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STATUS OF ATLANTIC SALMON IN THE RESTIGOUCHE RIVER IN 1993

by

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ABSTRACT

During 1993, 514 large and 3,268 small salmon were harvested by anglers in the Restigouche River (large salmon were harvested in Québec tributaries only). Angling catches (including catch and release of large salmon in N.B.) of large and small salmon in 1993 were 52% and 25% below previous 5-year averages, respectively. Catches per unit effort for small and large fish, respectively, were 33% and 53% below the previous 5-year averages for New Brunswick, and 33% above and 38% below the previous 5-year averages for Québec. First Nation harvest of large salmon was 17% below the previous 5-year average and harvest of small salmon was 100% below average. Based on angling data and an angling exploitation rate assumed to be between 0.3 and 0.5, returns of Atlantic salmon to the Restigouche River during 1993 were estimated to be between 6,087 and 9,349 large salmon (49% below previous 5-year means) and between 7,600 and 12,666 small salmon (26% below previous 5-year means). Spawning escapement was estimated as the difference between total returns and losses to angling and First Nation fisheries, poaching, disease and hatchery broodstock. 1993 escapement was between 3,339 and 6,079 large salmon (54% below previous 5-year means) and between 3,248 and 7,605 small salmon (26% below previous 5-year means). These spawners would result in a total egg deposition of 20 to 37 million eggs (28% to 52% of requirements). 1993 returns, spawners, and egg deposition were below previous 5-year means. Probability that large spawners and egg deposition were below target was 100%, but the target for small spawners was met (100% probability). Electrofishing surveys indicated that densities of 0+ and 1+ juvenile salmon were, respectively, 23% and 1% below previous 5-year averages. Density of 2+ juvenile salmon exceeded the previous 5-year average by 81%. A multiplicative model was used to compare 0+, 1+ and 2+ densities in 1993 with previous years. 0+ fry were significantly less abundant in 1993 than in 1991, but not different from 1992 and 1983-1990. Abundance of 1+ parr in 1993 was not different from abundance in 1983-1992, but was significantly higher than over half the years between 1972-1982. Abundance of 2+ parr did not significantly differ from 1983-1992, but 1993 abundance was significantly higher than most years before 1983.

Assuming average (1989 to 1993) returns of large and small salmon in 1994, total returns will be between 9,911 and 15,605 large and 8,551 and 14,155 small salmon.

RÉSUMÉ

En 1993, les pêcheurs à la ligne ont récolté 514 grands saumons et 3 268 petits saumons dans la rivière Restigouche (les grands saumons provenaient uniquement des tributaires de la rivière situés au Québec). Les prises de grands et de petits saumons par les pêcheurs à la ligne (y compris les grands saumons capturés et remis à l'eau au Nouveau-Brunswick) étaient inférieures de 52 % et de 25 % respectivement aux moyennes des cinq années antérieures. Les prises de petits et de grands saumons par unité d'effort étaient pour leur part inférieures de 33 % et 53 % respectivement aux moyennes des cinq années antérieures au Nouveau-Brunswick, tandis qu'elles étaient supérieures de 33 % pour les premières et inférieures de 38 % pour les secondes aux moyennes des cinq années antérieures au Québec. La récolte de grands saumons par les autochtones était inférieure de 17 % à la moyenne des cinq années antérieures, et celle de petits saumons se situait à 100 % sous la moyenne. Si l'on se fonde sur les statistiques de pêche à la ligne et sur un taux d'exploitation présumé de l'ordre de 0,3 à 0,5, on estime que les remontées de saumon de l'Atlantique dans la Restigouche en 1993 se chiffraient entre 6 087 et 9 349 grands saumons (49 % de moins que la moyenne des cinq années antérieures) et entre 7 600 et 12 666 petits (26 % de moins que la moyenne des cinq années antérieures). On a estimé que les échappées de reproducteurs représentaient la différence entre les remontées totales et les pertes dues à la pêche à la ligne, à la pêche des autochtones, au braconnage, aux maladies et au prélèvement de géniteurs pour les écloseries. En 1993, elles se situaient entre 3 339 et 6 079 grands saumons (54 % de moins que la moyenne des cinq années antérieures) et entre 3 248 et 7 605 petits saumons (26 % de moins que la moyenne des cinq années antérieures). Ces reproducteurs donneraient une ponte totale de 20 à 37 millions d'oeufs (comblant de 28 à 52 % des besoins). Les remontées, les échappées de reproducteurs et la ponte de 1993 sont inférieures aux moyennes des cinq années antérieures. La probabilité que les échappées de grands reproducteurs et la ponte soient inférieures à la cible était de 100 %, mais la cible à été atteinte pour les échappées de petits reproducteurs (probabilité de 100 %). Les expériences d'électropêche ont révélé que les densités de juvéniles de 0+ et 1+ étaient inférieures de 23 % et de 1 % respectivement à la moyenne des cinq années antérieures. La densité de juvéniles de 2+ était quant à elle supérieure de 81 % à la moyenne des cinq années antérieures. On a utilisé un modèle multiplicatif pour comparer les densités des junéviles de 0+, 1+ et 2+ de 1993 à celles des années antérieures. Les alevins de 0+ étaient beaucoup moins nombreux qu'en 1991, mais leur quantité était comparable à celle de 1992 et à la moyenne de 1983-1990. L'abondance des tacons de 1+ ne différait pas de la moyenne de 1983-1992, mais elle était bien supérieure à celle de plus de la moitié des années 1972-1982. Quant à l'abondance des tacons de 2+, elle ne différait pas sensiblement de la moyenne de 1983-1992, mais était nettement supérieure à celle de la plupart des années antérieures à 1983.

En supposant qu'en 1994 les remontées de grands et de petits saumons correspondent à la moyenne (1989-1993), elles se situeront entre 9 911 et 15 605 grands saumons et entre 8 551 et 14 155 petits saumons.

INTRODUCTION

During 1993, two user groups exploited Atlantic salmon in the Restigouche River: anglers and First Nation communities. Regulations controlling the harvest of salmon in 1993 were similar to regulations in 1992. Anglers in New Brunswick tributaries were obliged to release all large salmon (≥ 63 cm) back into the river; catches of small salmon were restricted by season 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; since 1990, if the first fish caught in a day was <63 cm, a second fish could be caught and retained irrespective of size. Québec/New Brunswick boundary waters were regulated by the New Brunswick catch and release policy for large salmon. The First Nation fishery at Restigouche, Québec, had no quota. The First Nation fishery at Eel River Bar, New Brunswick, was allocated a quota of 1450 small and 50 large salmon.

Commercial fisheries in Baie des Chaleurs have been closed in Québec since 1984, and in New Brunswick since 1985. Historical records of commercial landings prior to 1985 can be found in Randall et al. (1990). For both provinces, by-catch of salmon was prohibited in non-salmon fishing gear.

The objective of this report is to provide an evaluation of the status of Atlantic salmon in the Restigouche River for 1993. Angling and First Nation catch and effort data are summarized. Numbers of spawners and egg deposition are estimated from angling data and exploitation rates believed to represent lower and upper limits (the true rate is unknown). Juvenile salmon densities at 15 standard electrofishing sites are presented. Projections of adult salmon returns in 1994 are given.

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

TARGET EGG DEPOSITION

Egg deposition requirements for the Restigouche River, to provide a deposition rate of 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.

METHODS

1. Angling catch and effort.

Angling data from Québec tributaries of the Restigouche River were provided by the Ministère du loisir, de la chasse et de la pêche (MLCP); most data come directly from angling camp logbooks. Angling data from New Brunswick were provided by DFO fishery officers and by the New Brunswick Department of Natural Resources and Energy (DNRE). DFO fishery officers collect angling data directly from angling camps (daily logbooks) on a monthly basis. In the New Brunswick portion of the Restigouche system, most angling (79% of 1993 catch) occurs at private or government camps which keep individual records of angling catches. Angling catches in Crown Open waters (1% of 1993 catch) are estimates based on personal observations and interviews by the DFO fishery officers. Crown reserve data (20% of 1993 catch) are summarized by DNRE from data records returned by each angling party.

For both Québec and New Brunswick, angled salmon were identified as being either large or small. Effort was measured in rod-days, where one rod-day was one angler fishing a river for any portion of one day.

2. Within-river mortalities and removals.

River harvest for small fish is the sum of fish lost to angling and broodstock collection (Charlo hatchery, N.B.).

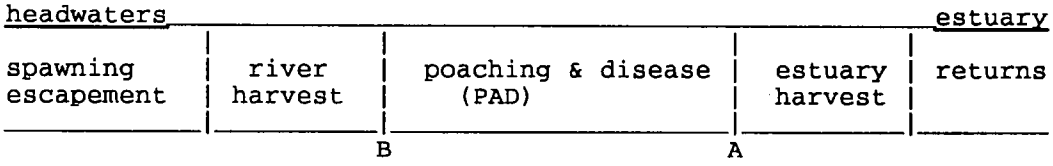
River harvest for large fish is the sum of fish lost to angling (Québec), mortality associated with catch and release (N.B.), and broodstock collection. The mortality rate associated with catch-and-release of large salmon was assumed to be 6% (Courtenay et al. 1991).

3. Estuarine mortalities.

First Nation landings (estuary harvest), poaching and disease are considered to be the main factors removing salmon from the estuary of the Restigouche River.

Landings of Atlantic salmon at Restigouche, Québec (Figure 1) were reported by the Band Office to DFO. Landings of salmon at Eel River Bar are reported on a weekly basis by individual gear types (gill nets, traps) to DFO.

Poaching and disease were added to river and estuary harvest to estimate total returns to the river. 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
= 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]

4. **Total Returns and spawning escapement.**

(1) Estimates based on angling catch

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

Returns = Estuary harvest + PAD + River harvest + Escapement

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.

The probabilities that estimates obtained in 1993 were different from previous 5-year means (spawning escapement, total returns and egg deposition) and from targets (spawning escapement and egg deposition) were assessed through a randomization procedure which used the uncertainty in angling exploitation rate (from which returns, escapement and eggs are calculated) and reported angling catches. The procedure was as follows:

a) Difference from 5-year mean

1. Estimate spawners (or returns, or egg deposition) in the current year and each of the past 5 years, 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. Express the number of spawners (or returns, or egg deposition) in the current year as a proportion of the mean of the previous 5 years.

3. Repeat steps 1 & 2 1000 times and plot the distribution of the proportions. The probability that the value for the current year is less than the 5-year mean is equal to the percentage of observations of proportions less than 1.

b) Difference from target

1. Estimate spawners or egg deposition in the current year as described above.

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 presented in Appendix 1.

(2) Mark-recapture estimates

An estimate of river population (point A in PAD description) was made using mark-recapture techniques. Salmon were marked with blue carlin tags at a trapnet operated by Eel River Bar First Nation at Morrissey Rock. The box portion of the trap was 3.7 m (12 feet) wide by 18.3 m (60 feet) long (plus a 2.4 m (8 feet) peak) and was constructed with 5.7 cm (2.25 inch) knotless nylon mesh. Downstream-angled leaders from the door of the trap were 42.7 m (140 feet) on the outside leader and 36.6 m (120 feet) on the leader to shore. Each leader was made from 12.7 cm (5 inch) polypropylene mesh. The trap was operated from June 1 to August 16 except for a 13 day period (June 3-15) when the trap was washed out by high water. A total of 329 small salmon and 46 large salmon were tagged at the Morrissey Rock trapnet.

Marks were recaptured in the angling fishery and at the Upsalquitch barrier pool. A summary of tag returns is provided below:

	Small		Large	
Location	Tag Returns	Catch	Tag Returns	Catch
Angling Camps	18	1850	1	1314
Upsalquitch Angling	14	644	0	221
All Angling	36	3268	2	2055
Upsalquitch Barrier	18	957	3	353

Angling camps are all camps exclusive of those directly on the Matapedia and Patapedia. Upsalquitch angling includes crown reserve and camps on the Upsalquitch.

An estimate of total returns was obtained using a Bayesian estimator as described by Gazey and Staley (1986). The most probable population size given R recaptures out of M marks placed in a sampled catch of C was calculated over a range of possible population sizes.

Reporting rate on Crown Reserve waters was estimated by conducting a phone survey of crown reserve anglers in New Brunswick waters. A total of 120 anglers were phoned and asked if they or any member of their party had caught a salmon with a tag. These names were then checked against tag returns received. The reporting rate estimated using this method was 77%. Tag loss was estimated using the mean number of days (14) to recapture and a 0.009 tag loss proportion per day as estimated on the Margaree River (Chaput et al. 1993).

The population estimate for small salmon was based only on tags reported from Upsalquitch angling and barrier returns. These tags were chosen because tags reported at the fence have a 100% reporting rate. The phone survey covered the type of angling taking place on the Upsalquitch providing confidence in the tag reporting rate for this section of river. In contrast, the ratio of tag returns from angling camps and total angling to numbers caught was 1/2 the ratio of Upsalquitch angling and fence tag:catch ratios (text table above). This result indicates that tag reporting is much lower for other parts of the angling fishery than the Upsalquitch and is also unestimated. Because any estimation of tag reporting for these portions of the fishery would depend on Upsalquitch, it was decided to just use tag returns and catch from areas where estimation was the result of the survey.

There were insufficient tags to use for an estimate of large salmon returns. Therefore, the large salmon estimate was made using the proportion of large salmon in the population as estimated by combined New Brunswick and Québec angling catch (proportion large = large/(large + small).

(3) Spawner counts from canoe surveys

A third method of estimating spawning escapement on the Restigouche River is direct counts of spawners during canoe surveys. These data are reported, but not used in calculating total returns or egg depositions, because their accuracy has not yet been adequately verified. These data have been collected since 1985.

(4) Spawner counts at protection barriers

Counts of spawners entering the Northwest Upsalquitch River and the Causapscal River (a tributary of the Matapedia River) are used as an additional index of spawning escapement. Spawners have been counted at the Northwest Upsalquitch protection barrier by DNRE since 1980, and at the Causapscal River barrier fence by MLCP since 1988.

5. Recruitment.

Densities of juvenile Atlantic salmon in headwater tributaries of the Restigouche River were determined by electrofishing surveys at 15 sites during August and September 1993. Densities were calculated by the removal method (Zippin 1956). Ninety-five percent confidence intervals of the mean densities for the 15 sites were calculated after individual site counts were transformed (natural logarithms). Densities of salmon fry and parr have been estimated at these sites each year since 1972.

Densities of fry (0+) and parr (1+, 2+) in 1993 were compared to densities measured from 1972-1992, using the following multiplicative model:

DENS = YEAR + TRIB + STRORD

Where: DENS: log (population density (no./m^2) at site)
YEAR: 1972-1993
TRIB: tributary of electrofishing site (Little Main Restigouche, Main Restigouche, or Kedgwick River)
STRORD: stream order of electrofishing site (4,5,6 or 7)

1972-1990 and 1993 data include all 15 electrofishing sites; 1991 data include only 8 sites, and 1992 data include 10 sites. Reference categories for year, tributary and stream order were 1993, Kedgwick River, and 6, respectively; the last two being chosen because they contained data in most years. Cells with zero counts were deleted from the analysis, because preliminary runs indicated that neither the above model, a similar model utilizing untransformed population density, or simpler models with one or more predictors omitted, was appropriate. A sample SAS program is included in Appendix 2.

6. Forecasts.

Three forms of forecasting were used:

(1) Five-year mean: Returns of large and small salmon in 1994 were predicted to be similar to average returns for the period 1989 to 1993.

The other two forecasts were based on indices of spawning success and adult survival in years that will produce small and large salmon returns in 1994. Forecasting from juvenile or small salmon densities in these years is based on the fact that in the Restigouche River, 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 1994 probably belong to the cohort of eggs laid in 1989 or 1990. Large salmon returning in 1994 probably belong to the cohort of eggs laid in 1987 through 1989.

(2) Adult survival: Returns of small fish in 1992 and 1993 were examined as an index of relative survival at sea of cohorts contributing to large salmon returns in 1994. Average returns of small salmon in 1992 and 1993 were compared to the previous 5-year average, as a possible index of sea survival. The predicted return of large salmon in 1994 is expressed as a percentage of the 5-year mean forecast.

(3) Spawning success: Abundance of age 1 parr was used as an index of spawning levels that was applicable to both large and small salmon returns. Average 1+ parr densities for 1989 to 1991 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 1994, age 1+ parr densities for 1991 and 1992 were considered. Predicted returns based on parr abundance are expressed as a percentage of the 5-year mean forecast.

RESULTS AND DISCUSSION

1. Angling catch and effort.

In Québec tributaries of the Restigouche River (Matapedia, mainly upper Patapedia and the upper Kedgwick rivers), angling catch of large salmon in 1993 was 514 fish, a decrease of 50% from the previous 5-year average (Table 1, Appendix 3). The lower catch of large salmon in 1993 was partly due to the required (temporary) releasing of large salmon in the Matapedia and Patapedia rivers during the last 3 weeks of the season. Effort was down 15% from the previous 5-year average to 6633 rod-days (Table 2). Catch-per-unit-effort (CPUE) decreased by 38% from the previous 5-year average to 0.08 fish/rod-day.

The number of large salmon estimated to have been caught and released in New Brunswick waters in 1993 was 1541 fish, a 53% decrease from the previous 5-year average (Table 1). Effort (10167 rod-days) was similar to the previous 5-year average (Table 2). CPUE decreased 53% from the previous 5-year average to 0.15 fish/rod-day.

Catch, effort and CPUE for New Brunswick was affected by the fact that Fraser Lodge did not fish its lease on the Kedgwick River in 1993.

The total angling catch of large salmon in 1993 (Québec and New Brunswick) was 2055 fish, a decrease of 52% from the 1988-1992 mean (Table 1).

Angling catch of small salmon in Québec tributaries was 796 fish, an increase of 19% from the previous 5-year mean (Table 1). CPUE increased by 33% from the previous 5-year mean to 0.12 fish/rod-day (Table 2). (Estimates of effort are those reported above for large salmon.)

Angling catch of small salmon in New Brunswick was 2472, a decrease of 33% from the previous 5-year average (Table 1). CPUE decreased 33% from the previous 5-year mean, to 0.24 fish/rod-day (Table 2).

The total angling catch of small salmon (Québec and New Brunswick) was 3268 fish, 25% below the previous 5-year mean (Table 1).

2. Within-river mortalities and removals.

Mortalities associated with the catch and release of 1541 large salmon in N.B. were estimated to be 92.

The numbers of large and small fish removed from the river to be used as broodstock at the Charlo hatchery were 165 and 20, respectively.

Total river harvests of large and small salmon were calculated as:

Large salmon	1993	1992
Angling harvest	514	1004
Broodstock	165	122
Catch/release mortality	92	201
TOTAL	771	1327

Small salmon	1993	1992
Angling harvest	3268	4751
Broodstock	20	4
TOTAL	3288	4755

3. **Estuarine mortalities.**

First Nation landings from Baie des Chaleurs and Restigouche River for 1975 to 1993 are presented in Appendix 4. Operating dates of these fisheries, 1979 to 1993, are summarized in Appendix 5.

The First Nation fishery at Restigouche, Québec, caught an estimated 901 large salmon and 0 small salmon in 1993 (Table 3). These harvests are down 9% and 100% from previous 5-year averages for large and small salmon respectively.

The First Nation fishery at Eel River Bar, New Brunswick, reported catching 293 large and 0 small salmon, 35% and 100% below previous 5-year means (Table 3). One reason for the lower catch of large salmon was because the fishery used only gillnets in 1993. In past years both gillnets and trapnets were used (Appendix 5).

Total nominal landings of Atlantic salmon in the Restigouche River from all fisheries in 1993 indicate a 31% decrease from the previous 5-year mean for large salmon, and a 27% decrease for small salmon (Table 3). Landings of large and small salmon combined have decreased by 28% (Table 4). Data sources are given in Appendix 6.

Estimates of poaching and disease, the second component of estuarine mortality of Restigouche salmon, for large salmon were 1305 and 783 for exploitation rates of 0.3 and 0.5 respectively. Comparable figures for small salmon were 1773 and 1064.

4. **Total returns and spawning escapement.**

(1) Returns from angling catch and spawning escapement

Returns and spawning escapement were calculated as:

	Exploitation 0.3	Exploitation 0.5	% Change from Previous 5 yr mean
Large salmon			
1. Total returns	9349	6087	-49
2. Harvest in estuary	1194	1194	-17
3. Harvest in river	771	771	-40
4. Poaching and disease	1305	783	-52
5. Spawners	6079	3339	-54
6. Target spawners	12200	12200	--
% of target (no.)	50	27	-54

Small salmon

1. Total returns	12666	7600	-26
2. Harvest in estuary	0	0	-100
3. Harvest in river	3288	3288	-25
4. Poaching and disease	1773	1064	-25
5. Spawners	7605	3248	-26
6. Target spawners	2600	2600	--
% of target (no.)	293	125	-26
% of target (eggs)	52	28	-54

Spawning escapement was estimated to be 27% to 50% of target for large salmon, and 125% to 293% of target for small salmon. Egg deposition was estimated to be 28% to 52% of target.

Spawning escapements, assuming exploitation rates of 0.3 and 0.5, are summarized for the period 1970 to 1993 in Tables 5 to 8. Spawning escapement of large salmon was between 3339 and 6079 fish, 54% below previous 5-year averages. Spawning escapement for small salmon was between 3248 and 7605 fish, 26% below previous 5-year averages.

Estimated total egg depositions in 1993 were between 20.1 and 36.8 million eggs, 54% below the previous 5-year averages (Tables 9 and 10; Figure 2). In 1993, as in the previous 5 years, 99% of eggs are estimated to have been deposited by large fish.

The preceding results and the randomization analysis summarized in the following table indicate that returns were below average values for the previous 5 years, and, with the exception of spawning escapement of small salmon, were below target levels. The following results indicate the probabilities associated with these differences.

		PROBABILITY THAT 1993 IS LESS THAN	
		5-YEAR MEAN	TARGET
TOTAL RETURNS	Large salmon	100% (Fig. 3)	----
	Small salmon	89% (Fig. 3)	----
SPAWNERS	Large salmon	--------	100% (Fig. 4)
	Small salmon	--------	0% (Fig. 4)
EGGS	Large + Small	--------	100% (Fig. 5)

(2) Mark-recapture experiment

Daily trapnet catches indicate that the peak in run-timing for small salmon occurred between day 194 (July 13) and day 201 (July 20) at Morrissey Rock (Figure 6). The proportion of large salmon in the angling catch declined in Québec and New Brunswick waters in 1993 from 1992 (Figure 7). The trend was also evident at the Upsalquitch barrier (Figure 8). The proportion of large salmon in the total Québec - New Brunswick angling catch for 1993 about (40%) was used

to obtain a large salmon estimate from the small salmon population estimate.

Returns and spawning escapement calculated by mark-recapture experiment were:

	Small salmon	Large salmon
1. Total returns	12431	9427
2. Harvest in estuary	0	1194
3. Population at point A	12431	8233
4. Poaching and disease	1740	1317
5. Harvest in river	3288	771
6. Spawners	7403	6145

The small salmon river population estimate using the Upsalquitch tags was 12,431 (9,650 - 18,150, 95% C.L.) fish with a spawning escapement of 7,403 (5,011 - 12,321, 95% C.L.) fish (Figure 9). Exploitation rate at point A for these fish was 26% (31% ang. ER at point B). The confidence interval around the small salmon spawning escapement estimate indicates 100% probability that small salmon spawning requirements were met. The large salmon river population estimate was 8,233 (6,433 - 12,100, 95% C.L.) fish with a spawing escapement of 6,145 (4,633 - 9,393, 95% C.L.) fish (Figure 10). The exploitation rate at point A for large salmon was 25% (30% ang. ER at point B). The confidence interval around the spawning escapement estimate indicates 0% probability that the required 12,200 large salmon was achieved (Figure 10).

(3) Spawner counts from canoe surveys

Visual counts of spawners, conducted from canoes, were 3512 large and 2352 small salmon (Tables 5-8, Appendix 7). The 1993 values are 58% (large salmon) and 39% (small salmon) below previous mean values.

(4) Spawner counts at protection barriers

Counts of large and small salmon at the NW Upsalquitch protection barrier may not be comparable to counts in other years because budget constraints in 1993 caused the removal of the barrier on October 13, about 2 weeks earlier than usual. Counts to October 13 indicate a decreased spawning escapement: large salmon counts, 353, were 63% below 1988-1992 means and small salmon counts, 957, were 22% below the 1988-1992 means (Table 11).

Counts of salmon at a barrier on the Causapscal River were 46% and 45% below the 1988-92 average for large and small salmon, respectively (Table 11). However, the barrier was washed out by high water on August 17, so these counts should not be compared to those obtained from a full season's operation.

(5) Comparison of spawning escapement as determined from angling catches, canoe surveys and barrier counts

Both the angling catch-based method and spawner counts from the Northwest Upsalquitch barrier fence suggest that the 1993 spawning escapement was below the 5-year mean. Spawner counts from canoe surveys were substantially lower than 1992 values, but the methodology used has not been adequately calibrated.

5. Recruitment.

Egg depositions from 1971 to 1992 for exploitation rates of 0.3 and 0.5 showed evidence of significant ($P \leq 0.05$) correlation with resulting 0+ and 1+, but not 2+ juvenile densities for both rates (Tables 9 and 10; Figures 11 and 12).

Average densities of 0+ and 1+ juvenile salmon in 1993 were lower than previous 5-year averages by 23% and 1% respectively (Tables 9 and 10; Figure 13), but the density of 2+ juveniles was 81% higher than the previous 5-year average. These data suggest that the high density of 0+ juveniles observed in 1991 was due, in part, to a strong yearclass as the increase carried through to the 2+ density of 1993. Variation in densities among individual sites was considerable however, as indicated by the wide confidence intervals (Figure 13).

Analysis by the multiplicative model indicated that mean fry density (0+) in 1993 was not significantly different from 1992. This density was significantly lower than 1991 but not significantly different from densities in 1983-1990 (Figure 14). Density in 1993 was significantly greater than in most years between 1972 and 1982. Both predictors used in the model (year and stream order) were significant. The R^2 of the model was 0.55 and a scatterplot of predicted versus residual values showed no reason to reject the model (Figure 15).

Parr density (1+) in 1993 was not significantly different from abundance in 1974-1976, 1978-1979 and 1983-1992, but was significantly greater than 1972-1973, 1977 and 1980-1982 (Figure 16). Both predictors used in the model (year and stream order) were significant. The R^2 of the analysis was 0.28 and residual plots showed no reason to reject the model (Figure 17).

Abundance of 2+ parr did not significantly differ from 1983-1992, but 1993 abundance was significantly higher than in most years before 1983 (Figure 18). Year and stream order were significant predictors in the model. The R^2 of the model was 0.29 and the residual plots showed no reason to reject the model (Figure 19).

6. Forecasts.

(1) Evaluation of forecasts for 1993

In the 1992 assessment of Atlantic salmon in the Restigouche River (Locke et al. 1993), predictions of large and small salmon returns in 1993 were:

Method	Forecast	
	Large salmon	Small salmon
Five-year mean	11,550 - 18,289	10,172 - 16,894
1+ parr density	+22%	+38%
Small salmon returns	-27%	--

Actual returns in 1993 calculated in the present assessment were -
Large salmon: 6,087 - 9,349 (52% of the forecast based on 5-year mean)
Small salmon: 7,600 - 12,666 (75% of the 5-year mean forecast).

Relative to the 5-year mean values, returns of large and small salmon decreased by 48% and 26%, respectively. The poor match between calculated returns and those predicted suggest that none of the methods were very effective forecasters of 1993 returns.

(2) Forecast for 1994

Forecasts for 1994 are presented below:

Method	Forecast	
	Large salmon	Small salmon
Five-year mean	9,911 - 15,605	8,551 - 14,155
1+ parr density	+53%	+41%
Small salmon returns	-11%	--

The 5-year mean of 1989-1993 returns (angling exploitation rate (ER) of 0.5 and 0.3 for 1989-1992; ER 0.5 and mark-recapture for 1993) predicts a range of returns in 1994 that exceed for large salmon and encompass for small salmon the returns in 1993.

The potential sea survival index (average returns of small salmon in 1992 (0.3 ER) and 1993 (mark-recapture ER)) predicts a below average return of large fish in 1994. The potential recruitment index (1+ density) predicts an above average return of large and small salmon in 1994.

7. Conclusions and recommendations.

The best estimate of river population numbers and spawning escapement comes from the mark-recapture experiment. This experiment indicates that large salmon spawners are about one-half the estimated number (0.3 ER) in 1992 and indicates that there was no chance that spawning requirement was exceeded in 1993. Exploitation rate from this experiment indicates that angling exploitation (at point B) in 1993 was equal to the minimum value assumed in previous assessments, 30% compared to a range of 30% to 50% used in previous assessments (Locke et al. 1993). This decline from 1992 to 1993 is also supported by a decline in angling catches (Table 1), field spawner counts (Tables 5 and 6) and returns to the Upsalquitch barrier (Table 11).

Improvements for the 1994 assessment will include operating two marking traps on either side of Smith Island and using the Morrissey Rock trapnet as a recapture site. Additional investigations concerning reporting rate in the different types of angling fisheries will allow an expanded use of tags returned from the angling fishery to be used in the river population estimate.

Fine-scale management of the river will be improved by reporting angling catch and spawner counts by tributary. Spawner counts will be reported by numbers of small and large combined and split into proportions of small and large based on trapnet catches. Operation of the trapnets for the entire season will be important for improving mark-recapture experiments and investigating changing proportions of small and large salmon.

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SUMMARY SHEET

STOCK: Restigcouche River, SFA 15
TARGET: 71.4 million eggs (12,200 large salmon, 2,600 small salmon)
REARING AREA: 29,768,000 m^2, 76% of SFA 15, 30% of Gulf New Brunswick

	1988[1]	1989[1]	1990	1991	1992	1993	MIN	MAX	MEAN[2]
Angling catch[3]									
Large	5675	4603	3735	3137	4355	2055	1016[4]	6707	4301
Small	6873	3360	4324	2522	4751	3268	896	6873	4366
First Nations' harvest									
Large	1430	1649	1606	1111	1412	1194	129[5]	2950	1442
Small	73	163	136	19	55	0	0	178	89
Spawning escapement[6]									
Large	10-18	8-14	6-11	5-9	7-13	3-6	1-2[4]	11-19	7-13
Small	7-16	3-8	4-10	3-6	5-11	3-7	1-2	7-16	4-10
Total returns[6]									
Large (x1000)	15-24	13-20	10-16	9-14	12-19	6-9	6-9[4]	23-30	12-19
Small (x1000)	16-27	8-13	10-17	6-10	11-18	8-12	3-4	16-27	10-17
% egg target met[6]	84-148	65-116	53-95	43-78	62-111	28-52	9-20[4]	89-159	61-110

[1] The values for 1988 and 1989 reflect changes resulting from the updating of Québec angling catches.
[2] MEAN for years 1988 to 1992.
[3] Angling catch includes hook and release catch of large salmon (in N.B.) rather than river harvest which was previously reported.
[4] MIN MAX for years 1970 to present.
[5] MIN MAX for years 1975 to present.
[6] Range given reflects uncertainty of angling exploitation rate (assumed to be between 0.3 and 0.5 for 1970 to 1992 and mark-recapture and 0.5 for 1993), 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 1993 were 52% and 25% below the five-year means, respectively. First Nations' harvest of large salmon was 17% below the previous five-year average and no small salmon were harvested.

Data and assessment: A mark-recapture experiment formed the basis for river population and spawning escapement estimation for the first time in the Restigouche River in 1993. Angling exploitation rates estimated using these river population estimates and angling catches were 31% and 30% for small and large salmon, respectively compared to the (assumed) rates of 30% to 50% used in previous assessments. Canoe surveys of spawners and salmon counted at headwater protection barriers on the Upsalquitch River and Causapscal River (Matapedia) provide additional indices of spawning escapement. Juvenile salmon densities estimated from electrofishing at up to 15 standard sites provide an index of spawning one and two years in the past.

State of the stock: Spawning escapement estimated by mark-recapture was 6,145 large salmon compared to a requirement of 12,200. All indications are that large salmon total returns in 1993 were 50% of the 1992 values (0.3 angling exploitation rate) value. Potential indices of spawning escapement (canoe counts, barrier counts and juvenile densities) suggest that the stock is larger now than it was in the early 1980s.

Forecast for 1994: Based on the mean returns from 1989-1993, between 10,000-16,000 large salmon and between 9,000-14,000 small salmon are expected to return in 1994. There is no evidence to suggest that returns will be significantly different from average. The ranges given reflect upper and lower exploitation rates used in calculating returns, not confidence limits.

Table 1. Estimated angling catches of salmon in the Restigouche River, 1970 to 1993.

Year	Large			Small			Proportion Large		
	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
1984a	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
Mean (88-92)	1029	3272	4301	670	3696	4366	0.61	0.48	0.50
1993 c.f. Mean	-50%	-53%	-52%	+19%	-33%	-25%	-36%	-21%	-22%

a Estimates of large salmon (1984 to 1993) 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.

Table 2. Preliminary estimates of angling catch, effort and CPUE in New Brunswick and Quebec portions of the Restigouche River, 1993. Catch, effort and CPUE in 1992 are given for comparison.

	1993			1992			Mean (88-92)			1993 c.f. Mean		
	Catch	Effort	CPUE	Catch	Effort	CPUE	Catch	Effort	CPUE	Catch	Effort	CPUE
N.B. Small	2472	10167	0.24	3999	9966	0.40	3696	10162	0.36	-33%	0%	-33%
aLarge	1541	10167	0.15	3351	9966	0.34	3272	10162	0.32	-53%	0%	-53%
P.Q. Small	796	6633	0.12	752	6948	0.11	670	7848	0.09	+19%	-15%	+33%
Large	514	6633	0.08	1004	6948	0.14	1029	7848	0.13	-50%	-15%	-38%

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

Table 3. Preliminary estimates of harvest (numbers) of small and large salmon in Restigouche River, 1993. Harvests of salmon in 1992 are given for comparison.

		1993		1992		Mean (88-92)		1993 c.f. Mean	
Fishery		Small	Large	Small	Large	Small	Large	Small	Large
Native									
	N.B.	0	293	2	464	71	453	-100%	-35%
	P.Q.	0	901	53	948	19	989	-100%	-9%
Angling									
	N.B.	2472		3999		3696		-33%	
	P.Q.	796	514	752	1004	670	1029	+19%	-50%
Total		3268	1708	4806	2416	4456	2471	-27%	-31%

Table 4. Commercial, angling and Native salmon landings from Baie des Chaleurs and Restigouche River, 1970 to 1993. Data sources given in Appendix 6.

	Commercial		Angling		Native		
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	1412	7222
1993	0	0	3268	514	0	1194	4976
Mean (88-92)	0	0	4366	1029	89	1442	6926
1993 c.f. Mean	0%	0%	-25%	-50%	-100%	-17%	-28%

Table 5. Estimated spawners (S) and total returns (R) of large salmon in Restigouche River, 1970 to 1993. Spawners were estimated using an angling exploitation rate (u) of 0.3.

Year	Harvest		Large Released plus P.Q.	PAD	Spawners (S)	Field Spawner Counts	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
1984a	3309	722	2276	1445	6865		12341
1985	1217	1173	4414	2803	13540	7934	18733
1986	1576	1695	6183	3926	18915	9542	26112
1987	1902	1170	4173	2650	12740	8535	18462
1988	1430	1329	5675	3604	17588	9520	23951
1989	1649	1492	4603	2923	13851	12362	19915
1990b	1606	1146	3735	2372	11304		16428
1991	1111	1181	3137	1992	9276	7092	13560
1992	1412	1327	4355	2765	13190	4704	18694
1993	1194	771	2055	1305	6079	3512	9349
Mean (88-92)	1442	1295	4301	2731	13042	8420	18510
1993 c.f. Mean	-17%	-40%	-52%	-52%	-53%	-58%	-49%

a River harvests (1984 to 1993) include catch and release mortalities and broodstock removals.
b High water prevented field spawner count.

Table 6. Estimated spawners (S) and total returns (R) of large salmon in Restigouche River, 1970 to 1993. Spawners were estimated using an angling exploitation rate (u) of 0.5.

Year	Harvest		Large Released plus P.Q.	PAD	Spawners (S)	Field Spawner Counts	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
1984a	3309	722	2276	867	3830		8728
1985	1217	1173	4414	1682	7655	7934	11727
1986	1576	1695	6183	2356	10671	9542	16298
1987	1902	1170	4173	1590	7176	8535	11838
1988	1430	1329	5675	2162	10021	9520	14942
1989	1649	1492	4603	1754	7714	12362	12609
1990b	1606	1146	3735	1423	6324		10499
1991	1111	1181	3137	1195	5093	7092	8580
1992	1412	1327	4355	1659	7383	4704	11781
1993	1194	771	2055	783	3339	3512	6087
Mean (88-92)	1442	1295	4301	1639	7307	8420	11682
1993 c.f. Mean	-17%	-40%	-52%	-52%	-54%	-58%	-48%

a River harvests (1984 to 1993) include catch and release mortalities and broodstock removals.
b High water prevented field spawner count.

Table 7. Estimated spawners (S) and total returns (R) of small salmon in Restigouche River, 1970 to 1993. Spawners were estimated using an angling exploitation rate (u) of 0.3.

Year	Harvest		Small Kept	PAD	Spawners	Field Spawner	Returns
	Estuary	River	N.B.+P.Q.		(S)	Counts	(R)
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	2132	13997
1986	30	5417		2940	12640	5190	21027
1987	100	5110		2773	11923	3930	19906
1988	73	6873		3730	16037	3861	26713
1989	163	3360		1823	7840	3970	13186
1990a	136	4324		2346	10089		16895
1991	19	2522		1369	5885	4257	9795
1992b	55	4755	4751	2578	11082	3272	18470
1993	0	3288	3268	1773	7605	2352	12666
Mean (88-92)	89	4367		2369	10187	3840	17012
1993 c.f. Mean	-100%	-25%		-25%	-25%	-39%	-26%

a High water prevented field spawner count.
b River harvests (1992 to 1993) include broodstock removals.

Table 8. Estimated spawners (S) and total returns (R) of small salmon in Restigouche River, 1970 to 1993. Spawners were estimated using an angling exploitation rate (u) of 0.5.

Year	Harvest		Small Kept	PAD	Spawners	Field Spawner	Returns
	Estuary	River	N.B.+P.Q.		(S)	Counts	(R)
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	2132	8412
1986	30	5417		1764	5417	5190	12628
1987	100	5110		1664	5110	3930	11984
1988	73	6873		2238	6873	3861	16057
1989	163	3360		1094	3360	3970	7977
1990a	136	4324		1408	4324		10192
1991	19	2522		821	2522	4257	5884
1992b	55	4755	4751	1547	4747	3272	11104
1993	0	3288	3268	1064	3248	2352	7600
Mean (88-92)	89	4367		1422	4365	3840	10243
1993 c.f. Mean	-100%	-25%		-25%	-26%	-39%	-26%

a High water prevented field spawner count.
b River harvests (1992 to 1993) include broodstock removals.

Table 9. Estimates of total egg deposition and resulting juvenile densities of Atlantic salmon in the Restigouche River, 1971 to 1993. Egg depositions were estimated using an angling exploitation rate (u) of 0.3. Juvenile densities (number per 100m2) are mean densities of 15 (1972-90 & 93), 8 (1991) and 10 (1992) standard sites.

Year (i)	Egg deposition (millions) Large (year i)	Small (year i)	Total (year i)	Juvenile salmon densities 0+ (year i+1)	1+ (year i+2)	2+ (year i+3)
			1.	2.	3.	4.
1971	14.1	0.2	14.3	5.2	2.8	0.6
1972	66.6	0.2	66.8	22.0	6.1	1.5
1973	71.7	0.6	72.3	13.1	4.8	1.0
1974	84.1	0.4	84.5	28.6	6.9	1.4
1975	44.4	0.4	44.8	13.3	3.9	1.0
1976	82.8	0.2	83.0	14.7	6.3	1.4
1977	85.2	0.0	85.2	19.5	5.9	2.1
1978	71.5	0.1	71.6	6.1	3.8	0.4
1979	26.2	0.6	26.8	9.3	2.4	0.4
1980	67.5	0.8	68.3	18.9	3.3	3.1
1981	58.7	0.7	59.4	11.2	7.8	2.5
1982	35.7	0.6	36.3	25.4	7.3	1.6
1983	28.6	0.2	28.8	25.1	10.4	2.8
1984	40.7	0.4	41.1	25.2	7.5	4.7
1985	80.3	0.7	81.0	23.9	9.4	2.1
1986	112.2	1.1	113.3	42.0	6.1	1.9
1987	75.6	1.0	76.6	53.2	12.1	3.1
1988	104.3	1.4	105.7	72.1	12.9	2.9
1989	82.2	0.7	82.9	53.2	12.3	2.8
1990	67.1	0.9	68.0	106.5	14.6	4.7
1991	55.0	0.5	55.5	49.6	11.5	-
1992	78.3	1.0	79.3	51.4	-	-
1993	36.1	0.7	36.8	-	-	-
Mean (88-92)	77.4	0.9	78.3	66.9	11.6	2.6
1993 c.f. Mean	-53%	-22%	-53%	-23%	-1%	+81%

Correlations:	n	r	p
ln. 1. with ln. 2.	22	0.52	0.01
ln. 1. with ln. 3.	21	0.44	0.05
ln. 1. with ln. 4.	20	0.37	0.11
ln. 2. with ln. 3.	21	0.84	<0.01
ln. 2. with ln. 4.	20	0.78	<0.01
ln. 3. with ln. 4.	20	0.77	<0.01

Table 10. Estimates of total egg deposition and resulting juvenile densities of Atlantic salmon in the Restigouche River, 1971 to 1993. Egg depositions were estimated using an angling exploitation rate (u) of 0.5. Juvenile densities (number per 100m2) are mean densities of 15 (1972-90 & 93), 8 (1991) and 10 (1992) standard sites.

Year (i)	Egg deposition (millions) Large (year i)	Small (year i)	Total (year i)	Juvenile salmon densities 0+ (year i+1)	1+ (year i+2)	2+ (year i+3)
			1.	2.	3.	4.
1971	6.0	0.1	6.1	5.2	2.8	0.6
1972	28.5	0.1	28.6	22.0	6.1	1.5
1973	30.7	0.3	31.0	13.1	4.8	1.0
1974	36.0	0.2	36.2	28.6	6.9	1.4
1975	19.0	0.2	19.2	13.3	3.9	1.0
1976	35.5	0.1	35.6	14.7	6.3	1.4
1977	36.5	0.0	36.5	19.5	5.9	2.1
1978	30.6	0.1	30.7	6.1	3.8	0.4
1979	11.2	0.2	11.4	9.3	2.4	0.4
1980	28.9	0.3	29.2	18.9	3.3	3.1
1981	25.2	0.3	25.5	11.2	7.8	2.5
1982	15.3	0.2	15.5	25.4	7.3	1.6
1983	12.3	0.1	12.4	25.1	10.4	2.8
1984	22.7	0.2	22.9	25.2	7.5	4.7
1985	45.4	0.3	45.7	23.9	9.4	2.1
1986	63.3	0.5	63.8	42.0	6.1	1.9
1987	42.6	0.4	43.0	53.2	12.1	3.1
1988	59.5	0.6	60.1	72.1	12.9	2.9
1989	45.8	0.3	46.1	53.2	12.3	2.8
1990	37.5	0.4	37.9	106.5	14.6	4.7
1991	30.2	0.2	30.4	49.6	11.5	-
1992	43.8	0.4	44.2	51.4	-	-
1993	19.8	0.3	20.1	-	-	-
Mean (88-92)	43.4	0.4	43.7	66.9	11.6	2.6
1993 c.f. Mean	-54%	-25%	-54%	-23%	-1%	+81%

Correlations:	n	r	p
ln. 1. with ln. 2.	22	0.64	<0.01
ln. 1. with ln. 3.	21	0.55	0.01
ln. 1. with ln. 4.	20	0.46	0.04
ln. 2. with ln. 3.	21	0.84	<0.01
ln. 2. with ln. 4.	20	0.78	<0.01
ln. 3. with ln. 4.	20	0.77	<0.01

Table 11. Counts of salmon at two fish barriers in the Restigouche River system.

Year	Small	Large	Total	Large/Small
NW Upsalquitch barrier				
1980	843	887	1730	1.05
1981	789	481	1270	0.61
1982	819	622	1441	0.76
1983	430	301	731	0.70
1984	518	642	1160	1.24
1985	748	517	1265	0.69
1986	1738	1166	2904	0.67
1987	1557	1000	2557	0.64
1988	1121	993	2114	0.89
1989a	1051	894	1945	0.85
1990b	1324	946	2270	0.71
1991c	1267	930	2197	0.73
1992	1351	963	2314	0.71
1993d	957	353	1310	0.37
Mean (88-92)	1223	945	2168	0.78
1993 c.f. Mean	-22%	-63%	-40%	-53%
Causapscal barrier				
1988	49	505	554	10.31
1989	7	605	612	86.43
1990e	37	456	493	12.32
1991	9	451	460	50.11
1992f	8	350	358	43.75
1993g	12	256	268	21.33
Mean (88-92)	22	473	495	40.58
1993 c.f. Mean	-45%	-46%	-46%	-47%

a Count incomplete. Barrier removed October 22 (c.f. October 26-28 in other years) due to budget constraint.
b Count incomplete. Barrier breached October 14 due to high water.
c Count incomplete. Barrier removed October 16 due to high water.
d Count incomplete. Barrier removed October 13 due to budget constraint.
e Count incomplete. Barrier breached August 14 due to high water.
f Count incomplete. Barrier removed August 5 due to high water.
g Count incomplete. Barrier breached August 17 due to high water.

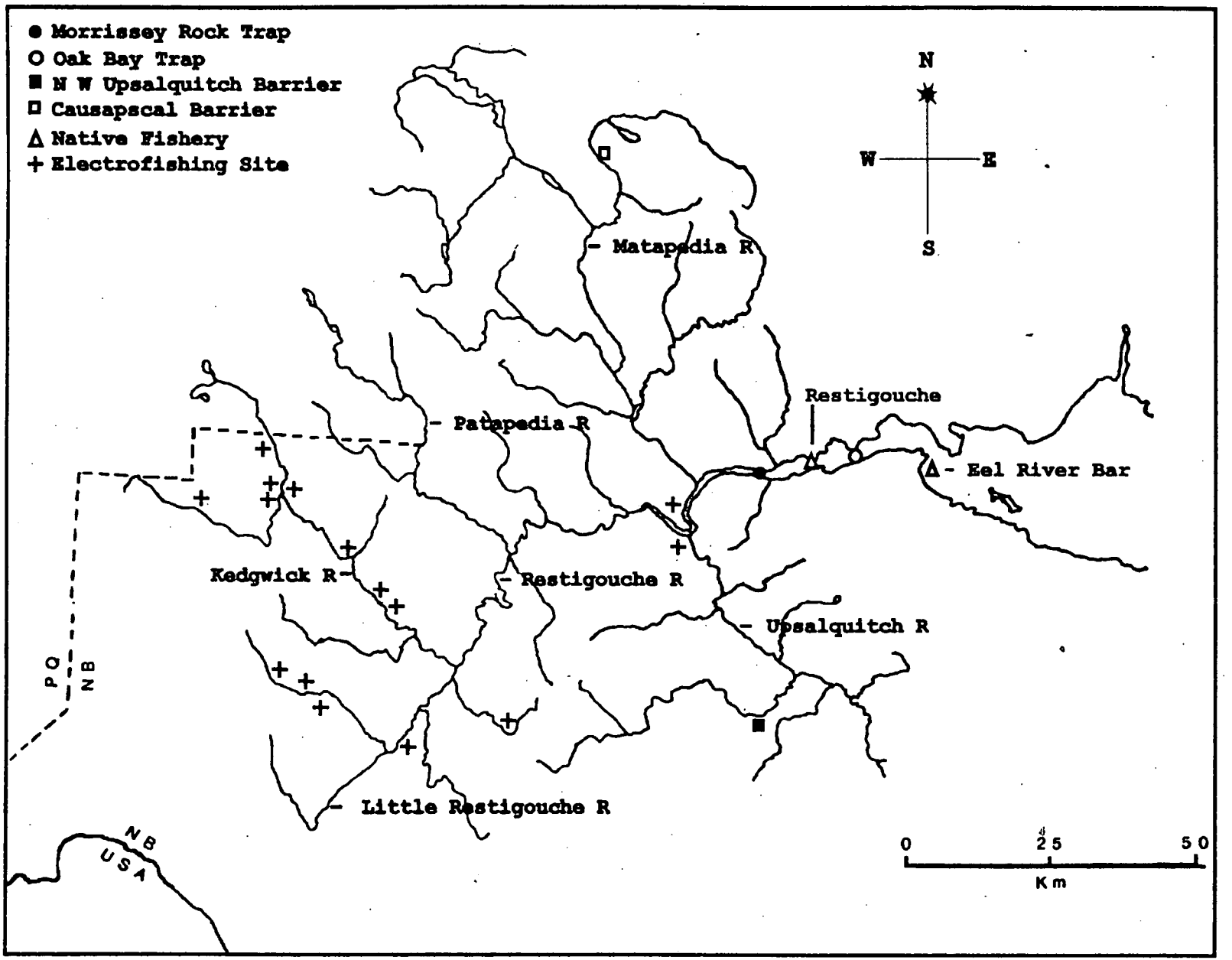


Figure 1. Map of the Restigouche River showing the location of salmon counting facilities, native fisheries and electrofishing sites in 1993

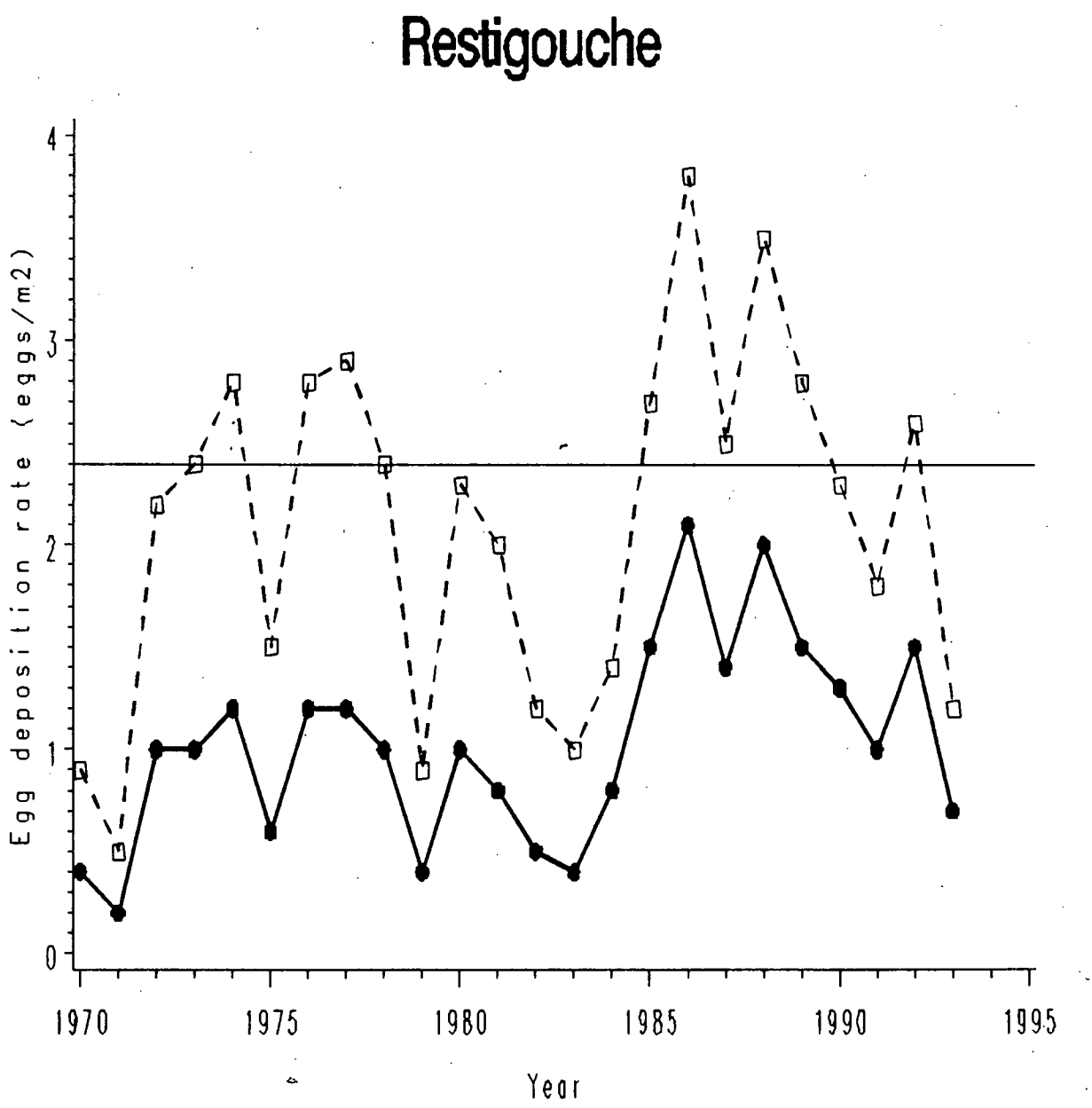
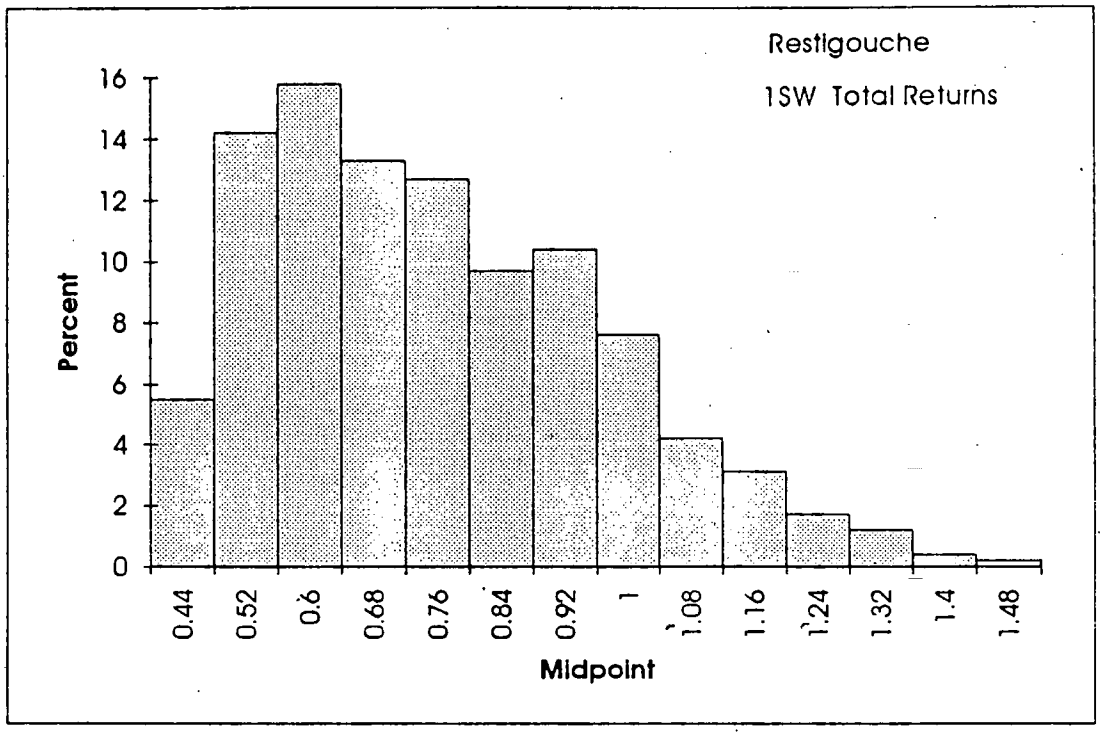


Figure 2. Egg deposition rates, 1970-1993, estimated from angling catch data and assumed exploitation rates of 0.3 (squares) and 0.5 (dots). Horizontal line indicates target deposition rate.



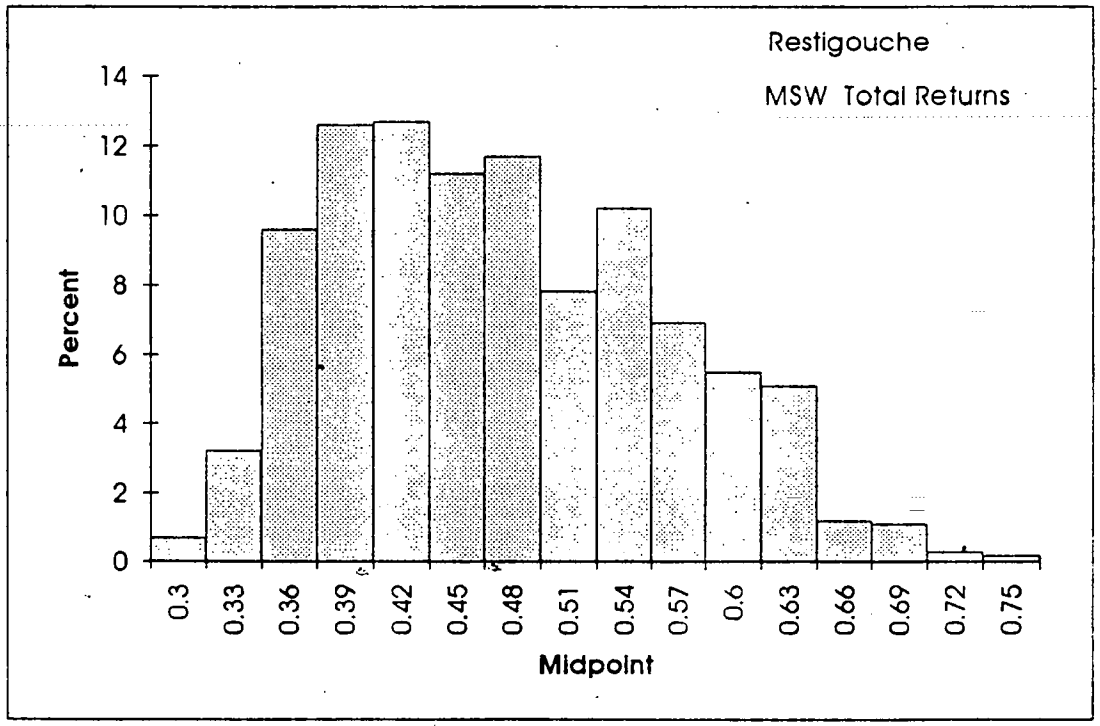


Fig. 3. Estimated small and large salmon as a proportion of the five year 1988-1992 average returns using the randomization procedure.

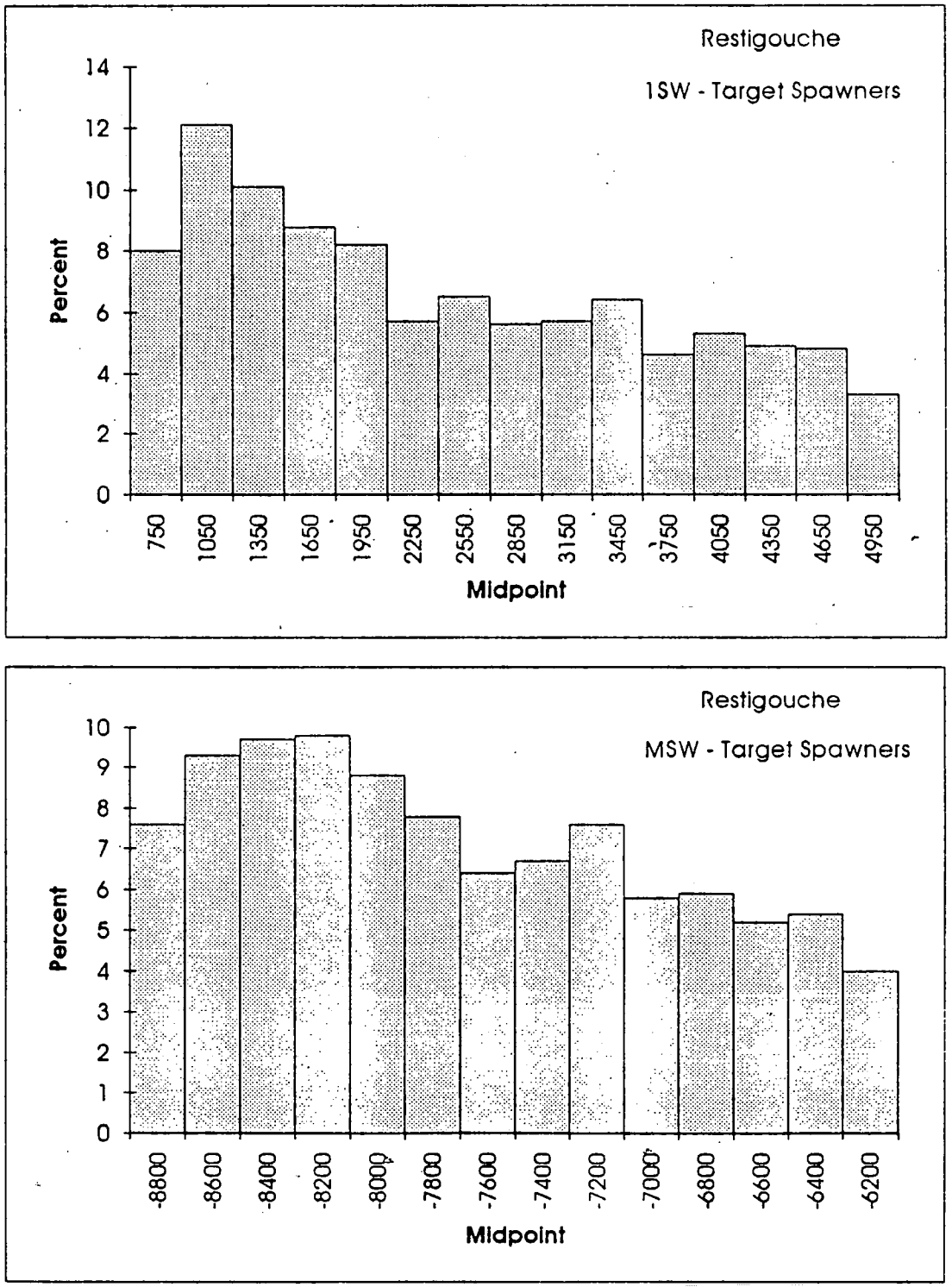


Fig. 4. Estimated small and large salmon - target spawners using the randomizatio procedure.

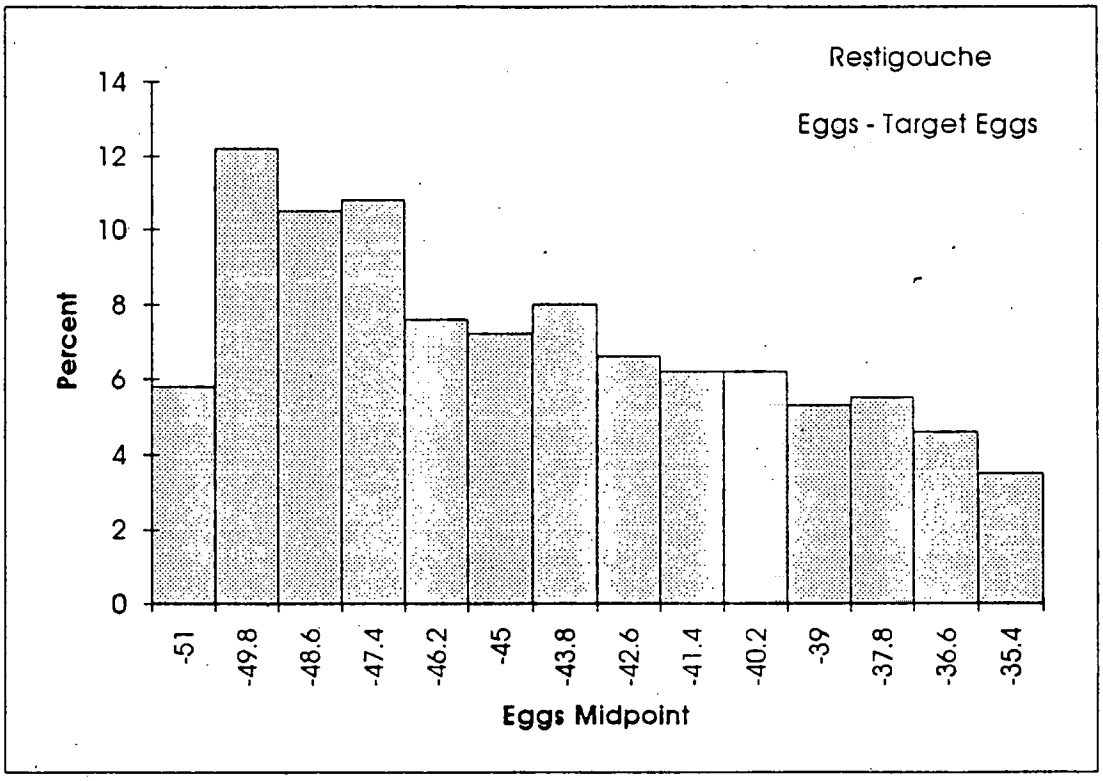


Fig. 5. Estimated egg desposition - target egg deposition using randomiztion procedure.

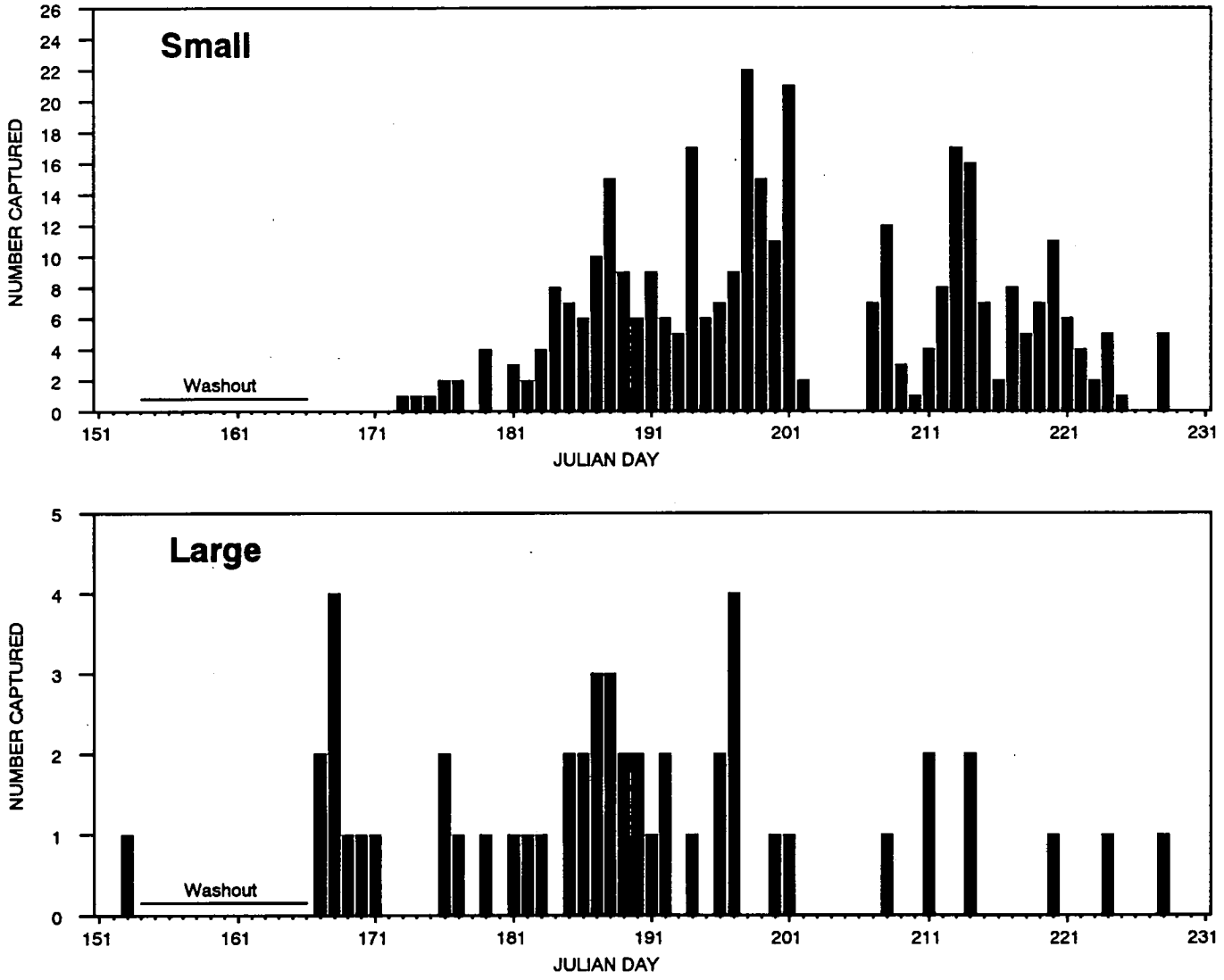


Figure 6. Daily small and large salmon captures in Morrissey Rock trap in 1993. Day 191 = July 10.

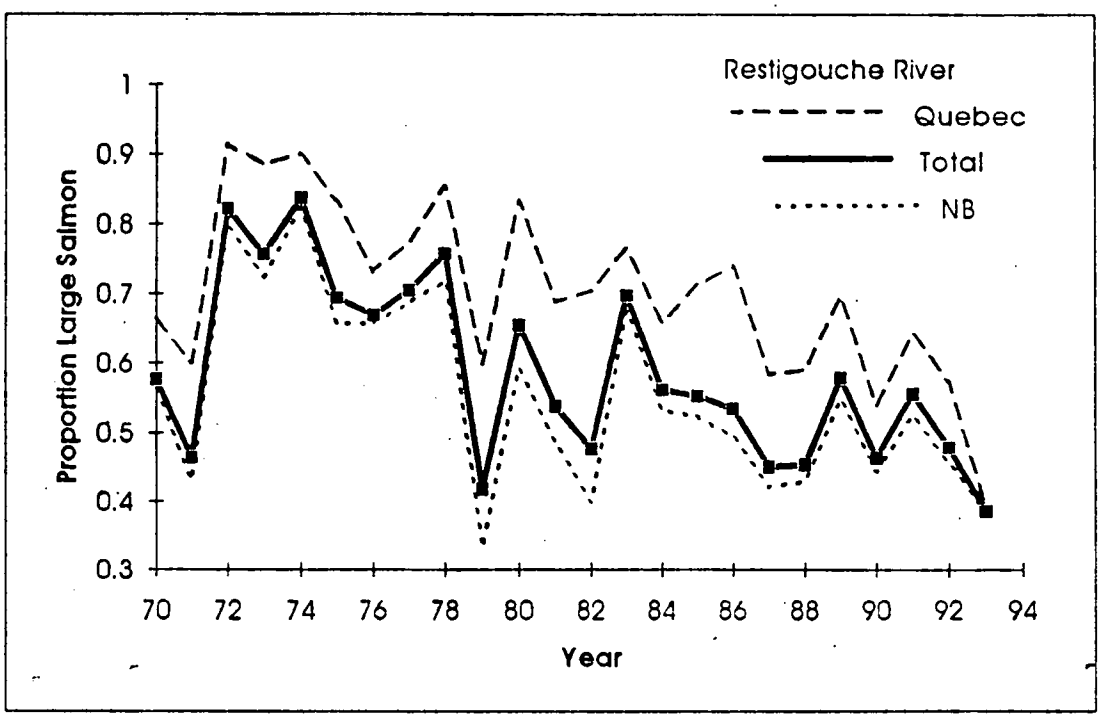


Fig. 7. Proportion of large salmon in Quebec, New Brunswick, and Total angling fisheries.

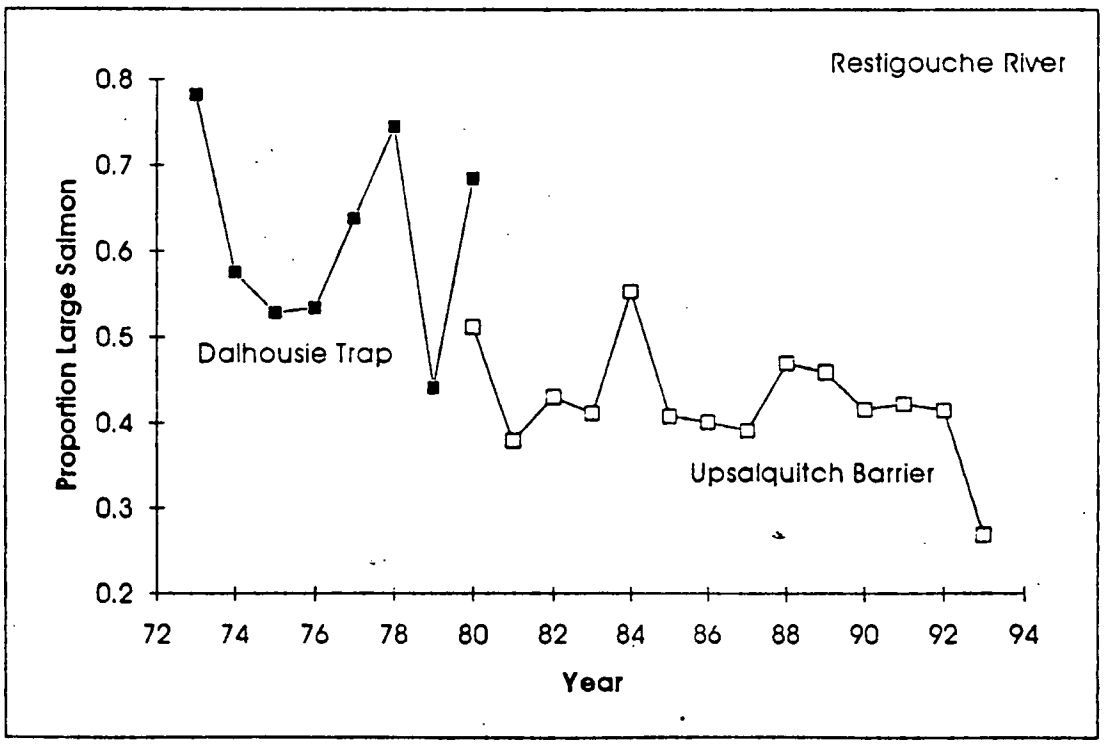


Fig. 8. Proportion of large salmon at index sites on the Restigouche River.

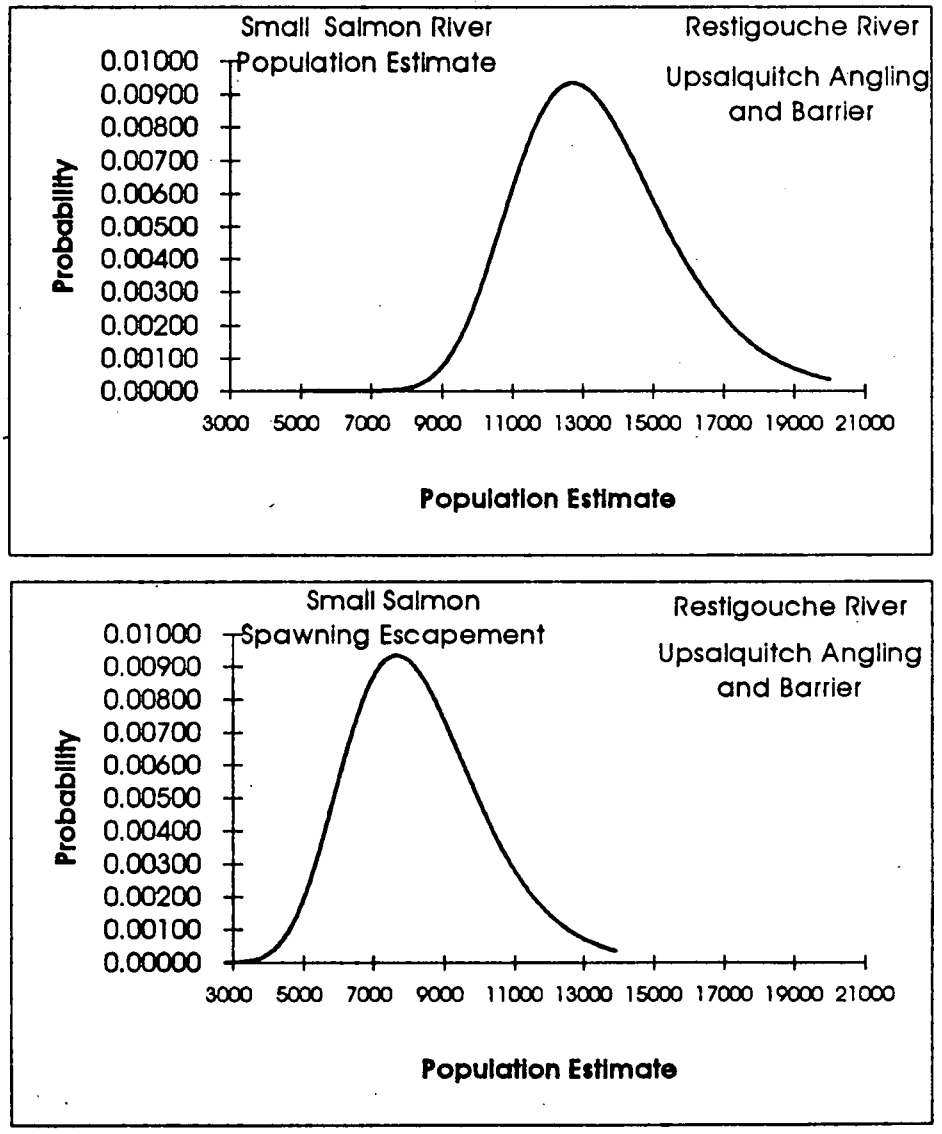


Fig. 9. Small salmon river population and spawning escapement estimates based on Upsalquitch angling and barrier tag returns.

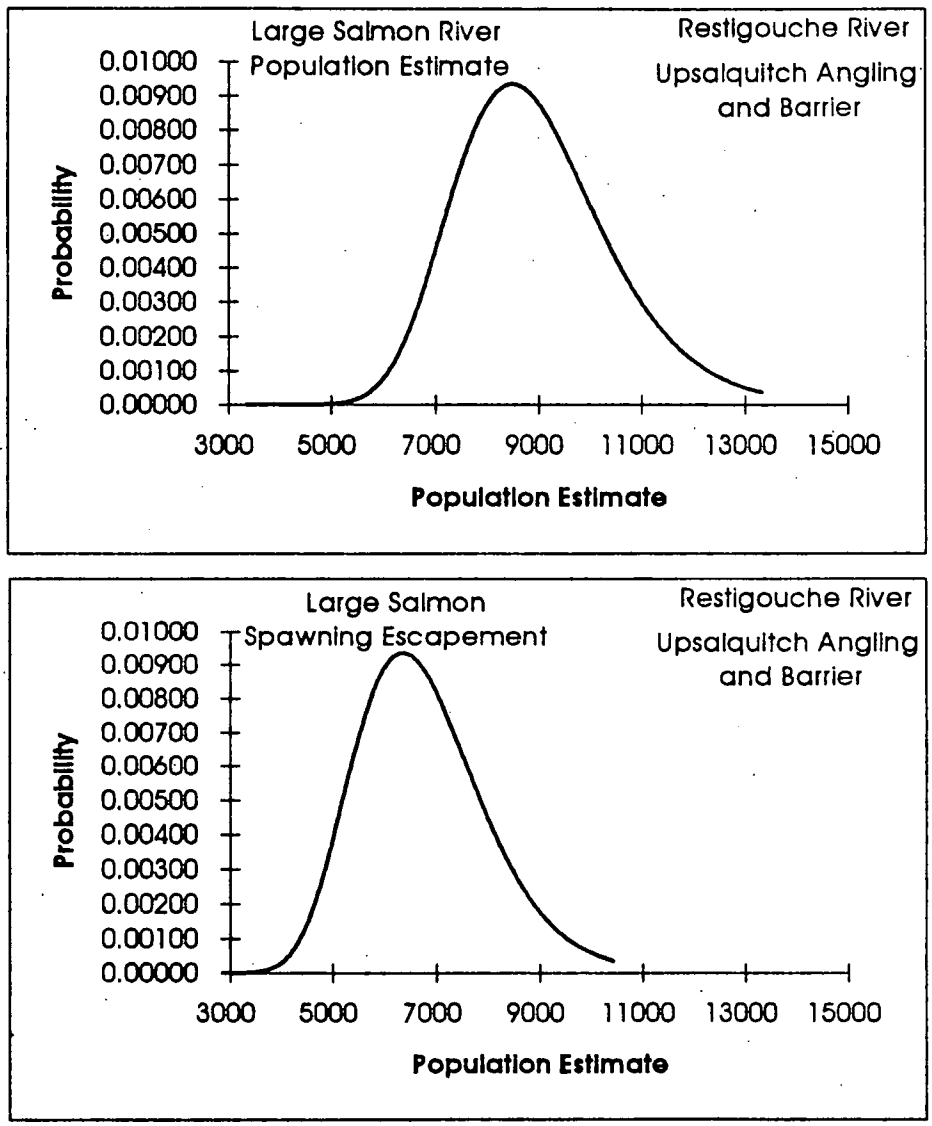
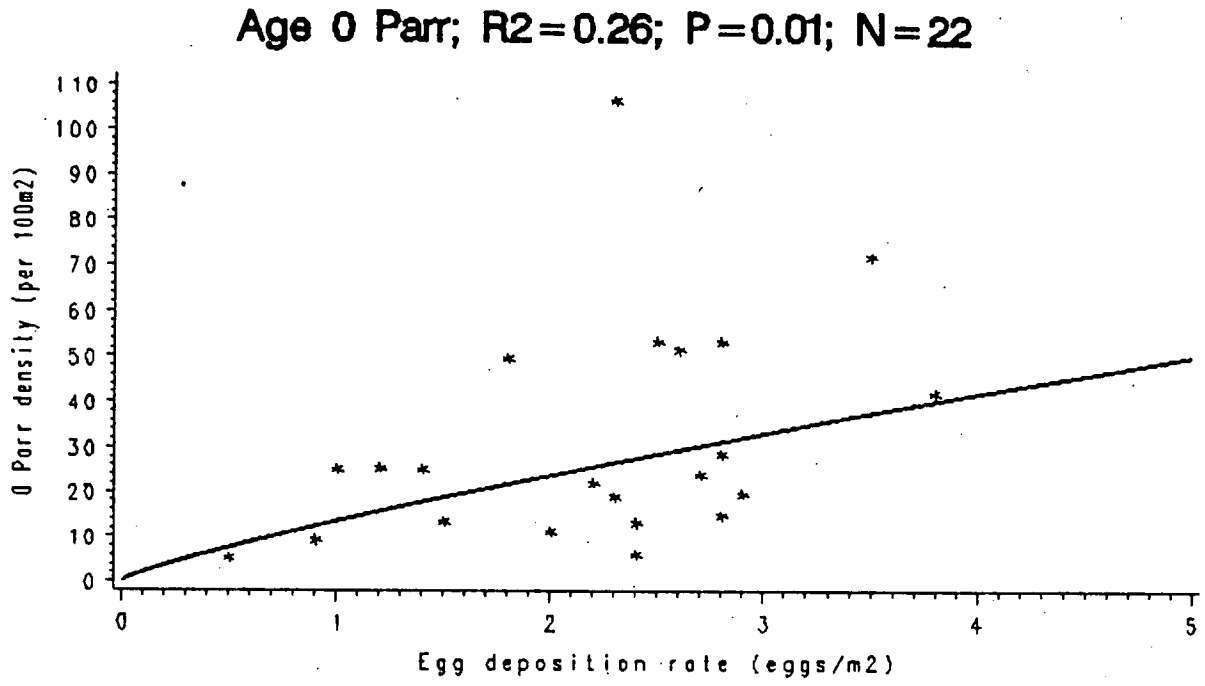


Fig. 10. Large salmon river population and spawning escapement estimates based on Upsalquitch angling and Barrier tag returns.



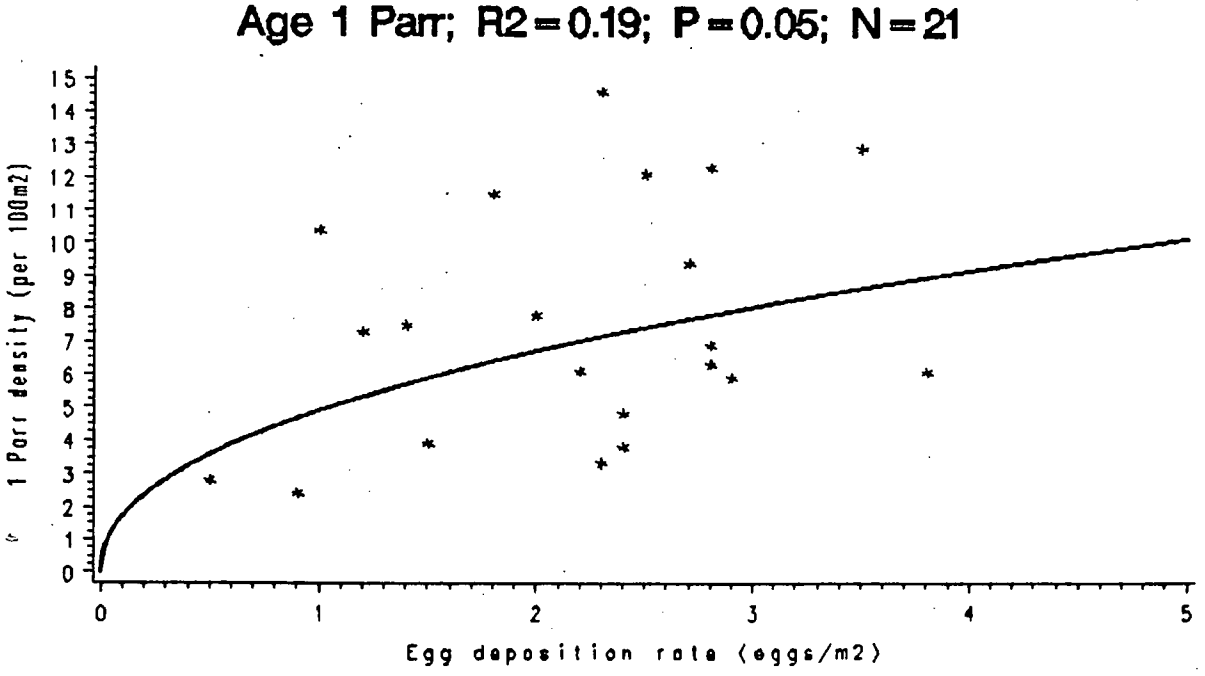
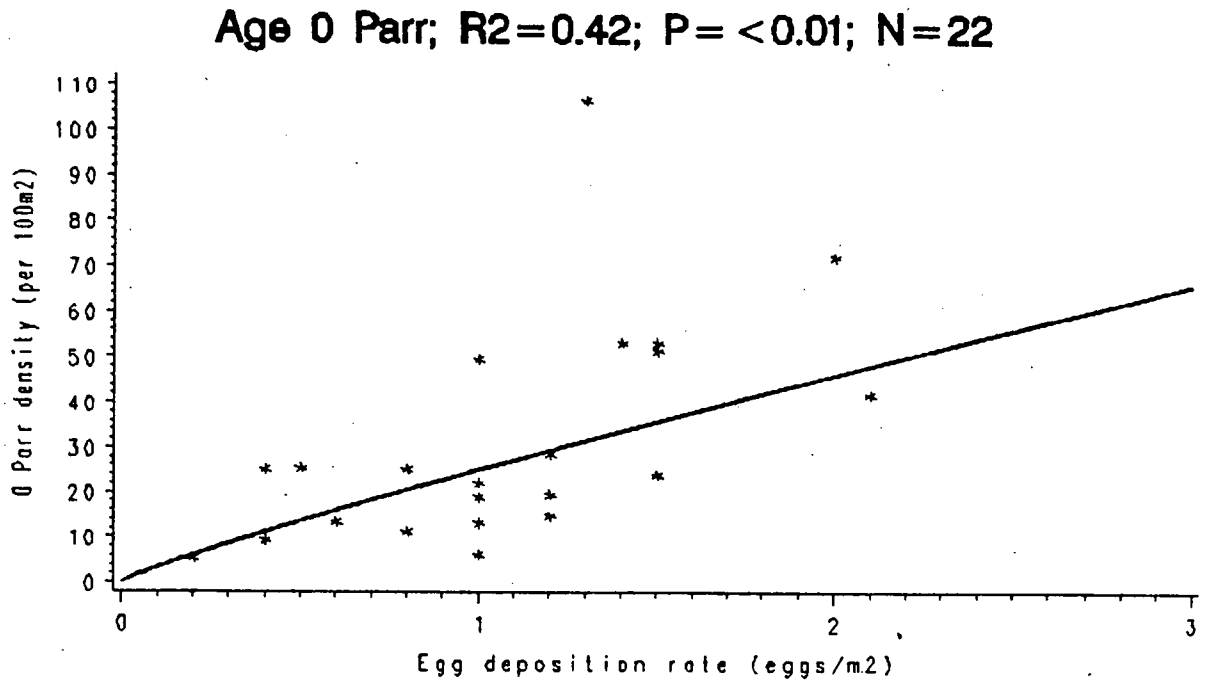


Figure 11. Relationship between egg deposition rate and resulting densities of 0+ and 1+ parr in the Restigouche River, 1972-1993. Egg deposition rates were estimated from angling catch and assumed exploitation rate of 0.3.



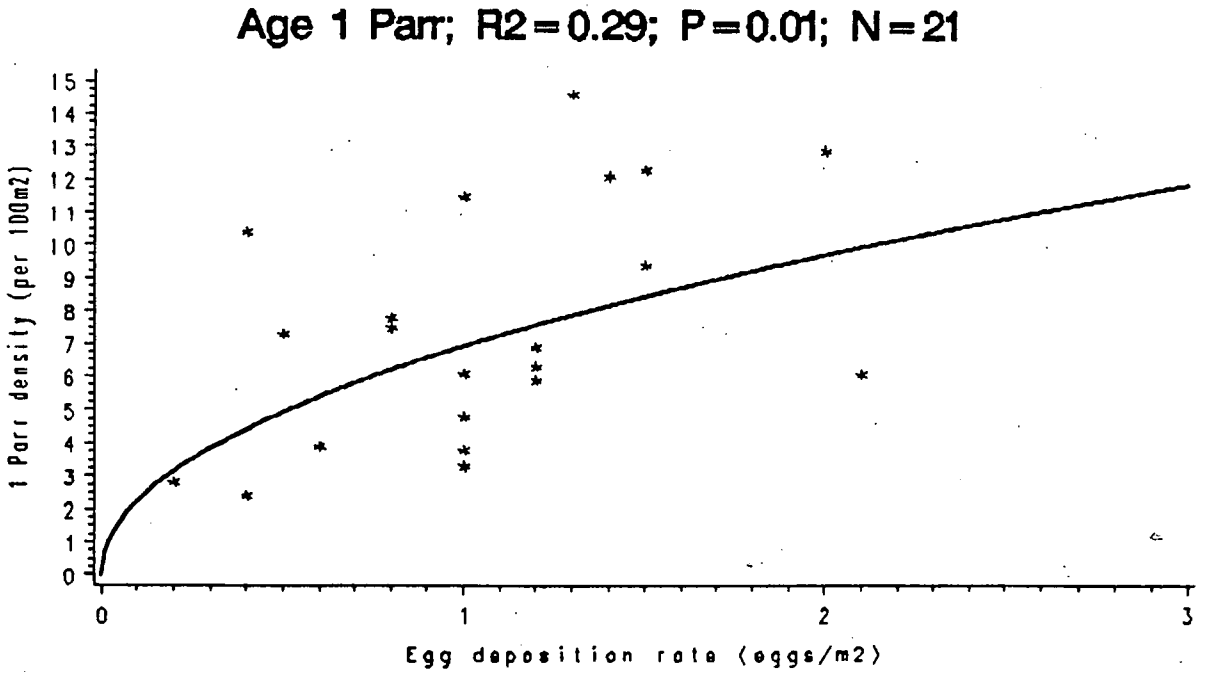


Figure 12. Relationship between egg deposition rate and resulting densities of 0+ and 1+ parr in the Restigouche River, 1972-1993. Egg deposition rates were estimated from angling catch and assumed exploitation rate of 0.5.

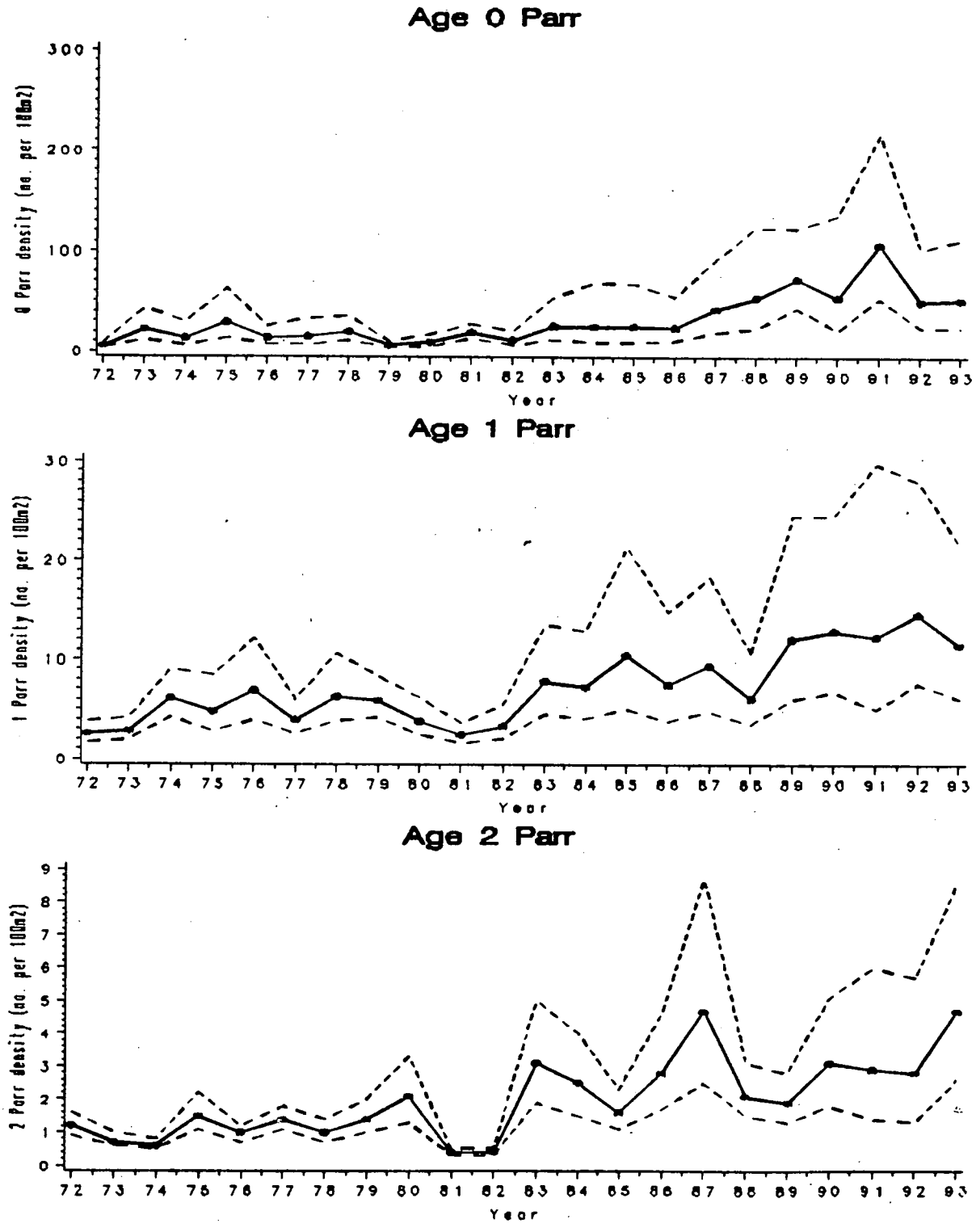


Figure 13. Mean densities of 0+, 1+ and 2+ parr in the Restigouche River, 1972-1993 (15 sites, 1972-1990 & 1993; 8 sites, 1991; 10 sites, 1992). Dashed lines are 95% confidence limits.

The SAS System

General Linear Models Procedure

Dependent Variable: DENSITY

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	24	216.17870372	9.00744599	13.10	0.0001
Error	257	176.70347106	0.68756214		
Corrected Total	281	392.88217478			

R-Square	C.V.	Root MSE	DENSITY Mean
0.550238	28.24964	0.82919367	2.93523641

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YEAR	21	158.33333675	7.53968270	10.97	0.0001
SSO	3	57.84536697	19.28178899	28.04	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YEAR	21	151.75420007	7.22639048	10.51	0.0001
SSO	3	57.84536697	19.28178899	28.04	0.0001

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		2.838285961 B	11.75	0.0001	0.24155682
YEAR	1972	-2.137343470 B	-6.82	0.0001	0.31340575
	1973	-0.774959617 B	-2.47	0.0141	0.31340575
	1974	-1.492355979 B	-4.67	0.0001	0.31940696
	1975	-0.332404306 B	-1.04	0.2990	0.31940696
	1976	-1.252352586 B	-4.00	0.0001	0.31340575
	1977	-1.088213670 B	-3.33	0.0010	0.32634568
	1978	-1.050073844 B	-3.41	0.0008	0.30820467
	1979	-1.691895145 B	-5.29	0.0001	0.31968454
	1980	-1.478978560 B	-4.63	0.0001	0.31940696
	1981	-0.783485344 B	-2.54	0.0116	0.30820467
	1982	-1.472236376 B	-4.70	0.0001	0.31340575
	1983	-0.603430536 B	-1.89	0.0600	0.31940696
	1984	-0.414412344 B	-1.20	0.2299	0.34434341
	1985	-0.231564149 B	-0.67	0.5011	0.34374052
	1986	-0.564820966 B	-1.73	0.0849	0.32659614
	1987	-0.155434373 B	-0.50	0.6204	0.31340575
	1988	0.281628297 B	0.88	0.3788	0.31946149
	1989	0.437786883 B	1.42	0.1567	0.30820467
	1990	0.057597409 B	0.18	0.8571	0.31946149
	1991	0.777180206 B	2.11	0.0357	0.36804996
	1992	0.002368164 B	0.01	0.9945	0.34367044
	1993	0.000000000 B	.	.	.
SSO	5	0.817261025 B	6.10	0.0001	0.13391756
	6	1.369493907 B	9.11	0.0001	0.15034237
	7	0.840608522 B	5.07	0.0001	0.16573452
	10	0.000000000 B	.	.	.

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

Figure 14. SAS output of multiplicative model comparing 0+ parr density in 1993 with previous years in the Restigouche River. SSO = stream order. Parr densities were measured by electrofishing at 15 standard sites in 1972-1990 & 1993, at 8 of those sites in 1991 and 10 in 1992.

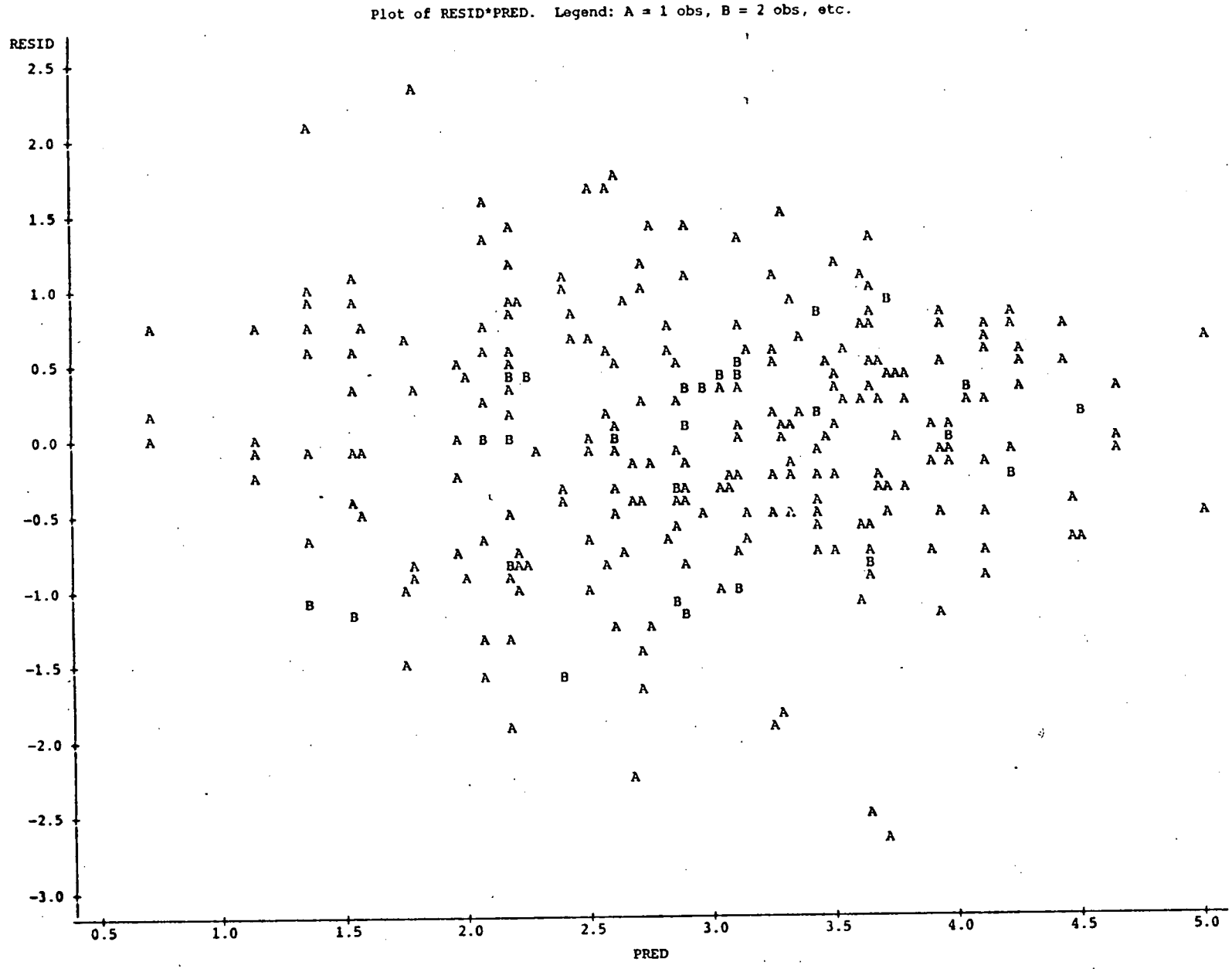


Figure 15. Scatterplot of residual vs. predicted values from multiplicative analysis shown in Figure 14.

The SAS System

General Linear Models Procedure

Dependent Variable: DENSITY

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	24	59.17764609	2.46573525	4.04	0.0001
Error	251	153.05756801	0.60979111		
Corrected Total	275	212.23521409			

R-Square	C.V.	Root MSE	DENSITY Mean
0.278830	42.58809	0.78089123	1.83359058

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YEAR	21	40.16869889	1.91279519	3.14	0.0001
SSO	3	19.00894719	6.33631573	10.39	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YEAR	21	39.20203843	1.86676373	3.06	0.0001
SSO	3	19.00894719	6.33631573	10.39	0.0001

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		1.847183597 B	8.28	0.0001	0.22315360
YEAR	1972	-0.966253307 B	-3.14	0.0019	0.30738126
	1973	-0.677967948 B	-2.21	0.0283	0.30725884
	1974	-0.359294588 B	-1.24	0.2169	0.29021884
	1975	-0.470157370 B	-1.53	0.1275	0.30748300
	1976	-0.226278410 B	-0.75	0.4527	0.30083292
	1977	-0.693101863 B	-2.35	0.0197	0.29528169
	1978	-0.467919529 B	-1.61	0.1082	0.29021884
	1979	-0.294652792 B	-1.02	0.3110	0.29021884
	1980	-0.655161987 B	-2.18	0.0303	0.30081077
	1981	-0.913561958 B	-2.97	0.0033	0.30805299
	1982	-0.647991044 B	-2.06	0.0405	0.31468267
	1983	-0.191138708 B	-0.65	0.5178	0.29514914
	1984	-0.092860031 B	-0.31	0.7578	0.30083292
	1985	0.226588626 B	0.74	0.4615	0.30725884
	1986	0.011268283 B	0.04	0.9715	0.31487599
	1987	-0.077639976 B	-0.26	0.7966	0.30083292
	1988	-0.157234499 B	-0.51	0.6095	0.30748300
	1989	0.380627878 B	1.24	0.2166	0.30725884
	1990	0.104597994 B	0.35	0.7233	0.29514914
	1991	0.339924999 B	0.94	0.3490	0.36224825
	1992	0.329918618 B	1.02	0.3087	0.32342653
	1993	0.000000000 B	.	.	.
SSO	5	0.207338010 B	1.67	0.0954	0.12385277
	6	0.197229460 B	1.43	0.1536	0.13778971
	7	0.826213878 B	5.42	0.0001	0.15232140
	10	0.000000000 B	.	.	.

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

Figure 16. SAS output of multiplicative model comparing 1+ parr density in 1993 with previous years in the Restigouche River. SSO = stream order. Parr densities were measured by electrofishing at 15 standard sites in 1972-1990 & 1993, at 8 of those sites in 1991 and 10 in 1992.

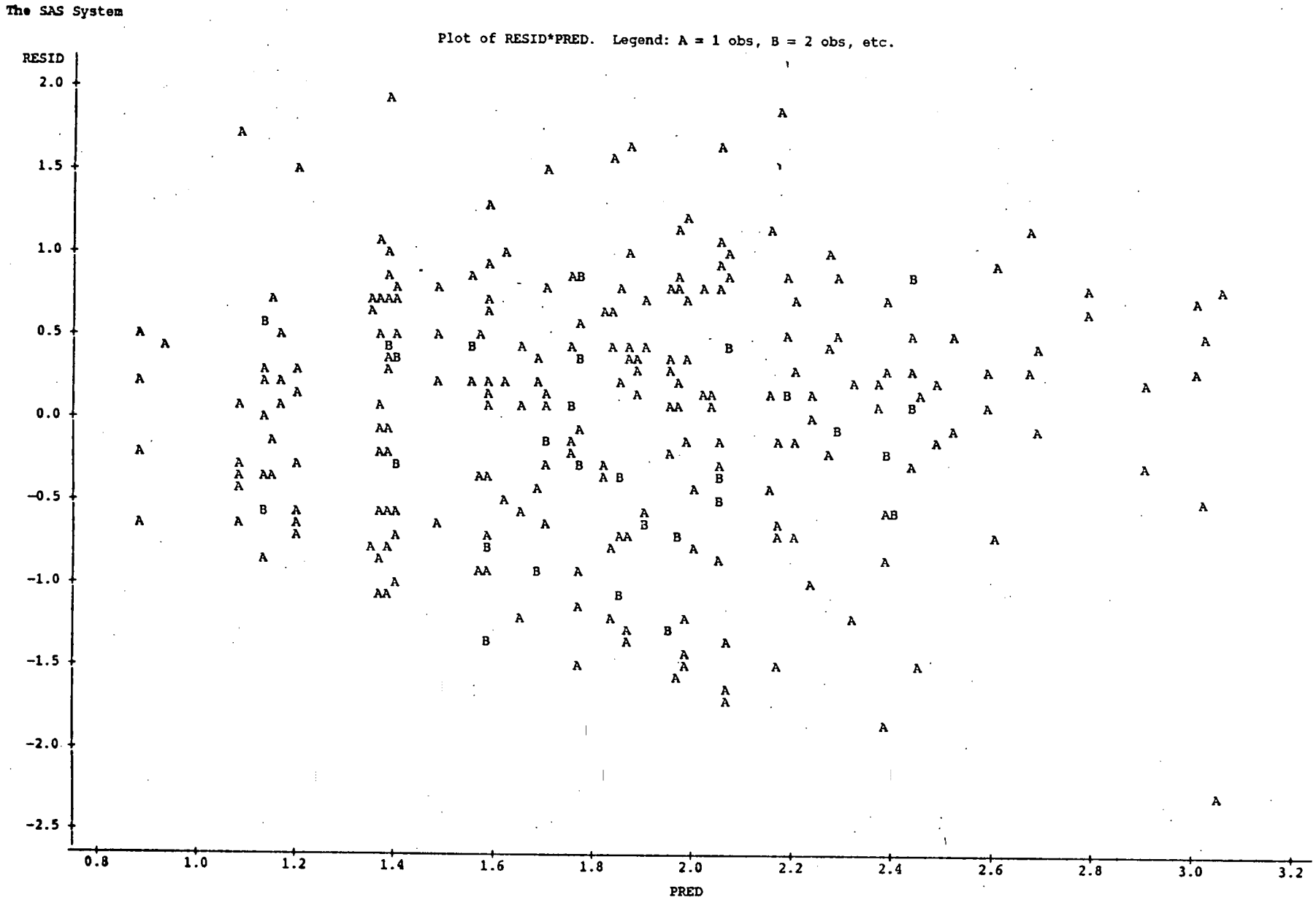


Figure 17. Scatterplot of residual vs. predicted values from multiplicative analysis shown in Figure 16.

The SAS System

General Linear Models Procedure

Dependent Variable: DENSITY

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	24	28.74718969	1.19779957	3.19	0.0001
Error	189	71.00969872	0.37571269		
Corrected Total	213	99.75688842			

R-Square	C.V.	Root MSE	DENSITY Mean
0.288172	56.77748	0.61295407	1.07957260

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YEAR	21	23.06126719	1.09815558	2.92	0.0001
SSO	3	5.68592251	1.89530750	5.04	0.0022

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YEAR	21	21.65354317	1.03112110	2.74	0.0001
SSO	3	5.68592251	1.89530750	5.04	0.0022

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		1.496518471 B	7.72	0.0001	0.19387628
YEAR	1972	-0.641395864 B	-2.50	0.0133	0.25667038
	1973	-0.654424156 B	-2.37	0.0188	0.27602320
	1974	-0.740618653 B	-2.68	0.0080	0.27613087
	1975	-0.440645065 B	-1.68	0.0937	0.26153390
	1976	-0.553910284 B	-2.11	0.0361	0.26245210
	1977	-0.459812231 B	-1.83	0.0695	0.25185050
	1978	-0.442804900 B	-1.55	0.1222	0.28522520
	1979	-0.557222678 B	-2.21	0.0282	0.25189307
	1980	-0.261522483 B	-0.95	0.3442	0.27580990
	1981	-0.879098407 B	-2.96	0.0034	0.29671852
	1982	-0.826223735 B	-2.49	0.0135	0.33146887
	1983	0.120823216 B	0.45	0.6525	0.26788298
	1984	-0.036918201 B	-0.14	0.8905	0.26788298
	1985	-0.389776565 B	-1.49	0.1380	0.26166479
	1986	0.004682891 B	0.02	0.9861	0.26788298
	1987	0.428764157 B	1.60	0.1117	0.26830046
	1988	-0.238909060 B	-0.93	0.3522	0.25619009
	1989	-0.252980826 B	-0.97	0.3348	0.26164660
	1990	-0.086987748 B	-0.33	0.7398	0.26153390
	1991	-0.083369330 B	-0.27	0.7905	0.31336572
	1992	0.096767638 B	0.29	0.7717	0.33302730
	1993	0.000000000 B	.	.	.
SSO	5	-0.153436179 B	-1.48	0.1400	0.10352944
	6	-0.454026972 B	-3.29	0.0012	0.13785827
	7	0.089229410 B	0.70	0.4821	0.12669163
	10	0.000000000 B	.	.	.

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

Figure 18. SAS output of multiplicative model comparing 2+ parr density in 1993 with previous years in the Restigouche River. SSO = stream order. Parr densities were measured by electrofishing at 15 standard sites in 1972-1990 & 1993, at 8 of those sites in 1991 and 10 in 1992.

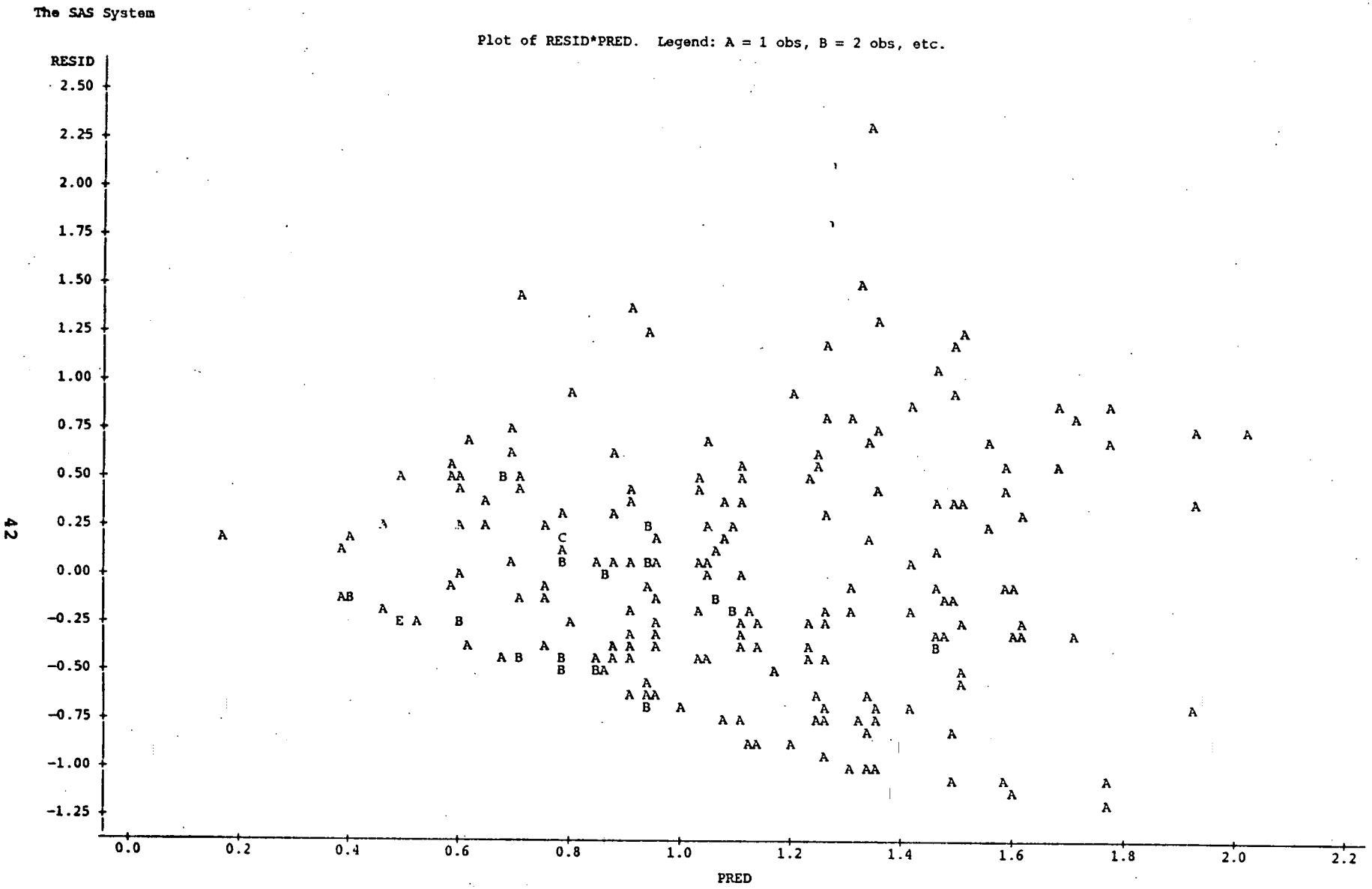


Figure 19. Scatterplot of residual vs. predicted values from multiplicative analysis shown in Figure 18.

Appendix 1. SAS program of randomization procedure for comparing estimate of returns, spawners and egg deposition in 1993 to 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. SAS program of multiplicative model for comparing juvenile density in 1993 to densities in previous years.

```
* cafsac.sas - restigouche electrofishing data, parr 1972 to 1993;

options linesize=160 pagesize=85 nocentre;
libname a 'dua0:[chaput.russell]';

data all;
  set a.dens4;
  if dens=0 then delete;

  if site=4 or site=5 or site=28 or site=30 or site=40 or site=45 or
site=52 or site=55 or site=29 or site=38 or site=39 or site=41 or site=42
or site=49 or site=54;

  if age ne 0 then delete;
  year=year+1900;
  dens=log(dens+1);

if trib="KR" then trib="ZKR";
if so=4 then so=10;

proc glm;
  class year trib so;
  model dens=year so trib/solution;
  output out=res p=pred r=resid;
proc plot data=res;
  plot resid*pred;
  plot dens*year;
```

Appendix 3. Angling salmon catches from Restigouche River system, 1970 to 1993. Data sources given in Appendix 6.

	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
1982a	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
1984b	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
Mean (88-92)	616	990	924	461	98	60	403	446	216	86	2109	2258
1993 c.f. Mean	+19%	-49%	-30%	-52%	-18%	-73%	-43%	-77%	-61%	-51%	-29%	-48%

a Prior to 1982 Little Main catches included in Main Restigouche.
b Catches of large salmon (1984 to 1993) include released fish in New Brunswick.

Appendix 4. Native salmon landings from Baie des Chaleurs and Restigouche River, 1975 to 1993. Data sources given in Appendix 6.

Year	New Brunswick			Quebec			Total
	Small	Large	Total	Small	Large	Total	
1975	3	132	135				135
1976	13	124	137	0	1517	1517	1654
1977	19	212	231	0	2738	2738	2969
1978	23	129	152				152
1979	84	148	232	85	748	833	1065
1980	34	264	298	24	1563	1587	1885
1981	20	211	231				231
1982	12	155	167	148	1521	1669	1836
1983	0	260	260	32	1216	1248	1508
1984	1	213	214	177	1070	1247	1461
1985	0	241	241	35	976	1011	1252
1986	26	431	457	4	1145	1149	1606
1987a	95	916	1011	5	986	991	2002
1988	70	509	579	3	921	924	1503
1989	151	568	719	12	1081	1093	1812
1990	120	471	591	16	1135	1151	1742
1991	10	252	262	9	859	868	1130
1992	2	464	466	53	948	1001	1467
1993	0	293	293	0	901	901	1194
Mean (88-92)	71	453	523	19	989	1007	1531
1993 c.f. Mean	-100%	-35%	-44%	-100%	-9%	-11%	-22%

a Quebec native landings from (Randall et al. 1988).

Appendix 5. Operating dates of Native fisheries in Baie des Chaleurs and Restigouche River, 1979 to 1993. Data sources given in Appendix 6.

Year	New Brunswick		Quebec
	Gillnet	Trap net	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
1986a	May 19 - August 10	May 26 - July 20	June 2 - June 26
1987b	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

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

Appendix 6. Sources of data on salmon landings in the Restigouche River and Baie des Chaleurs.

1. Commercial fishery data

New Brunswick: Districts 63, 64 and 65
Québec: Districts 12, 13, 14 and 15

New Brunswick, 1970 to 1984: from Redbooks (compiled by Department of Fisheries and Oceans, Science Branch, Halifax).

Québec, 1970 to 1981: from Bureau de la Statistique du Québec (G. Ouellet and J.P. Lebel, pers. comm.), and assume average weight and large/small salmon ratio same as calculated from Redbooks.

Québec, 1982 to 1983: from Ministère du Loisir, de la Chasse et de la Pêche, Québec (G. Ouellet and G. Landry, pers. comm.).

2. Angling data

New Brunswick, 1970 to 1979: from O'Neil and Swetnam (1984); 1980 to 1983 from Swetnam and O'Neil (1984); 1984 from O'Neil et al. (1985); 1985 from O'Neil et al. (1986); 1986 from O'Neil et al. (1987); 1987 from O'Neil et al. (1989); 1988 from O'Neil et al. (1991); and 1989 to 1992 from O'Neil (pers. comm.).

Québec, 1970 to 1992: from Ministère du Loisir, de la Chasse et de la Pêche, Québec (G. Ouellet, J.P. Lebel and G. Landry, pers. comm.).

3. Native food fishery data

New Brunswick, 1975 to 1982: from Department of Fisheries and Oceans, Protection and Regulations Branch files (R. Roy and M. Sullivan, pers. comm.); 1983 to 1986 from Department of Fisheries and Oceans, Resource Allocation and Development Branch (K. Atwin, F. Ring and R. Hébert, pers. comm.); and 1987 to 1992 from Department of Fisheries and Oceans, Protection and Regulations Branch, (R. Roy, R. MacNair and R. Senechal, pers. comm.).

Québec, 1976 to 1984: from Gaudreault (1984); 1985 to 1992 from Ministère du Loisir, de la Chasse et de la Pêche, Québec (G. Landry, pers. comm.).

4. All 1993 data are preliminary as described in text.

Appendix 7. Field spawner counts from Restigouche River system, 1985 to 1993.

	Matapedia		Upsalquitch		Patapedia		Kedgwick		Little Main		Main Restigouche	
Year	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
1986	336	1114	2632	2451	311	728	281	976	1241	2541	413	1708
1987	622	946	1948	2179	80	953	582	1729	610	1418	357	949
1988	791	1243	1761	2140	317	1117	602	1546	536	2128	238	962
1989	764	1834	1387	2223	178	1012	289	1640	923	2442	803	2837
1990a	1080	1289			214	783						
1991	640	1152	2247	1575	162	586	423	1204	332	862	453	1713
1992	711	1023	1986	1434	141	502	161	515	200	665	73	565
1993	628	1010	1183	570	98	442	127	370	175	500	141	620
Mean (88-92)	797	1308	1845	1843	202	800	369	1226	498	1524	392	1519
1993 c.f. Mean	-21%	-23%	-36%	-69%	-51%	-45%	-66%	-70%	-65%	-67%	-64%	-59%

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

Appendix 8. Minutes of the workshop held to obtain industry input into the Restigouche salmon assessment.

MINUTES OF THE RESTIGOUCHE STOCK WORKSHOP

Campbellton, N.B. (NB DNRE Office)
0930-1600 Hours, Tuesday, 18 January 1994

Chairperson:

Michael Chadwick	DFO, Science, Moncton

Recording Secretary:

John Peppar	DFO, Science, Moncton

Attendees:

Beaver Paul	Restigouche First Nation
Ken Ross	Eel River Watershed Protection Assoc.
Alan Madden	NB DNRE, Campbellton
Allan McNeish	NB DNRE, Campbellton
Gilles Landry	MLCP, N-Richmond, Quebec
Robert Roy	DFO, C&P, Dalhousie
Paul Cameron	DFO, Science, Charlo SEC
Ann Turcotte	DFO, Science, Charlo SEC
Ross Claytor	DFO, Science, Moncton
Kevin Davidson	DFO, Science, Moncton
Tim Lutzac	DFO, Science, Moncton

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

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

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

1. **Roles of government and the public:** the public wants to participate, money is scarce, agencies must remove redundancy, horizontal links in resource management, combine enhancement and assessment, DFO focus on analysis and structure.
2. **Scientific basis for resource management:** what are the problems?, assemble knowledge, make a model, where is model sensitive?, ask an answerable question, develop test, document repeatable methods, improve model, ask another important question.

3. **Watershed Management:** fine-scale information, in-season management, all stocks, knowledge accessible to everyone, indentify problems in order of priority, best projexts distinguish between alternative views of the resource, share tasks.
4. **Stock assessment process:** stock workshops, stock assessments, peer review, research document, summary sheets, zonal meetings, national roll-ups.

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

2. Salmon Stock Status - Salmon Assessments.

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

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

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

Restigouche Salmon

Ross Claytor presented information on the status of the Restigouche River salmon stock.

Points of Discussion

Landings

- Total Restigouche angling catch down 50-60% from previous years; Upsalquitch barrier count and Crown Reserve catches down approx. same amount (60% from previous years); A. Madden to provide crown reserve catches.
- The sports catch needs to be summarized by major tributary.
- The angling season for MSW salmon closed early in Quebec in 1993 (August 9) because of poor abundance; numbers of 1SW up since closure of Nfld. fishery; may affect how we look at 1SW/MSW salmon ratios in historical catch data.
- First Nation catches were not recorded for Listiguj in 1993. Total catches were said to be 7-10% below 1992; individual catches need to be recorded daily in 1994.
- Catches by Eel River Bar First Nation were recorded weekly, reporting rates were estimated to be 75%; total catch said to be down from 1992; data needed.
- DFO and DNRE to provide summaries of violations (numbers of apprehensions, nets

seized, fish seized, etc.) for the past years, and to look at ways of measuring extent of illegal activities.

- Poaching and disease is estimated to be 16%. On Upsalquitch, 18 of 22 fish in the catch-and-release study were positive for furunculosis.

Target

- DNRE and DFO estimates of rearing area to be compared; the present accepted value for the Restigouche River system rearing area is 30 million square metres.
- Data derived from SEC broodstock collections on the Kedgwick River (Forks Pool) re: 1SW/MSW salmon ratios to be examined.
- There appears to be more salmon in the upper part of the system, which needs to be checked.

Returns

- There was uncertainty about the catch of large salmon in the fish trap; the salmon could have been delayed by the heavy fishing activity at Cross Point. In the future, net-marked fish will be documented in the fish traps and counting fences.
- Analysis to focus on the 1SW salmon catch at the trap; must examine MSW salmon catch and the factors affecting the catch more completely before using these data.
- Tag reporting rate from angling needs to be verified using a phone survey of crown reserve anglers. Quebec uses a reporting rate of 60%; correction factors needed, to adjust for season availability (fish tagged late in the season are not vulnerable to the sport fishery), loss, etc. Use of Crown Reserves and phone surveys, and counting fences (Upsalquitch and Causcapscal) to verify reporting rate of tags, estimate returns to system in 1994.
- Spawning count surveys should be evaluated, but they were considered useful for estimating total numbers of fish. DNRE has run the rivers by canoe since 1982; 80-85% of the Restigouche River system is covered, including all the main spawning areas (extreme headwater areas only, not included)(15+% extrapolated); grilse and large salmon counted, where distributed, etc.; accuracy tested; redds counted, if fish cannot be counted; fish counts, followed by redd counts (number/fish) to determine how many fish redds represent; repeatability of method has not been tested.
- There was discussion centering on evidence (from other such surveys, example - in Upsalquitch, 1985) that ratios of fish (1SW vs MSW salmon) can be over- or under-estimated (pool vs stream) by this technique; total number of fish observed may be right, but proportion of 1SW vs MSW inaccurate; it was suggested that an alternative would be to use ratios of 1SW and MSW salmon from other indicators (such as counting fences), then apply to total counts derived from the spawning count surveys.
- Electrofishing methods being used in N.B. and Quebec were compared; in N.B., electrofishing is being used to show general trends only; in Quebec, the approach is to operate river by river, with the appropriate number of sites/each, with the technique improved by the number of sites used. Electrofishing in the Upsalquitch could be used

to evaluate spawning above and below the fence.
- Marked fish should be identified in the electrofishing surveys.
- Tag loss rate needs to be calculated using broodstock held at the SEC.
- Stocking needs to be summarized.

Restigouche Trout

Landings

- Group felt that a project proposal to examine sea-trout should be proposed to the Eel River Watershed Committee ($50K, trap, tagging, etc.). Creel survey needs to be developed; it could be focused on the estuary and the Patapedia.
- An angler licence stub system, with an angler creel survey (to help interpret the stubs), should be introduced; 'locals' fish trout, the camps do not; fishing is concentrated in the headwater areas, primarily because they are 'open' and the lower mainstream areas are not.
- There is a need for a support group to take this up as a project in the Restigouche.
- Counts of fish at Christopher Brook need to be summarized.
- All stocking needs to be summarized.

Eel River

- Some limited trout migration censuses have been conducted in the watershed.
- The fishway is in poor shape, and is well-below '94 standards for such structures.
- The watershed has good "ecosystem" potential -- trails, sea-trout fishing, etc.
- The Eel River Watershed Protection Association has submitted a report to DNRE and DFO detailing results of their 1993 investigations ("Trout and Salmon Counting Station and Head Pond Survey" by Ken Ross)(attached).
- Three areas of concern require immediate investigation: angling (landings, biological characteristics, etc.), water quality, and status of the fishway; these concerns require evaluation, before any progress can be made into specifics, etc. -- A creel survey could be organized, to evaluate stocks; a meeting (involving the municipality, NB Power, First Nations, DNRE, DFO, and others)) will be arranged to discuss the status of the fishway, problems associated with its operation, how to correct, etc.

Jacquet River

- Thought to be a productive river, but with history of heavy poaching.
- Public support is needed; a support group for the system is needed; this should be recommended to the Watershed Committee.