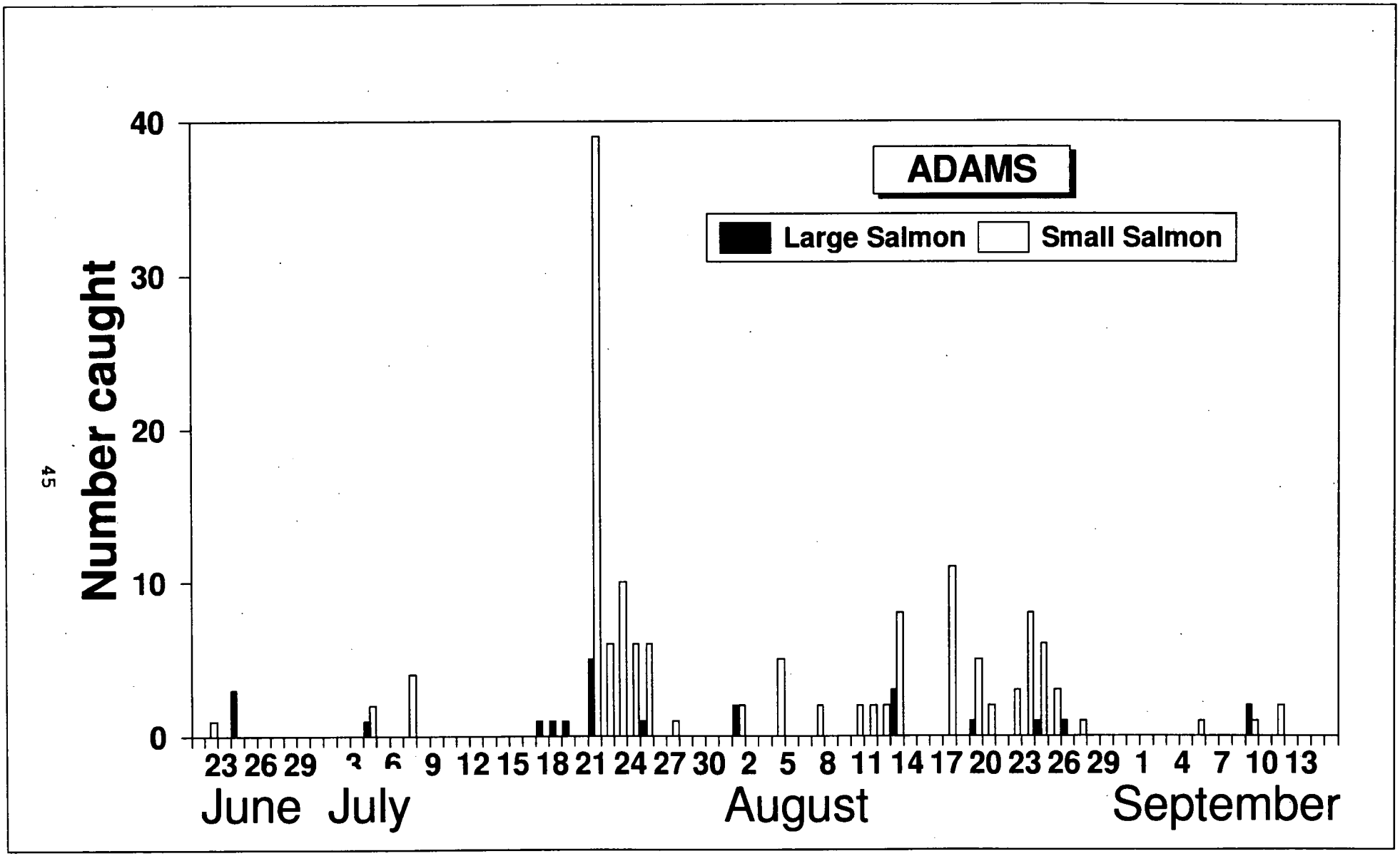


Figure 4. Daily catches of small and large salmon at the Adams' Shore assessment trap in 1994.

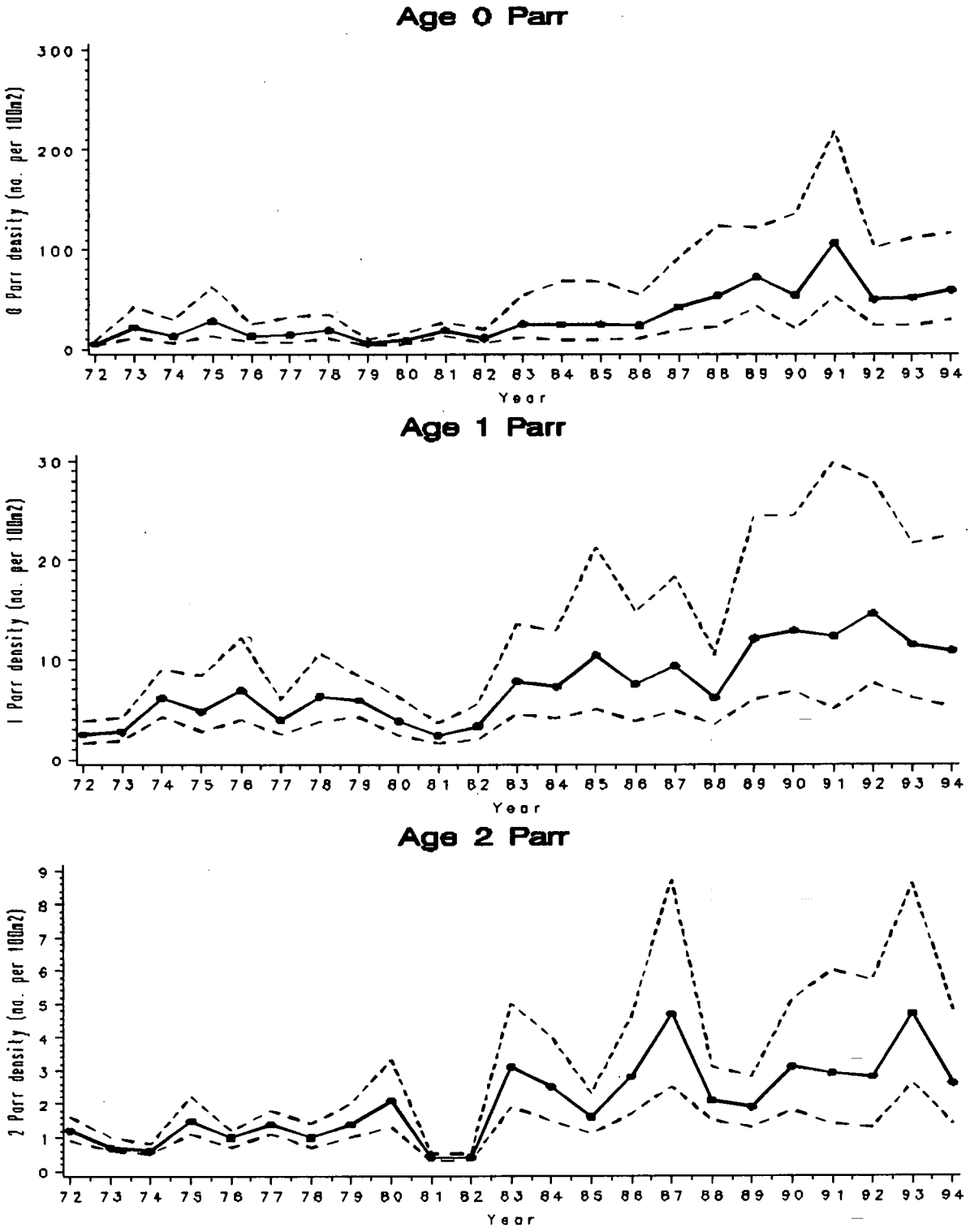


Figure 5. Mean densities of 0+, 1+ and 2+ parr in the Restigouche River, 1972-1994 (15 sites, 1972-1990 and 1993; 8 sites, 1991; 10 sites, 1992; 11 sites, 1994). Dashed lines are 95% confidence limits.

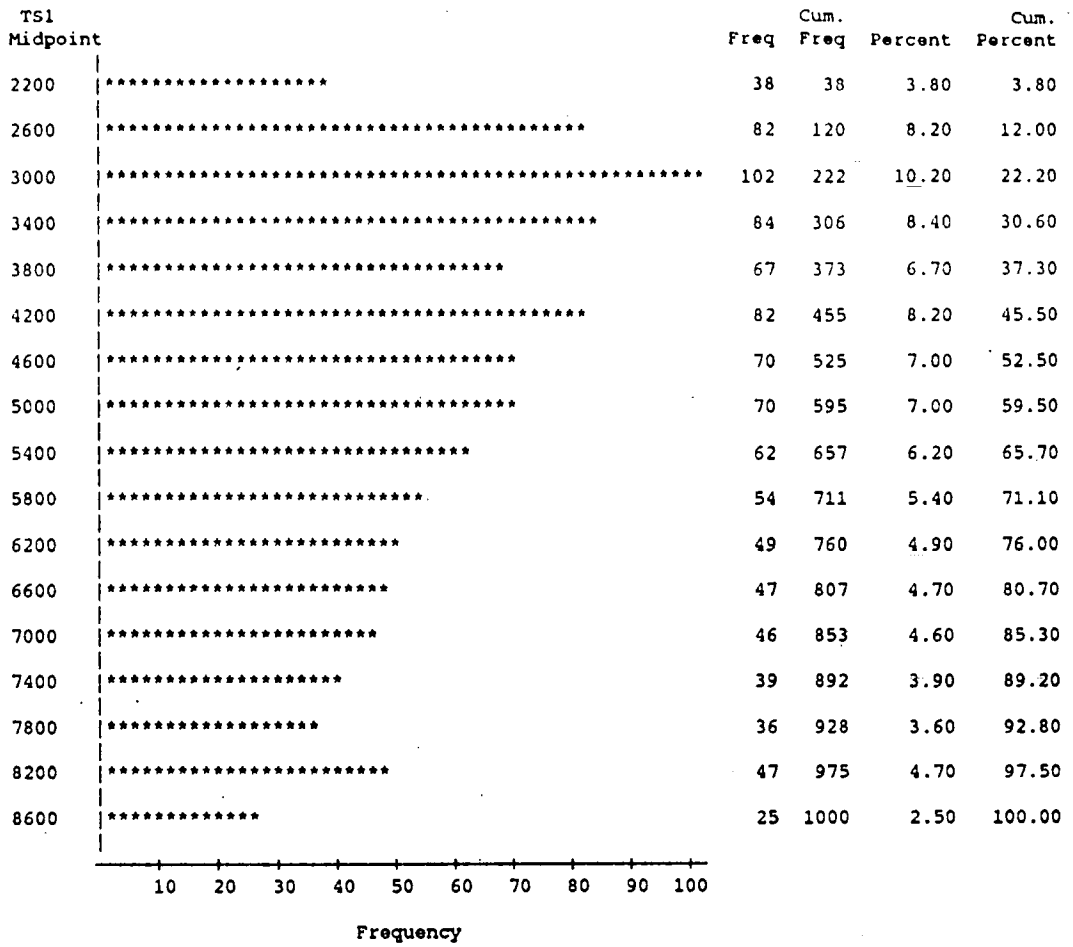


Figure 6. Results of randomization procedure on angling-based estimate of (small salmon spawners - spawning target of 2,600). Randomization is based on exploitation rates drawn from uniform distribution of 0.3-0.5, catch estimates assumed within 20% of true value, 1000 simulations.

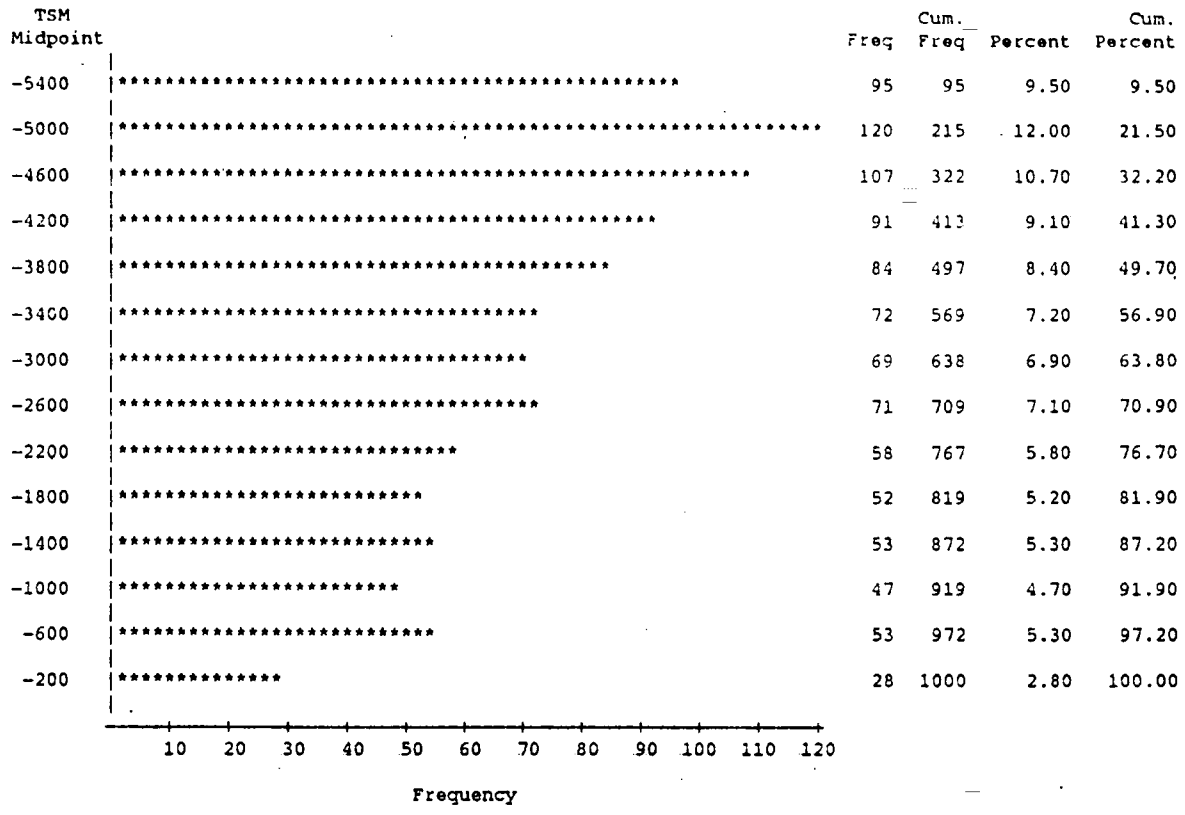


Figure 7. Results of randomization procedure on angling-based estimate of (large salmon spawners - spawning target of 12,200). Randomization is based on exploitation rates drawn from uniform distribution of 0.3-0.5, catch estimates assumed within 20% of true value, 1000 simulations.

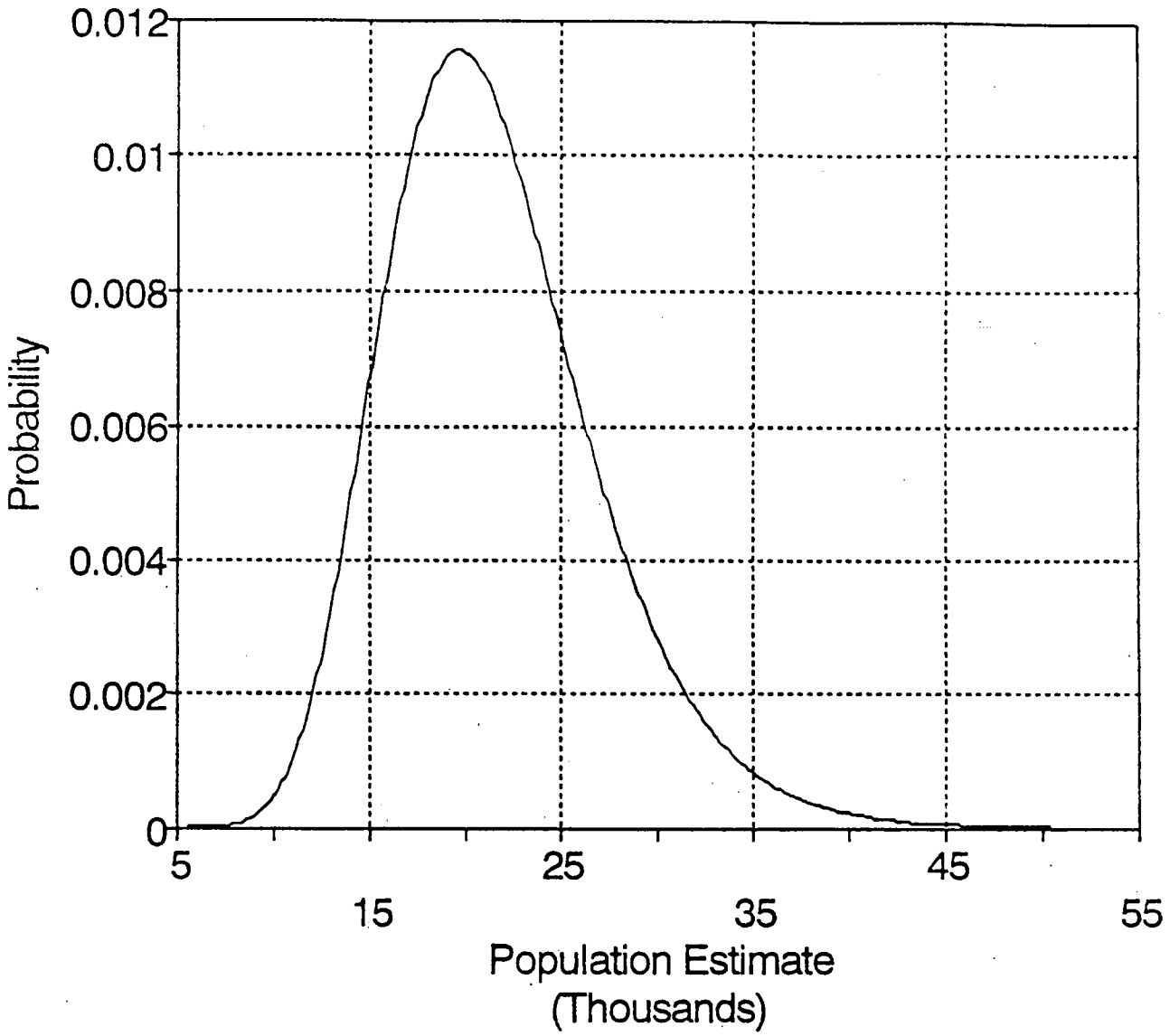


Figure 8. Probability curve of 1994 large salmon spawning escapement based on mark-recapture method.

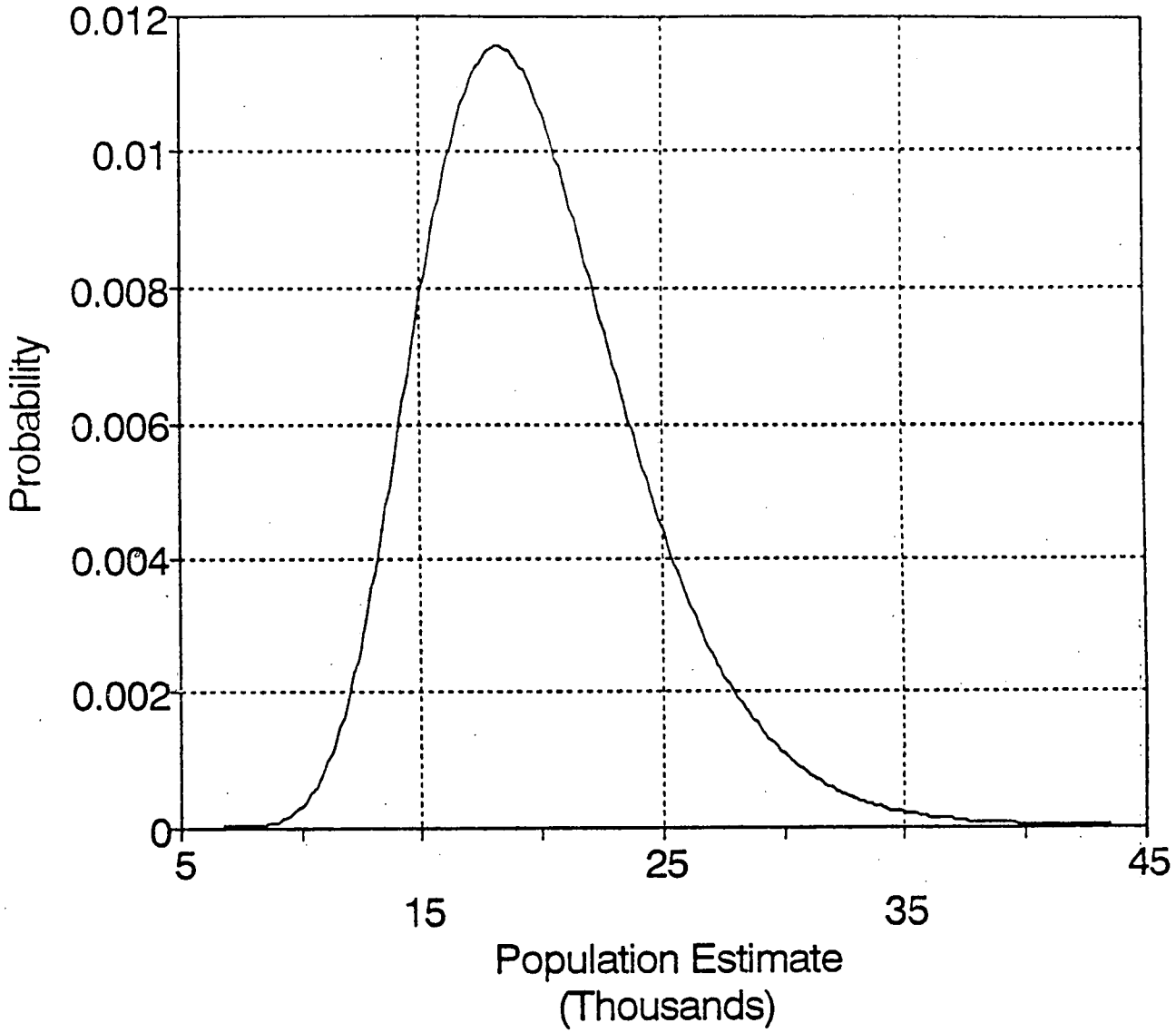


Figure 9. Probability curve of 1994 small salmon spawning escapement based on mark-recapture method.

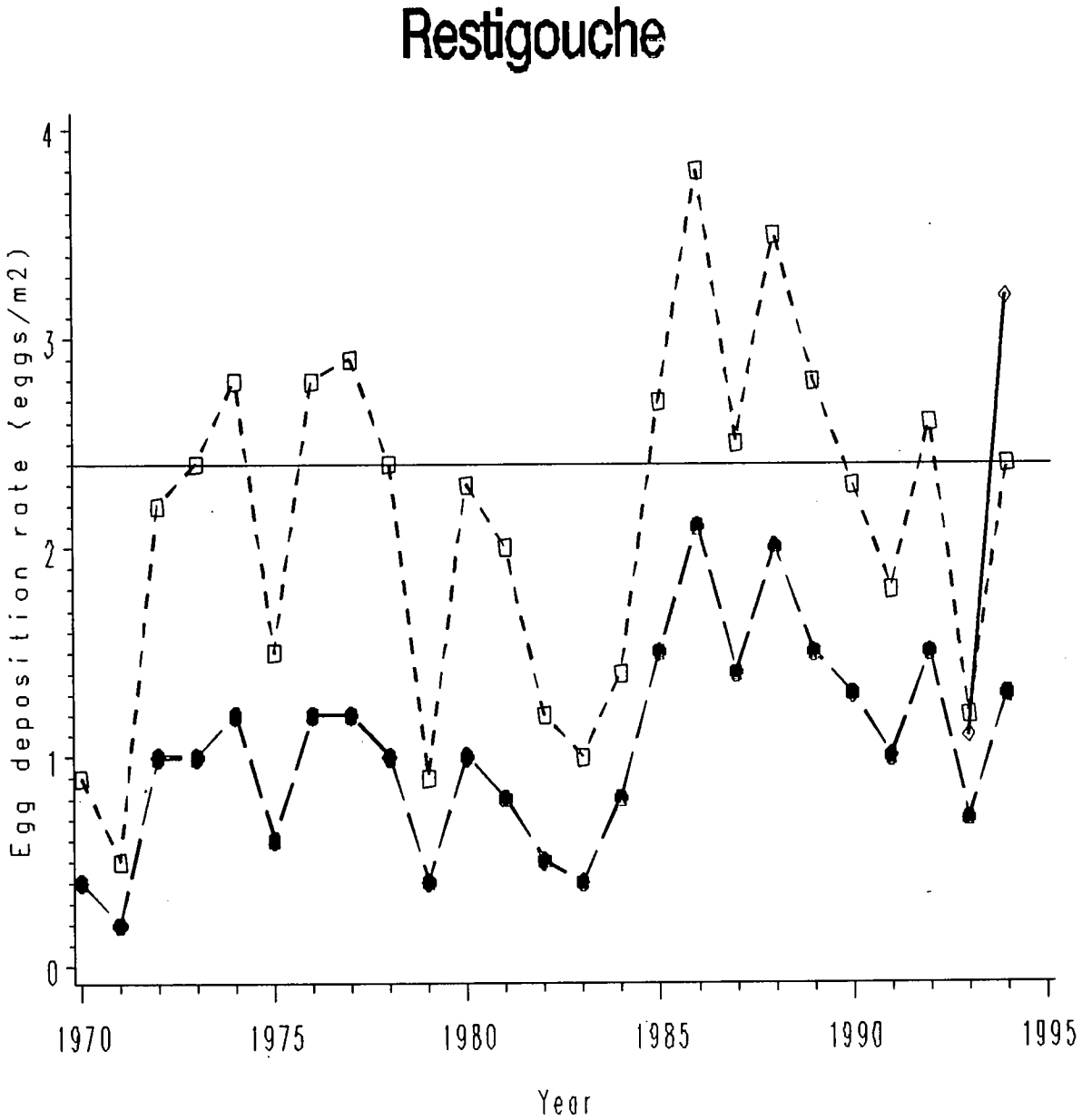


Figure 10. Egg deposition rates, 1970-1994, estimated from angling catch data and assumed exploitation rates of 0.3 (squares) and 0.5 (dots), and mark-recapture method (diamonds). Horizontal line indicates target deposition rate.

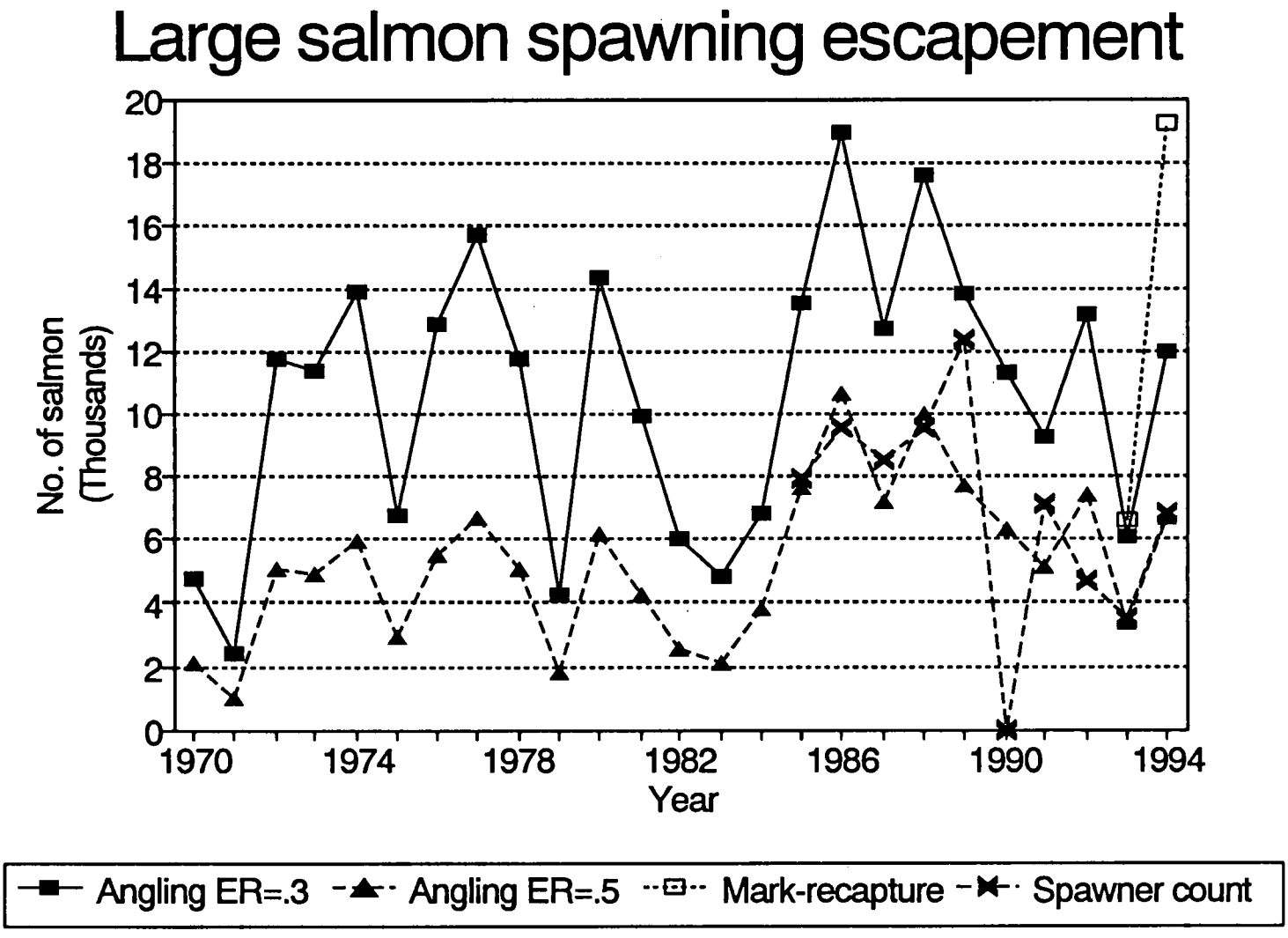


Figure 11. Comparison of large salmon spawning escapement estimates by different methods, 1970-1994.

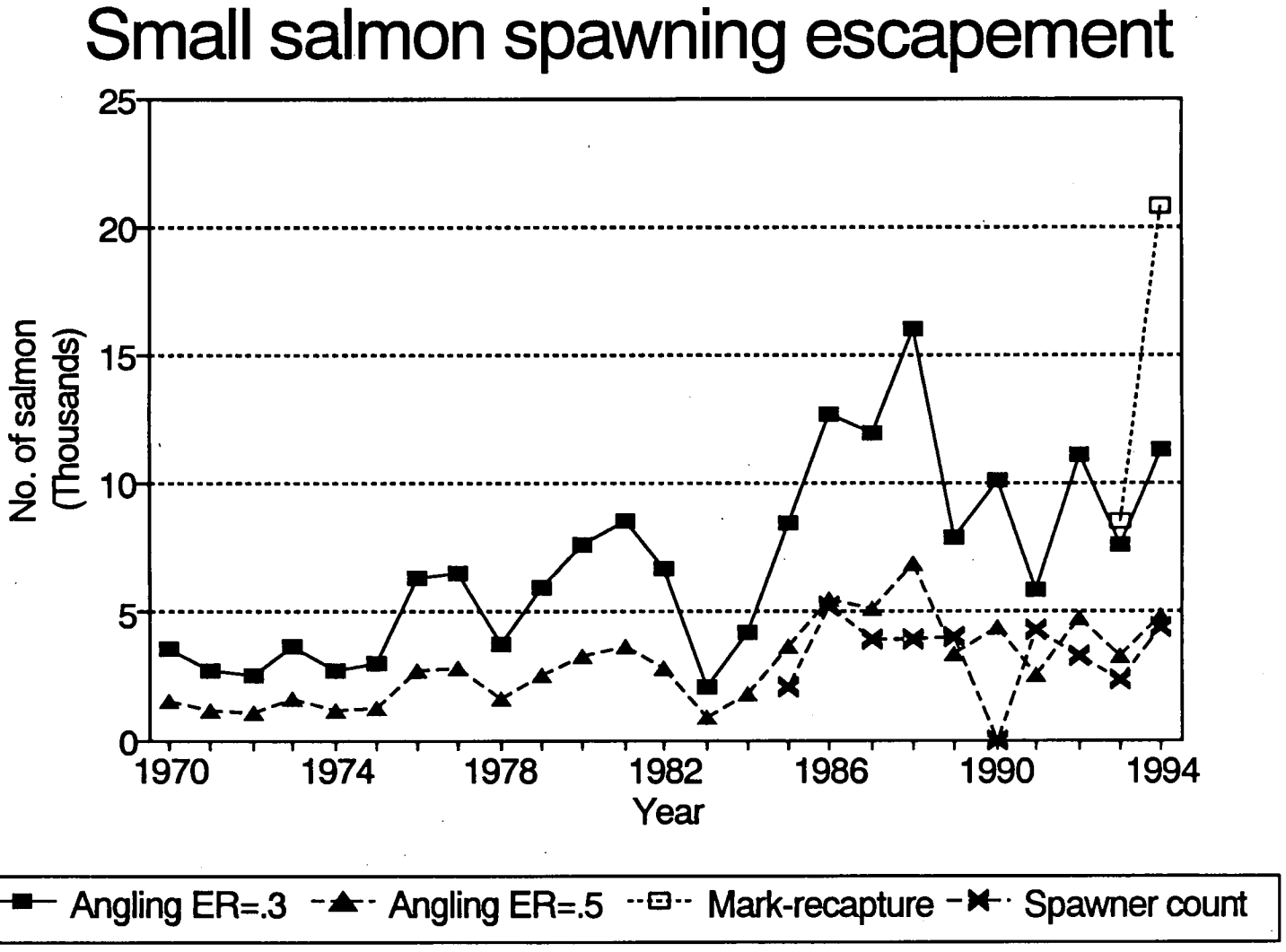


Figure 12. Comparison of small salmon spawning escapement estimates by different methods, 1970-1994.

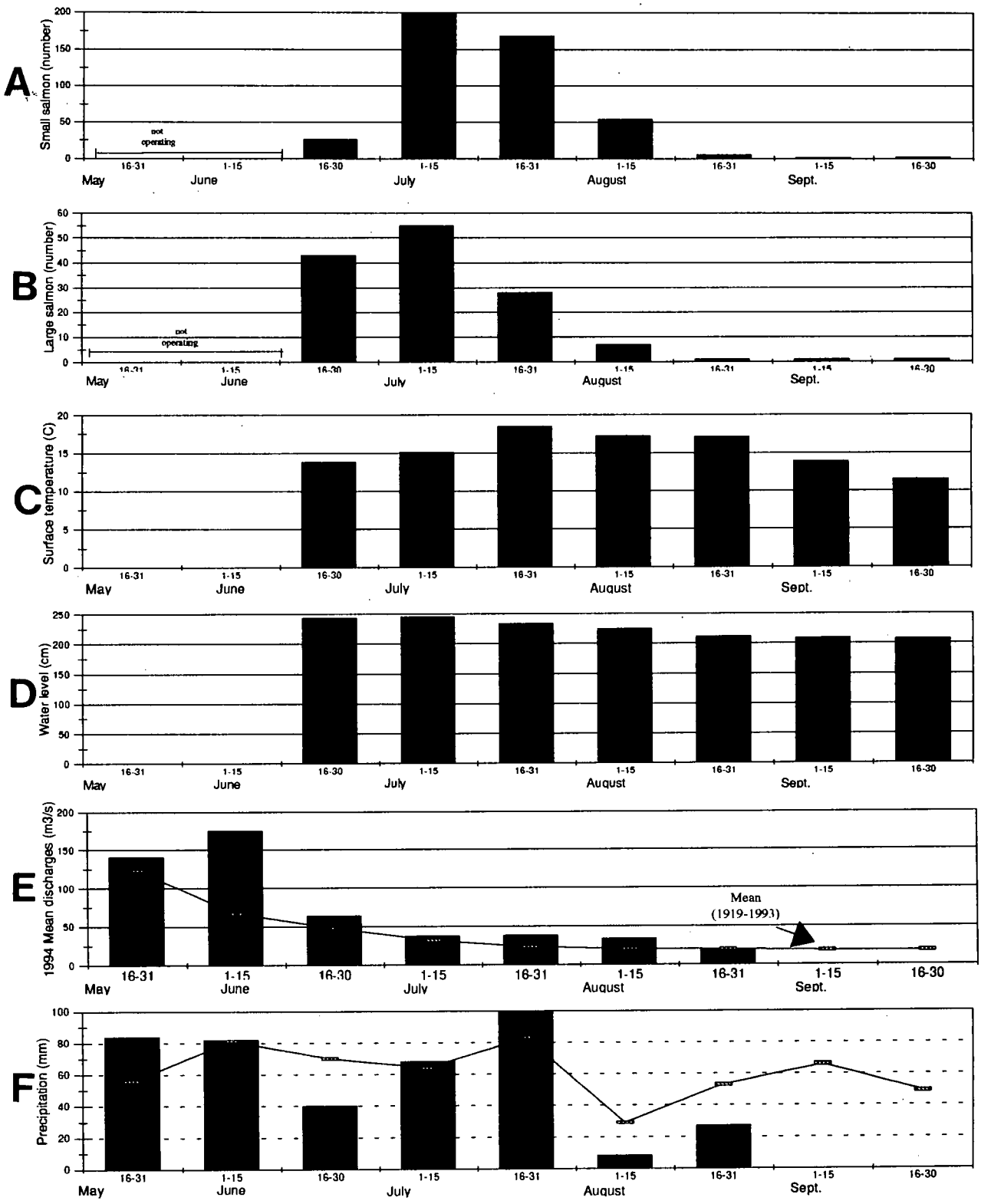


Figure 13. Counts of Atlantic salmon (A&B), mean surface water temperature (C) and mean water depth (D) at the Morrissey Rock assessment trap, mean daily discharge at the Upsalquitch hydrological station (E) and total precipitation at the Charlo meteorological station (F). Values presented for semimonthly periods from May 16-September 30, 1994.

Appendix 1. SAS program of randomization procedure for comparing estimate of returns, spawners and egg deposition in 1994 to previous 5-year means and targets.

```
/* shelterr.sas - translation of shelton.sas into proc iml   19912-01-13
                  programme to read restigouche river
                  salmon catch data and calulate probability
                  of cuurent year escapement
                  mean of the previous years

USE THIS PROGRAM TO GET
(1) TE = EGGS - TARGET
(2) PE = EGGS/5-YR MEAN
- CALCULATED USING U=.3 TO .5, REPORTED CATCH CORRECT WITHIN 20%
   variables estcat esthrv are the observed values, and variables
   estimated from them (estesc estsp91 esteggm estegg91) are assumed to
   have no other error than that in the exploitation rate (.3-.5)

   variables angcat rivhrv are assumed to be the 'true' values, within
   20% of the observed data. variables estimated from them, are then
   assumed to be the 'true' values (esc sp91)                          */

proc iml;
reset nocenter noname linesize=130 pagesize=80;
infile 'restigouche.dat' missover;
create s var {yr nbcat  nbhrv  pqcat  pqhrv bsm bs1 angc1 esthm esth1};
do data ; input yr nbcat nbhrv pqcat pqhrv bsm bs1 angc1; append; end;
close s; closefile 'restigouche.dat';

use s;
read all var {yr} into year;
read all var {nbcat pqcat angc1} into ac;
read all var {bsm bs1} into brood;
read all var {nbhrv pqhrv angc1} into rh;
prop=rh/ac;
explo=.3;
exphi=.5;

cat=ac;

estcat=(cat[,1]+cat[,2])||cat[,3];
esthrv=(rh[,1]+rh[,2]+brood[,1])||(rh[,3]+brood[,2]);
*ranlo=cat/1.2;
*ranhi=cat/.8;
ranlo=cat; ranhi=cat;

nr=nrow(cat);
nc=ncol(cat)-1;
```



```
iter=1000;
mat0=shape(0,iter,4);
mat=shape(0,iter,8);
do ijk=1 to iter;
```

```
seed=0;

do i = 1 to nr;
  do j = 1 to nc+1;
     ac[i,j]=ranlo[i,j]+(ranhi[i,j]-ranlo[i,j])#ranuni(seed);
*    print (cat[i,j]||ac[i,j]);
  end;
end;

angcat=(ac[,1]+ac[,2])||ac[,3];
rivhrv=((ac[,1]#prop[,1])+ac[,2]+brood[,1])||(ac[,3]+brood[,2]);

*print (angcat||rivhrv);

esc=shape(0,nr,nc);
estesc=shape(0,nr,nc);

do i=1 to nr;
   do j=1 to nc;
      exp=(explo+(exphi-explo)#ranuni(seed));
      esc[i,j]=(angcat[i,j]/exp)-rivhrv[i,j];
      estesc[i,j]=(estcat[i,j]/exp)-esthrv[i,j];
*     print (i||j||exp||esc[i,j]);
   end;
end;

* estsp91 = estesc[nr,]/((estesc[1:nr-1,][+,])/(nr-1));
*sp91 = esc[nr,]/((esc[1:nr-1,][+,])/(nr-1));

*print sp91;
estsp91 = estesc[nr,];
sp91=esc[nr,];
esteggm = (estesc[1:nr-1,]#shape((5993||86),nr-1,2))[+,+]/(nr-1);
eggm=(esc[1:nr-1,]#shape((5993||86),nr-1,2))[+,+]/(nr-1);
estegg91= ((estesc[nr,])#(5933||86))[+];
egg91=((esc[nr,])#(5933||86))[+];
mat0[ijk,]=eggm||egg91||estsp91; *use random eggm and egg91 but estsp is
based on estimated catch and random exploitation;
mat[ijk,]=sp91||estsp91||
           (esc[1:nr-1,][+,])/(nr-1)||(estesc[1:nr-1,][+,])/(nr-1);

end;
*print mat0;
fname={ 'eggsm' 'eggs91' 'spm91' 'sp191'};
create done from mat0 [ colname=fname];
append from mat0;

/*fname = {'spm91' 'sp191' 'estspm91' 'estsp191'
                 'avgm' 'avg1' 'estavgm' 'estavg1'};
create done from mat [ colname=fname];
append from mat*/;

filename store 'sim2.dat';
data upd;
set done;
file store;
put eggsm eggs91 spm91 sp191;
*put spm91 sp191 estspm91 estsp191 avgm avg1 estavgm estavg1;
run;
```

```
data step1;
infile 'sim2.dat';
/*input spm91 sp191 estspm91 estsp191 avgm avg1 estavgm eatavg1;
difm=spm91-estspm91;
dif1=sp191-estsp191;
difavgm=avgm-estavgm;
difavg1=avg1-estavg1;
proc means;
     var spm91 sp191 estspm91 estsp191 difm dif1 difavgm difavg1;
run;
proc chart;
     hbar spm91 sp191/midpoints= 0 to 1.5 by .125;
run;
proc chart;
     hbar estspm91 estsp191/midpoints= 0 to 1.5 by .125;
run;
proc chart;
     hbar difavgm difavg1;
run;
*/

input eggsm eggs91  spm91 sp191;
tm=spm91-12200;
t1=sp191-2600;
te=eggs91-71400000;
pe=eggs91/eggsm;
proc means;
     var   eggsm  eggs91  spm91 sp191 tm t1 te pe;
/*proc chart;
     hbar tm t1;
run;*/
proc chart;
     hbar te pe;
run;
```

Appendix 2. NOTES FROM THE RESTIGOUCHE SALMON SCIENCE WORKSHOP, Campbellton, N.B. (NB DNRE Office), 0930-1715 Hours, Tuesday, 22 November 1994.

Chairperson (+ notes):

Ross Claytor	DFO, Science, Moncton

Notes:

John Peppar	DFO, Science, Moncton

Attendees:

Richard Simonson	Eel River Bar First Nation
Donald Sullivan	MSRT Association
Roland Bernard	Island Lake Club
Fred Whoriskey	Atlantic Salmon Federation
Gilles Landry	MEF, New-Richmond, Quebec
Pierre D'Amours	MEF, New-Richmond, Quebec
Alex Bielak	NB DNRE, Fredericton
Bill Hooper	NB DNRE, Fredericton
Alan Madden	NB DNRE, Campbellton
Andrea Locke	DFO, Science, Moncton
Paul Cameron	DFO, Science, Charlo SEC

1. Introduction

Ross Claytor provided an overview of the objectives of the meeting, an outline of the proposed agenda (attached), and a brief summary of the process and action items of last year's meeting.

He noted that the ultimate objective of the science workshop process was to produce an assessment document for the Restigouche River salmon stock.

2. Restigouche Salmon Stock Status

Ross noted that presentations and points of discussion at this workshop would follow a format similar to last year, and be arranged under the following basic components:

1. **Fisheries** -- landings and description.
2. **Target** -- spawning escapement.
3. **Data** -- mark-recapture, logbook summaries, age determination, 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.

Andrea Locke presented information on the status of the Restigouche salmon stock in 1994.

Points of Discussion

Fisheries (Landings)

- The total angling catch in 1994 was up from the previous year and the 5-year mean; proportions of large and small salmon in catches in the tributaries were much the same as previous years.
- Members were asked if they thought the higher catches in 1994 reflected more fish in the system, or better angling success in 1994? It was noted that exploitation rates can be highly dependent on water conditions. Water conditions in June and July (adequate water and cool temperatures) provided excellent angling opportunity, whereas, the conditions in August (low water) likely provided poor angling opportunity.
- Catches were not recorded for Listiguj First Nation in 1994. It was suggested by MEF, Quebec that the 5-year mean of catches prior to 1993 be used in the stock assessment for this year. MEF will be working with the Listiguj First Nation to obtain estimates in 1995.
- Catches (from nets at Eel River Bar, and angling in the Upsalquitch River) were provided by Eel River Bar First Nation; their total harvest at Eel River Bar was up from 1993, but down from the 5-year mean catch.

Target

- The DNRE estimate of rearing area is higher than the DFO estimate. DNRE to table their estimate, with a description of the method for calculating rearing area, so that the reason for the different estimates can be determined, and one estimate accepted.
- DNRE proposed that 2.4 eggs per square metre may not be appropriate for the Restigouche, and cited work by Jessop, suggesting that 4.0 eggs per square metre may be appropriate for some rivers.
- The value of 2.4 eggs per square metre is to be retained for the assessment and document; where studied, this value appears to be the most appropriate for a 'whole system' approach to determining target spawning escapement, i.e., to compensate for different qualities of rearing habitats within a total river system. Recent work by Gerald Chaput appears to support the 2.4 eggs per square metre value. A workshop was suggested as a method for making progress on this issue on the Restigouche.

Data

- Most of the effort put into data gathering by DFO in 1994 went into mark-recapture operations; to capture/tag (via traps at Morrissey Rock and Adams Shore), and recapture tags via angling and Provincial counting fences. The emphasis was placed on the tagging of small salmon and the subsequent recapture of tags in the angling fishery and counting fence on the Upsalquitch River. Phone survey contact in the Upsalquitch will be used to verify reporting of tags (recaptures), and to estimate the extent of non-reporting of tags.

- Morrissey Rock trap likely missed a considerable portion of the

earliest-running salmon (large salmon) because of the installation date; and missed the entire late-run, but this is a small proportion of the annual returns.

- MEF, Quebec conducted scuba surveys in the Matapedia, Patapedia, Causapscal, Kedgwick, Little Main Restigouche, Restigouche, Gounamitz and Upsalquitch Rivers this year (from approx. Aug 1 to Oct 25); numbers and sizes of salmon were recorded. Conditions this year were said to be ideal for such surveys (low water, good visibility).
- DNRE adds MEF's survey data to their survey data to obtain a total salmon count for the Restigouche system as a whole. The extent of coverage was explained. It was noted by DNRE that, since 1983, their surveys are primarily fish counts, supplemented each year with some redd counts, when areas can't be surveyed before the fish spawn (this is normally a small percentage each year). Prior to 1983, the field surveys assessed primarily redd numbers and distribution. This information, with a description of the methodology, will be included in the assessment.
- Salmon broodstock collections (adults) and distributions (eggs and unfed fry) were made from the Charlo SEC in 1994. No fall fingerlings or parr distributions were made this year; all releases were in the late-spring as unfed fry, because of the SEC renovations conducted this year. This information will be included in the assessment.
- DNRE presented results of electrofishing on the Upsalquitch River system (below and above the barrier pool on the NW, and at the control site on the SE Upsalquitch); and angling catches for the Crown Lease waters.
- DFO's electrofishing results (for 11 index sites) indicated that mean abundance for the system was down about 10% from the 5-year mean.
- Results to date re: a study of released satellite-reared salmon was presented by ASF. Results indicate that this year's satellite-reared and released fish have retained a 'blue' colouration, devoid of parr marks, are not moving very much; they appear to be staying where stocked, but in less favourable habitat than what the wild fish are occupying. Low water levels were encountered at the sites studied this year, so the behaviour noted may not be typical of all water conditions. Activity levels, colouration and behaviour may vary among satellite sites, depending on water current speed, feed available, and previous rearing tank colour. More years of study are needed. A visual implant tag is being tested for possible application in future investigations.

Status

- In a comparison of the estimates of stock status (returns and numbers of spawners) derived by the different methods, the mark-recapture method provided the highest estimate of returns, and the spawner count surveys (snorkel/canoe counts) the lowest estimate of returns.
- Concerns re: the mark-recapture experiment were:
  (a) Tagged fish were biased towards returning to the Upsalquitch.
  (b) Reporting rate of tags and tag loss need to be evaluated.
  (c) More tags or greater recoveries of tags are needed to reduce the

error in the mark-recapture estimate.
(d) There may be potential use of MEF Registration Stations to help obtain tag return data on the Matapedia.

- Concerns re: spawner counts were:
  (a) Spawner counts at Upsalquitch and Causapscal barriers suggest a higher percentage of spawners in these areas than the amount of habitat may indicate.
  (b) Very high water levels can affect the enumeration of fish and redd counts; since 1970, there has been only one exceptional year (1990) when fish and redd counts could not be assessed.
  (c) Previous investigations into spawner count methodology by Randall et al. indicate an inability to distinguish grilse from large salmon and that total counts are an under-estimate.
  (d) The relationship between redds and spawners varies among tributaries and requires further verification.
- Further scientific validation of the different methods should be conducted.

Recommendations re: mark-recapture experiments were:
(a) Continue the phone survey for estimating reporting rate.
(b) Find a method for using tags returned at camps.
(c) Record tag information from spawner surveys.
(d) Use hatchery to estimate tag loss rate, based on Restigouche tagging method.

Recommendations re: spawner counts were:
(a) Record methods - including dates, time and weather conditions. It was noted that the method used by MEF this year may be an improvement on the one used in other years. The methods should be documented, so they can be compared.
(b) The use of spawner counts as indices could be examined by estimating angling exploitation rates using spawner counts and determining if they seem reasonable, given what is known about Restigouche angling conditions amongst years.
(c) The use of spawner counts as indices could also be examined using correlations with juvenile data.
(d) The habitat areas should be tabled, to evaluate the reasonability of the distribution observed by the counts.
(e) Two sites should be used to compare known counts to snorkel, canoe and photo estimates. The Upsalquitch barrier could be one of these sites.

- The question of what anglers should do with the tagged fish that they angle, was raised by several members. There was general agreement that further instructions should be given to anglers in the proper procedure to follow when handling a tagged fish. The tag should be left on the fish, and a report made that the fish was tagged, i.e., that the tag was observed. It is not really necessary to get the tag number, but at least report that the tag was present. This reporting also applies to marks (such as fin clips, etc.). Instructions to anglers should be included in the Provincial angling summary.

Prospects

- Forecasts for 1994 and 1995 seasons were based on the same sources of data (5-year mean, 1+ parr, small salmon counts).
- There is an increasing need for "in-season" predicting. It may be

possible to use data provided by the four index angling camps, and the Upsalquitch River barrier, where complete counts are known.
- The value of in-season forecasting must be considered from all the methods we employ to estimate returns to the River.
- There is increasing pressure from management to provide in-season forecasting for all our major streams and stocks.

Summary

- Re: the workshop process, it was generally felt by the members present that more client groups should be in attendance at these workshops. It was felt that poor attendance may be due, at least in part, to the fact that so many of the clients reside elsewhere during the time meetings are held (i.e., during the winter months).
- These workshops attempt to handle a great deal of information, over a very short period of time. This may be overwhelming for some organizations.
- Circulation of some form of uniform rough data framework to members to study before the workshop was actually held, may help encourage greater attendance.
- It was decided until further review, to adopt the returns and spawners estimated by the exploitation rate method. The group suggested the 50% exploitation rate, but most expressed concern that actual spawning escapement could be over-estimated by the 50% rate. Scientific peer review of these methods will take place in February.