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STATUS OF ATLANTIC SALMON IN THE RESTIGOUCHE RIVER IN 1992

by

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ABSTRACT

During 1992, 1,004 large and 4,751 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 1992 were 4% and 8% above previous 5-year averages, respectively. Catches per unit effort for small and large fish, respectively, were 8% and 6% above the previous 5-year averages for New Brunswick, and 38% and 17% above the previous 5-year averages for Québec. Native harvest of large salmon was 8% below the previous 5-year average and harvest of small salmon was 44% 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 1992 were estimated to be between 11,781 and 18,694 large salmon (3% above previous 5-year means) and between 11,113 and 18,485 small salmon (8% above previous 5-year means). Spawning escapement was estimated as the difference between total returns and losses to angling and native fisheries, poaching, disease, and hatchery broodstock. 1992 escapement was between 7,383 and 13,190 large salmon (3% above previous 5-year means) and between 4,755 and 11,095 small salmon (8% above previous 5-year means). These spawners would result in a total egg deposition of 44 to 79 million eggs (62% to 111% of requirements). 1992 returns, spawners, and egg deposition were similar to previous 5-year means. Probability that large spawners and egg deposition were below target was approximately 90%, but the target for small spawners was met (100% probability). Electrofishing surveys indicated that densities of 0+ and 2+ juvenile salmon were, respectively, 24% and 3% below previous 5-year averages. Density of 1+ juvenile salmon exceeded the previous 5-year average by 38%. A multiplicative model was used to compare 0+, 1+ and 2+ densities in 1992 with previous years. 0+ fry were significantly less abundant in 1992 than in 1991, but not different from 1983-1990. Abundance of 1+ parr in 1992 was not different from abundance in 1989-1991, but was significantly higher than most preceding years. Abundance of 2+ parr did not significantly differ from 1983-1991, but 1992 abundance was significantly higher than most years before 1983.

Assuming average (1988 to 1992) returns of large and small salmon in 1993, total returns will be between 11,550 and 18,289 large and 10,172 and 16,894 small salmon.

RÉSUMÉ

En 1992, les pêcheurs sportifs ont débarqué 1 004 gros saumons et 4 751 petits saumons pêchés dans la rivière Restigouche (les gros saumons provenaient uniquement des tributaires de la rivière Restigouche situés au Québec). Les prises de gros et de petits saumons par les pêcheurs sportifs (y compris les gros spécimens capturés et remis à l'eau au Nouveau-Brunswick) étaient supérieures de 4 % et 8 % respectivement aux moyennes des cinq années antérieures. Les prises de petits et de gros saumons par unité d'effort étaient pour leur part supérieures de 8 % et 6 % respectivement aux moyennes des cinq années antérieures au Nouveau-Brunswick et supérieures de 38 % et 17 % aux moyennes des cinq années antérieures au Québec. La récolte de gros saumons par les autochtones était inférieure de 8 % à la moyenne des cinq années antérieures, et leur récolte de petits saumons inférieure de 44 % à la moyenne. Selon les statistiques de pêche sportive et un taux d'exploitation présumé de l'ordre de 0,3 à 0,5, on estime que les montaisons de saumon de l'Atlantique dans la Restigouche en 1992 se situaient entre 11 781 et 18 694 pour les gros saumons (3 % de plus que la moyenne des cinq années antérieures) et entre 11 113 et 18 485 pour les petits (8 % de plus que la moyenne des cinq années antérieures). On a estimé que les échappées de reproducteurs représentaient la différence entre les montaisons totales et les pertes dues à la pêche sportive, à la pêche des autochtones, au braconnage, aux maladies et au prélèvement de géniteurs pour les écloseries. En 1992, elles se situaient entre 7 383 et 13 190 gros saumons (3 % de plus que la moyenne des cinq années antérieures) et entre 4 755 et 11 095 petits saumons (8 % de plus que la moyenne des cinq années antérieures). Ces reproducteurs donneraient une ponte totale de 44 à 79 millions d'oeufs (de 62 % à 111 % des besoins). Les montaisons, les échappées de reproducteurs et la ponte de 1992 sont comparables aux moyennes des cinq années antérieures. La probabilité que les échappées de gros reproducteurs et la ponte soient inférieures à la cible était d'environ 90 %, mais la cible à été atteinte pour les échappées de petits reproducteurs (probabilité de 100 %). Les études d'électropêche ont révélé que les densités de juvéniles 1+ étaient supérieures de 38 % 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 1992 à celles des années antérieures. Les alevins de 0+ étaient considérablement moins nombreux qu'en 1991, mais leur quantité restait comparable à la moyenne de 1983-1990. L'abondance des tacons de 1+ ne différait pas de la moyenne de 1989-1991, mais était bien supérieure à celle de la plupart des années antérieures. Quant à l'abondance des tacons de 2+, elle ne différait pas sensiblement en 1992 de la moyenne de 1983-1991, mais était nettement supérieure à celle de la plupart des années antérieures à 1983.

En supposant qu'en 1993 les montaisons de gros et de petits saumons correspondent à la moyenne (1988-1992), elles se situeront entre 11 550 et 18 289 gros saumons et entre 10 172 et 16 894 petits saumons.

INTRODUCTION

During 1992, two user groups exploited Atlantic salmon in the Restigouche River: anglers and native fishermen. Regulations controlling the harvest of salmon in 1992 were similar to regulations in 1991. Anglers in New Brunswick tributaries were obliged to release all large salmon ($\geq$ 63 cm) back into the river; catches of small salmon were restricted by season, possession and daily bag limits to eight, six 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; as in 1991, 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. Native fishermen at Restigouche, Québec, were allocated a quota of 6818 kg. Native fishermen at Eel River Bar, New Brunswick, had no quota.

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, fishermen were prohibited from landing salmon caught in non-salmon fishing gear (by-catch).

The objective of this report is to provide an evaluation of the status of Atlantic salmon in the Restigouche River for 1992. Angling and native 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 10 standard electrofishing sites are presented. Projections of adult salmon returns in 1993 are given.

In the terminology of this report, small salmon are adults less than 63 cm in fork length, which are comprised of 1SW (one-sea-winter) virgin salmon only. Large salmon are adults greater than or equal to 63 cm in fork length. This category contains components of previous spawners and virgin 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 native 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 (72% of 1992 catch) occurs at private or government camps which keep individual records of angling catches. Angling catches in Crown Open waters (2% of 1992 catch) are rough estimates based on personal observations and interviews by the DFO fishery officers. Crown reserve data (26% of 1992 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.

Native 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) are reported on a weekly basis by the Band Office to MLCP. Landings of salmon at Eel River Bar are reported on a weekly basis by individual gear types (gill nets, traps) to DFO fishery officers.

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 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:

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

B (between river harvest and poaching & disease); A (between poaching & disease and estuary harvest)

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. Spawning escapement and total returns.

(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 1992 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 shown in Appendix 1.

(2) Spawner counts from canoe surveys

A second 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 1982.

(3) 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 10 of the usual 15 sites during August and September 1992. Densities were calculated by the removal method (Zippin 1956). Ninety-five percent confidence intervals in mean densities among the 10 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 1992 were compared to densities measured from 1972-1991, using the following multiplicative model:

DENS = YEAR + TRIB + STRORD

Where: DENS: log (population density (no./m^2) at site)
YEAR: 1972-1992
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 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 1992, 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 1993 were predicted to be similar to average returns for the period 1988 to 1992.

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 1993. 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 1993 probably belong to the cohort of eggs laid in 1988 or 1989. Large salmon returning in 1993 probably belong to the cohort of eggs laid in 1986 through 1988.

(2) Adult survival: Returns of small fish in 1991 and 1992 were examined as an index of relative survival at sea of cohorts contributing to large salmon returns in 1993. Average returns of small salmon in 1991 and 1992 were compared to the previous 5-year averages, as a possible index of sea survival. The predicted return of large salmon in 1993 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 1988 to 1990 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 1993, age 1+ parr densities for 1990 and 1991 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 River), angling catch of large salmon in 1992 was 1004 fish, an increase of 6% from the previous 5-year average (Table 1, Appendix 3). Effort was down 14% from the previous 5-year average to 6948 rod-days (Table 2). Catch-per-unit-effort (CPUE) increased by 17% from the previous 5-year average to 0.14 fish/rod-day.

The number of large salmon estimated to have been caught and released in New Brunswick waters in 1992 was 3351 fish, a 3% increase from the previous 5-year average (Table 1). Effort decreased 2% from the previous 5-year average to 9966 rod-days (Table 2). CPUE increased 6% from the previous 5-year average to 0.34 fish/rod-day.

The total angling catch of large salmon in 1992 (Québec and New Brunswick) was 4355 fish, an increase of 4% from the 1987-1991 mean (Table 1).

Angling catch of small salmon in Québec tributaries was 752 fish, an increase of 24% from the previous 5-year mean (Table 1). CPUE increased by 38% from the previous 5-year mean to 0.11 fish/rod-day (Table 2). (Estimates of effort are those reported above for large salmon.)

Angling catch of small salmon in New Brunswick was 3999, an increase of 6% from the previous 5-year average (Table 1). CPUE increased 8% from the previous 5-year mean, to 0.40 fish/rod-day (Table 2).

The total angling catch of small salmon (Québec and New Brunswick) was 4751 fish, 8% above the previous 5-year mean (Table 1).

2. Within-river mortalities and removals.

Mortalities associated with the catch and release of 3351 large salmon in N.B. were estimated to be 201.

The numbers of large and small fish removed from the river to be used as broodstock at the Charlo hatchery were 122 and 4, respectively.

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

Large salmon	1992	1991
Angling harvest	1004	956
Broodstock	122	94
Catch/release mortality	201	131
TOTAL	1327	1181

Small salmon	1992	1991
Angling harvest	4751	2522
Broodstock	4	0
TOTAL	4755	2522

3. **Estuarine mortalities.**

Native landings from Baie des Chaleurs and Restigouche River for 1975 to 1992 are presented in Appendix 4. Operating dates of these fisheries, 1979 to 1992, are summarized in Appendix 5.

Native fishermen at Restigouche, Québec, caught an estimated 948 large salmon and 53 small salmon in 1992 (Table 3). These harvests are down 5% and up 489% from previous 5-year averages for large and small salmon respectively. The higher catch of small salmon in 1992 probably occurred because the fishery was active later in the season in 1992 than in the previous 5 years (Appendix 5), corresponding to the timing of the run of small salmon.

Nominal landings by native fishermen at Eel River Bar, New Brunswick, were 464 large and 2 small salmon, 98% and 15% below previous 5-year means (Table 3).

Total nominal landings of Atlantic salmon in the Restigouche River from all fisheries in 1992 indicate a 3% decrease from the previous 5-year mean for large salmon, and a 7% increase for small salmon (Table 3). Landings of large and small salmon combined have increased by 4% (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 2765 and 1659 for exploitation rates of 0.3 and 0.5 respectively. Comparable figures for small salmon were 2580 and 1548.

4. **Spawning escapement and total returns.**

(1) Spawning escapement and returns from angling catch

Returns and spawning escapement were calculated as:

	Exploitation 0.3	Exploitation 0.5	% Change from Previous 5 yr mean
Large salmon			
1. Total returns	18694	11781	+3
2. Harvest in estuary	1412	1412	-8
3. Harvest in river	1327	1327	+12
4. Poaching and disease	2765	1659	+4
5. Spawners	13190	7383	+3
6. Target spawners	12200	12,200	--
% of target (no.)	108	61	+3
Small salmon			
1. Total returns	18485	11113	+8
2. Harvest in estuary	55	55	-44
3. Harvest in river	4755	4755	+8
4. Poaching and disease	2580	1548	+8
5. Spawners	11095	4755	+8
6. Target spawners	2600	2600	--
% of target (no.)	427	183	+8
% of target (eggs)	111	62	+3

Spawning escapement was estimated to be 61% to 108% of target for large salmon, and 183% to 427% of target for small salmon. Egg deposition was estimated to be 62% to 111% of target.

Spawning escapements, assuming exploitation rates of 0.3 and 0.5, are summarized for the period 1970 to 1992 in Tables 5 to 8. Spawning escapement of large salmon was between 7383 and 13190 fish, 3% above previous 5-year averages. Spawning escapement for small salmon was between 4755 and 11095 fish, 8% above previous 5-year averages.

Estimated total egg depositions in 1992 were between 44.2 and 79.3 million eggs, 3% above the previous 5-year averages (Tables 9 and 10; Figure 2). In 1992, 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, spawners and eggs deposited were similar to average values for the previous 5 years, and, with the exception of returns and spawning escapement of small salmon, were below target levels. The following results indicate the probabilities associated with these differences.

		PROBABILITY THAT 1992 IS LESS THAN	
		5-YEAR MEAN	TARGET
TOTAL RETURNS	Large salmon	<55% (Fig. 3)	----
	Small salmon	<46% (Fig. 4)	----
SPAWNERS	Large salmon	<55% (Fig. 5)	<92% (Fig. 6)
	Small salmon	<47% (Fig. 7)	0% (Fig. 8)
EGGS	Large + Small	<55% (Fig. 9)	<91% (Fig. 10)

These analyses suggest that 1992 returns, spawners, and egg deposition were significantly smaller than previous 5-year averages. Large spawners and egg deposition were significantly below target, but the target for small spawners was almost certainly met.

(2) Spawner counts from canoe surveys

Visual counts of spawners, conducted from canoes, were 4909 large and 3002 small salmon (Table 5-8, Appendix 7). The 1992 values are 48% (large salmon) and 23% (small salmon) below previous mean values. Water levels were high during the 1992 survey and may have adversely affected water clarity, leading to underestimates of spawner abundance.

(3) Spawner counts at protection barriers

Counts of large and small salmon at the NW Upsalquitch protection barrier indicate an average spawning escapement: 963 large and 1351 small salmon (1 and 7% above the 1987-1991 annual means, respectively) (Table 11).

Counts of salmon at a barrier on the Causapscal River were 31% and 69% below the 1988-91 average for large and small salmon, respectively (Table 11). However, the barrier was washed out by high water on August 5, so these counts should not be compared to those obtained from a full season's operation.

(4) 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 1992 spawning escapement was similar to the 5-year mean. Spawner counts from canoe surveys were substantially lower than 1991 values, but the methodology used has not been adequately calibrated.

5. **Recruitment.**

Egg depositions from 1971 to 1991 showed evidence of significant ($P \leq 0.05$) correlation with resulting 0+ and 1+, but not 2+ juvenile densities (Tables 9 and 10; Figures 11 and 12).

Average densities of 0+ and 2+ juvenile salmon in 1992 were lower than previous 5-year averages by 24% and 3% respectively (Tables 9 and 10; Figure 13), but the density of 1+ juveniles was 38% higher than the previous 5-year average. These data suggest that the increase in spawning levels and/or juvenile survival rates observed in 1991 did not carry over into 1992. 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 fry density (0+) in 1992 was significantly lower than that in 1991, but not significantly different from densities in 1983-1990 (Figure 14). Density in 1992 was significantly greater than in most years between 1972 and 1982. All predictors used in the model (year, stream order) were significant, with the exception of tributary. The R^2 of the model was 56% and a scatterplot of predicted versus residual values showed no serious deviation from linearity (Figure 15).

Parr density (1+) in 1992 was not significantly different from abundance in 1989-1991, but was significantly greater than most preceding years (Figure 16). All predictors used in the model (year, stream order, tributary) were significant. The R^2 of the analysis was 42% and the model appeared to fit the data well (Figure 17).

Abundance of 2+ parr did not significantly differ from 1983-1992, but 1992 abundance was significantly higher than in most years before 1983 (Figure 18). Year, stream order and tributary were significant predictors in the model. The R^2 of the model was 33% and the model appeared to fit the data well (Figure 19).

6. **Forecasts.**

(1) Evaluation of forecasts for 1992

In the 1991 assessment of Atlantic salmon in the Restigouche River (Courtenay et al. 1992), predictions of large and small salmon returns in 1992 were:

Method	Forecast	
	Large salmon	Small salmon
Five-year mean	11,515 - 18,165	10,297 - 17,097
1+ parr density	+26%	+54%
Small salmon returns	-29%	--

Actual returns in 1992 calculated in the present assessment were - Large salmon: 11,791 - 18,694 (103% of the forecast based on 5-year means) Small salmon: 11,113 - 18,485 (108% of the 5-year means forecast). The calculated returns were forecast quite closely by this method.

Relative to the 5-year mean values, returns of large and small salmon increased by 3% and 8%, respectively. The poor match between these values and those predicted by the two indices of spawning escapement and adult survival suggest that the latter were not very effective forecasters of 1992 returns.

(2) Forecast for 1993.

Forecasts for 1993 are very similar to those presented for 1992.

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%	--

The 5-year mean of 1988-1992 returns predicts returns in 1993 similar to those in 1992.

The potential sea survival index (average catch of small salmon in 1991 and 1992) predicts a below average return of large fish in 1993. The potential recruitment index (1+ density) predicts an above average return of large and small salmon in 1993.

In 1993, two methods of estimating returns to the Restigouche River are expected to be used: the existing method based on angling catches and assumed exploitation rates, and a mark-recapture method using salmon tagged in a new assessment trap operated in collaboration with the Eel River Bar Band. The CAFSAC subcommittee made the following suggestions to improve existing and proposed assessment techniques:

(1) installation of a second trap might improve results by increasing the number of fish tagged and allowing tag recaptures at the second trap.

(2) calibrations of visual spawner counts conducted above barrier fences would improve their reliability as indicators of spawning escapement

(3) angling exploitation rates should be estimated using tag returns.

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Summary Sheet

Stock: Restigouche River, SFA 15
Life Stage: juveniles (0+,1+,2+), small and large salmon
Target: 71.4 million eggs (12,200 large salmon, 2,600 small salmon)

	1987	1988	1989	1990	1991	1992	87-91	92/87-91	MIN	MAX
River harvest (Angling harvest, Catch-release mortalities, Broodstock removals)										
Large	1073	1207	1336	1146	1181	1327	1189	+12%	688[1]	6707
Small	5005	6776	3301	4324	2522	4755	4386	+8%	896	6776
Estuary harvest (Native harvest)										
Large	1902	1430	1649	1606	1111	1412	1540	-8%	23[1]	18180
Small	100	73	163	136	19	55	98	-44%	0	7339
Spawning Escapement[2]										
Large (X 1000)	7-13	10-17	8-13	6-11	5-9	7-13	7-13	+3%	1-2[1]	11-19
Small (X 1000)	5-12	7-16	3-8	4-10	3-6	5-11	4-10	+8%	1-2	7-16
Total Returns[2]										
Large (X 1000)	12-18	15-23	12-19	10-16	9-14	12-19	12-18	+3%	6-9[1]	23-26
Small (X 1000)	12-19	16-26	8-13	10-17	6-10	11-18	10-17	+8%	3-4	16-26
% egg target met[2]	59-105	83-146	63-113	53-95	43-78	62-111	60-107	+3%	9-20[1]	89-159
Canoe counts of Spawners										
Large	8535	9520	12362	----	7513	4909[3]	9483	-48%	2397[4]	12362
Small	3930	3861	3970	----	3836	3002	3899	-23%	986	5190
Barrier Counts of Spawners										
Upsalquitch: Large	1000	993	894[5]	946[5]	930[5]	963	953	+1%	301[6]	1166
Small	1557	1121	1051	1324	1267	1351	1264	+7%	430	1738
Causapscal: Large	----	505	605	456[5]	451	350[5]	504	-31%	350[7]	605
Small	----	49	7	37	9	8	26	-69%	7	49
Juvenile Densities										
0+	42.0	53.2	72.1	53.2	106.5	49.6	65.4	-24%	5.2[8]	106.5
1+	9.4	6.1	12.1	12.9	12.3	14.6	10.6	+38%	2.4	14.6
2+	4.7	2.1	1.9	3.1	2.9	2.8	2.9	-3%	0.4	4.7

[1] MIN MAX for years 1970 to present.
[2] Range given reflects uncertainty of angling exploitation rate (assumed to be between 0.3 and 0.5), from which spawning escapement (and therefore eggs), and total returns are derived.
[3] May be underestimated due to high water conditions.
[4] MIN MAX for years 1982 to present.
[5] Incomplete counts.
[6] MIN MAX for years 1980 to present.
[7] MIN MAX for years 1988 to present.
[8] MIN MAX for years 1972 to present.

Recreational catches: Angling catch of both large and small salmon in 1992 was within 10% of the 5-year mean.

Data and assessment: Spawning escapement, losses to poaching and disease, and total returns are all calculated from angling catch and exploitation rate. Exploitation rate has not been measured since 1977, but is assumed to be between 0.3 and 0.5. Spawning escapement has been estimated by canoe surveys since 1982. Salmon are counted at headwater protection barriers on the Upsalquitch River (since 1980) and Causapscal River (Matapedia) (since 1988). Juvenile salmon densities (number/100 m^2) were estimated from electrofishing at 15 standard sites (since 1972) except in 1991 (8 sites) and 1992 (10 sites).

State of the Stock: Because angling exploitation rates have not been measured in recent years, true spawning escapements are unknown. 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 1993: Based on the mean returns from 1988 - 1992, between 12 and 18 thousand large and between 10 and 17 thousand small salmon are expected to return in 1993. 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 1992.

Year	MSW			1SW			Proportion MSW		
	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	570	1672	2242	348	1474	1822	0.62	0.53	0.55
1985	752	3563	4315	259	3258	3517	0.74	0.52	0.55
1986	1418	4763	6181	498	4915	5413	0.74	0.49	0.53
1987	873	3203	4076	591	4414	5005	0.60	0.42	0.45
1988	1007	4546	5553	692	6084	6776	0.59	0.43	0.45
1989	1006	3441	4447	450	2851	3301	0.69	0.55	0.57
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
Mean (87-91)	947	3243	4190	607	3779	4386	0.61	0.47	0.50
1992/Mean	+6%	+3%	+4%	+24%	+6%	+8%	-7%	-2%	-4%

a Estimates of MSW salmon (1984 to 1992) 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, 1992. Catch, effort and CPUE in 1991 are given for comparison.

		1992			1991			Mean (87-91)			1992/Mean		
		Catch	Effort	CPUE	Catch	Effort	CPUE	Catch	Effort	CPUE	Catch	Effort	CPUE
N.B.	1SW	3999	9966	0.40	1987	9217	0.22	3779	10195	0.37	+6%	-2%	+8%
	MSWa	3351	9966	0.34	2181	9217	0.24	3243	10195	0.32	+3%	-2%	+6%
P.Q.	1SW	752	6948	0.11	535	7264	0.07	607	8083	0.08	+24%	-14%	+38%
	MSW	1004	6948	0.14	956	7264	0.13	947	8083	0.12	+6%	-14%	+17%

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

Table 3. Preliminary estimates of harvest (numbers) of 1SW and MSW salmon in Restigouche River, 1992. Harvests of salmon in 1991 are given for comparison.

Fishery		1992		1991		Mean (87-91)		1992/Mean	
		1SW	MSW	1SW	MSW	1SW	MSW	1SW	MSW
Native									
	N.B.	2	464	10	252	89	543	-98%	-15%
	P.Q.	53	948	9	859	9	996	+489%	-5%
Angling									
	N.B.	3999		1987		3779		+6%	
	P.Q.	752	1004	535	956	607	947	+24%	+6%
Total		4806	2416	2541	2067	4484	2486	+7%	-3%

Table 4. Commercial, angling and Native salmon landings from Baie des Chaleurs and Restigouche River, 1970 to 1992. Data sources given in Appendix 6.

Year	Commercial		Angling		Native		Total
	1SW	MSW	1SW	MSW	1SW	MSW	
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	1822	570	178	1283	13040
1985	0	0	3517	752	35	1217	5521
1986	0	0	5413	1418	30	1576	8437
1987	0	0	5005	873	100	1902	7880
1988	0	0	6776	1007	73	1430	9286
1989	0	0	3301	1006	163	1649	6119
1990	0	0	4324	893	136	1606	6959
1991	0	0	2522	956	19	1111	4608
1992	0	0	4751	1004	55	1412	7222
Mean (87-91)	0	0	4386	947	98	1540	6970
1992/Mean	0%	0%	+8%	+6%	-44%	-8%	+4%

Table 5. Estimated spawners (S) and total returns (R) of MSW salmon in Restigouche River, 1970 to 1992. Spawners were estimated using an angling exploitation rate (u) of 0.3.

Year	Harvest Estuary	Harvest River	MSW Released plus P.Q.	PAD	Spawners (S)	Field Spawner Counts	Returns (R)
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	3563	16360
1983	6045	2068		1313	4825	2397	14251
1984a	3309	688	2242	1424	6785	5233	12206
1985	1217	1074	4315	2740	13309	7934	18340
1986	1576	1693	6181	3925	18910	9542	26104
1987	1902	1073	4076	2588	12514	8535	18077
1988	1430	1207	5553	3526	17303	9520	23466
1989	1649	1336	4447	2824	13487	12362	19296
1990b	1606	1146	3735	2372	11304		16428
1991	1111	1181	3137	1992	9276	7513	13560
1992	1412	1327	4355	2765	13190	4909	18694
Mean (87-91)	1540	1189	4190	2660	12777	9483	18165
1992/Mean	-8%	+12%	+4%	+4%	+3%	-48%	+3%

a River harvests (1984 to 1992) 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 MSW salmon in Restigouche River, 1970 to 1992. Spawners were estimated using an angling exploitation rate (u) of 0.5.

Year	Harvest Estuary	Harvest River	MSW Released plus P.Q.	PAD	Spawners (S)	Field Spawner Counts	Returns (R)
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	3563	12261
1983	6045	2068		788	2068	2397	10969
1984a	3309	688	2242	854	3796	5233	8647
1985	1217	1074	4315	1644	7556	7934	11491
1986	1576	1693	6181	2355	10669	9542	16293
1987	1902	1073	4076	1553	7079	8535	11607
1988	1430	1207	5553	2116	9899	9520	14652
1989	1649	1336	4447	1694	7558	12362	12237
1990b	1606	1146	3735	1423	6324		10499
1991	1111	1181	3137	1195	5093	7513	8580
1992	1412	1327	4355	1659	7383	4909	11781
Mean (87-91)	1540	1189	4190	1596	7191	9483	11515
1992/Mean	-8%	+12%	+4%	+4%	+3%	-48%	+2%

a River harvests (1984 to 1992) 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 1SW salmon in Restigouche River, 1970 to 1992. Spawners were estimated using an angling exploitation rate (u) of 0.3.

Year	Harvest		PAD	Spawners (S)	Field Spawner Counts	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	1577	13412
1983	1584	896	486	2091	986	5057
1984	7339	1822	989	4251	1374	14401
1985	35	3517	1909	8206	2132	13667
1986	30	5413	2937	12630	5190	21010
1987	100	5005	2716	11678	3930	19499
1988	73	6776	3677	15811	3861	26337
1989	163	3301	1791	7702	3970	12957
1990a	136	4324	2346	10089		16895
1991	19	2522	1369	5885	3836	9795
1992b	55	4755	2580	11095	3002	18485
Mean (87-91)	98	4386	2380	10233	3899	17097
1992/Mean	-44%	+8%	+8%	+8%	-23%	+8%

a High water prevented field spawner count.
b River harvest includes broodstock removals.

Table 8. Estimated spawners (S) and total returns (R) of 1SW salmon in Restigouche River, 1970 to 1992. Spawners were estimated using an angling exploitation rate (u) of 0.5.

Year	Harvest		PAD	Spawners (S)	Field Spawner Counts	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	1577	8992
1983	1584	896	292	896	986	3668
1984	7339	1822	593	1822	1374	11576
1985	35	3517	1145	3517	2132	8214
1986	30	5413	1762	5413	5190	12618
1987	100	5005	1630	5005	3930	11740
1988	73	6776	2206	6776	3861	15831
1989	163	3301	1075	3301	3970	7840
1990a	136	4324	1408	4324		10192
1991	19	2522	821	2522	3836	5884
1992b	55	4755	1548	4755	3002	11113
Mean (87-91)	98	4386	1428	4386	3899	10297
1992/Mean	-44%	+8%	+8%	+8%	-23%	+8%

a High water prevented field spawner count.
b River harvest includes broodstock removals.

Table 9. Estimates of total egg deposition and resulting juvenile densities of Atlantic salmon in the Restigouche River, 1971 to 1992. 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), 8 (1991) and 10 (1992) standard sities.

Year (i)	Egg deposition (millions) MSW (year i)	1SW (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	40.3	0.4	40.7	25.2	7.5	4.7
1985	79.0	0.7	79.7	23.9	9.4	2.1
1986	112.2	1.1	113.3	42.0	6.1	1.9
1987	74.2	1.0	75.2	53.2	12.1	3.1
1988	102.7	1.4	104.1	72.1	12.9	2.9
1989	80.0	0.7	80.7	53.2	12.3	2.8
1990	67.1	0.9	68.0	106.5	14.6	-
1991	55.0	0.5	55.5	49.6	-	-
1992	78.3	1.0	79.3	-	-	-
Mean (87-91)	75.8	0.9	76.7	65.4	10.6	2.9
1992/Mean	+3%	+11%	+3%	-24%	+38%	-3%

Correlations:

	n	r	p
ln. 1. with ln. 2.	21	0.50	0.02
ln. 1. with ln. 3.	20	0.45	0.05
ln. 1. with ln. 4.	19	0.36	0.13
ln. 2. with ln. 3.	20	0.84	<0.01
ln. 2. with ln. 4.	19	0.75	<0.01
ln. 3. with ln. 4.	19	0.74	<0.01

Table 10. Estimates of total egg deposition and resulting juvenile densities of Atlantic salmon in the Restigouche River, 1971 to 1992. 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), 8 (1991) and 10 (1992) standard sities.

	Egg deposition (millions)			Juvenile salmon densities		
Year (i)	MSW (year i)	1SW (year i)	Total (year i)	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	22.5	0.2	22.7	25.2	7.5	4.7
1985	44.8	0.3	45.1	23.9	9.4	2.1
1986	63.3	0.5	63.8	42.0	6.1	1.9
1987	42.0	0.4	42.4	53.2	12.1	3.1
1988	58.7	0.6	59.3	72.1	12.9	2.9
1989	44.8	0.3	45.1	53.2	12.3	2.8
1990	37.5	0.4	37.9	106.5	14.6	-
1991	30.2	0.2	30.4	49.6	-	-
1992	43.8	0.4	44.2	-	-	-
Mean (87-91)	42.6	0.4	43.0	65.4	10.6	2.9
1992/Mean	+3%	0%	+3%	-24%	+38%	-3%

Correlations:

	n	r	p
ln. 1. with ln. 2.	21	0.62	<0.01
ln. 1. with ln. 3.	20	0.55	0.01
ln. 1. with ln. 4.	19	0.44	0.06
ln. 2. with ln. 3.	20	0.84	<0.01
ln. 2. with ln. 4.	19	0.75	<0.01
ln. 3. with ln. 4.	19	0.74	<0.01

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

Year	1SW	MSW	Total	MSW/1SW
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
Mean (87-91)	1264	953	2217	0.76
1992/Mean	+7%	+1%	+4%	-7%
Causapscal barrier				
1988	49	505	554	10.31
1989	7	605	612	86.43
1990d	37	456	493	12.32
1991	9	451	460	50.11
1992e	8	350	358	43.75
Mean (88-91)	26	504	530	39.79
1992/Mean	-69%	-31%	-32%	+10%

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 breached August 14 due to high water.
e Count incomplete. Barrier removed August 5 due to high water.

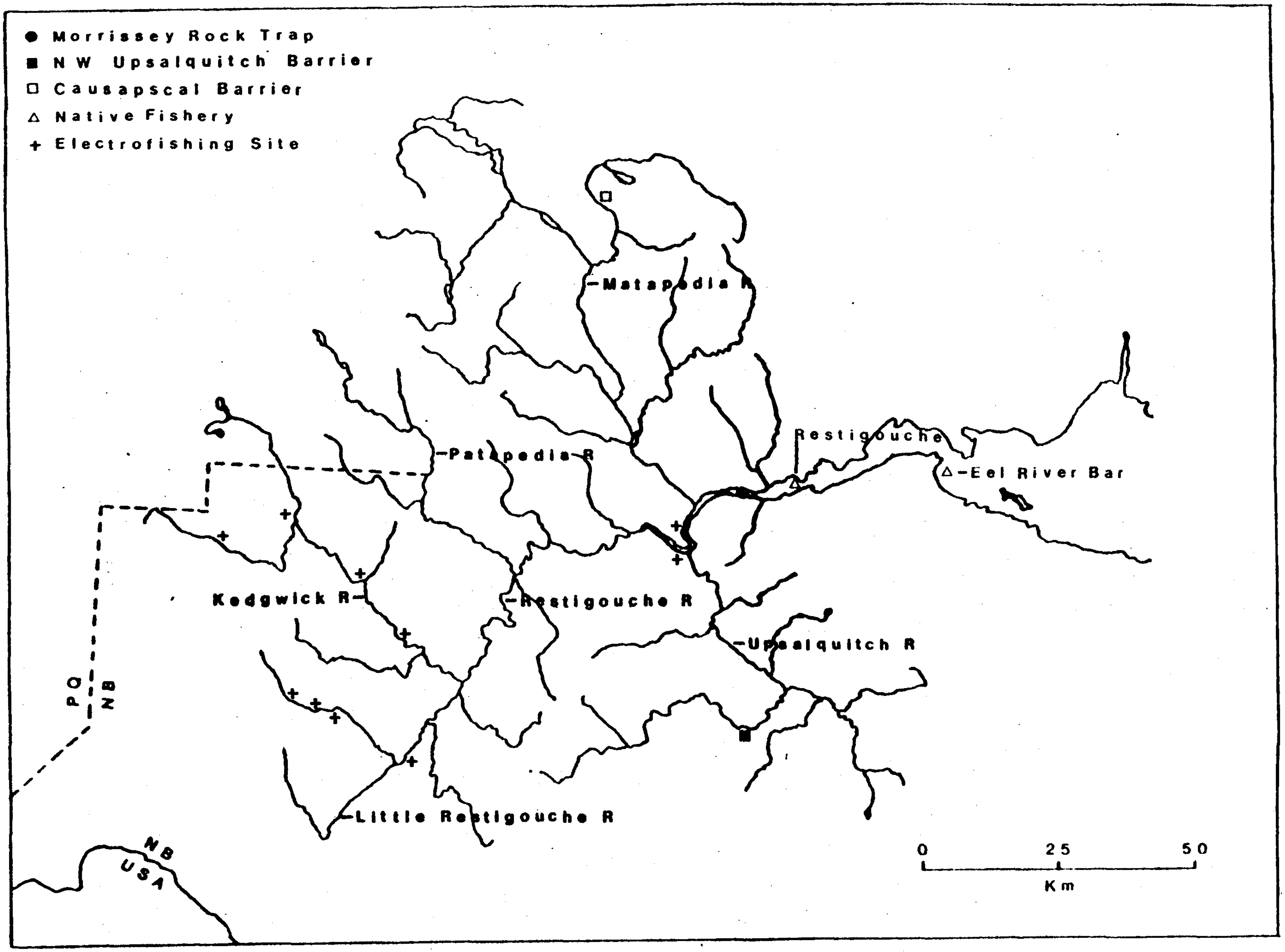


FIGURE 1. Map of the Restigouche River showing the location of electrofishing sites fished in 1992, native fisheries, and barrier fences at which salmon were enumerated.

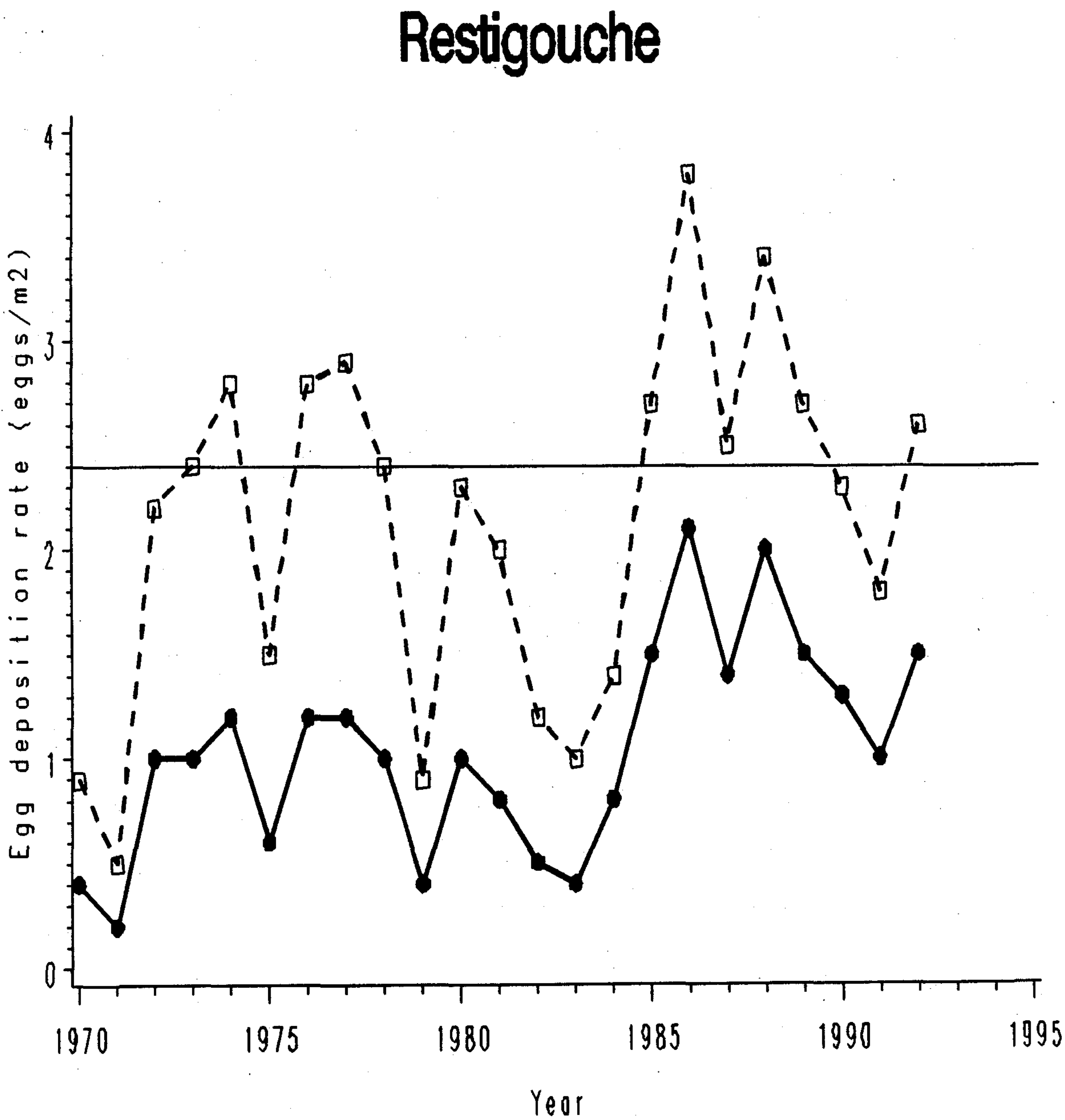
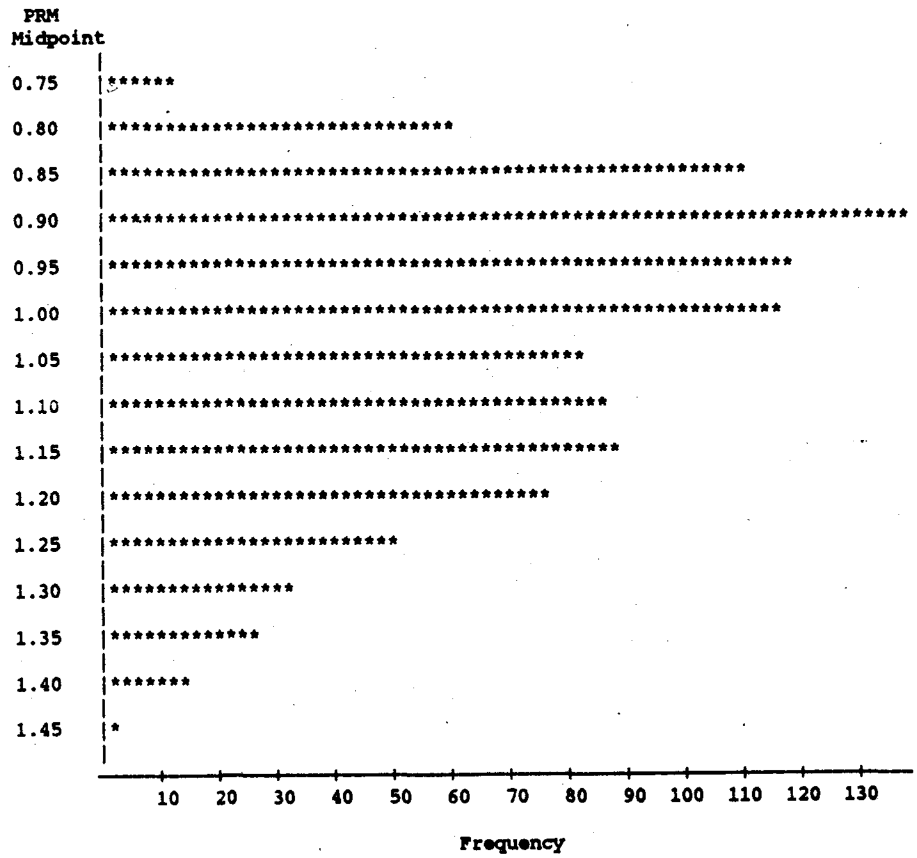
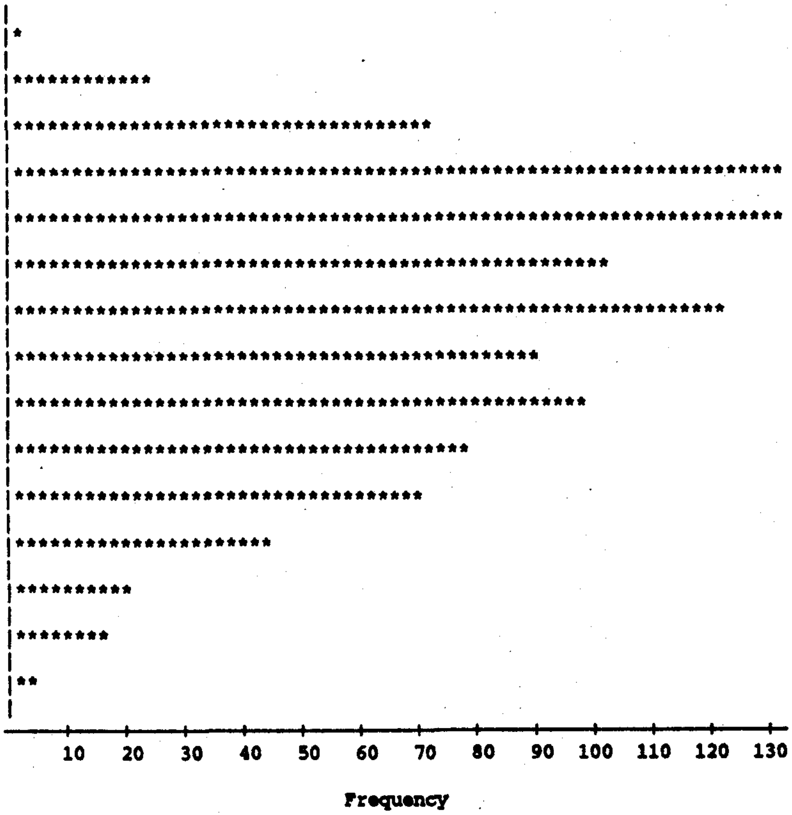


FIGURE 2. Egg deposition rates, 1970-1992, estimated from angling catch data and assumed exploitation rates of 0.3 (squares) and 0.5 (dots). Horizontal line indicates target deposition rate.



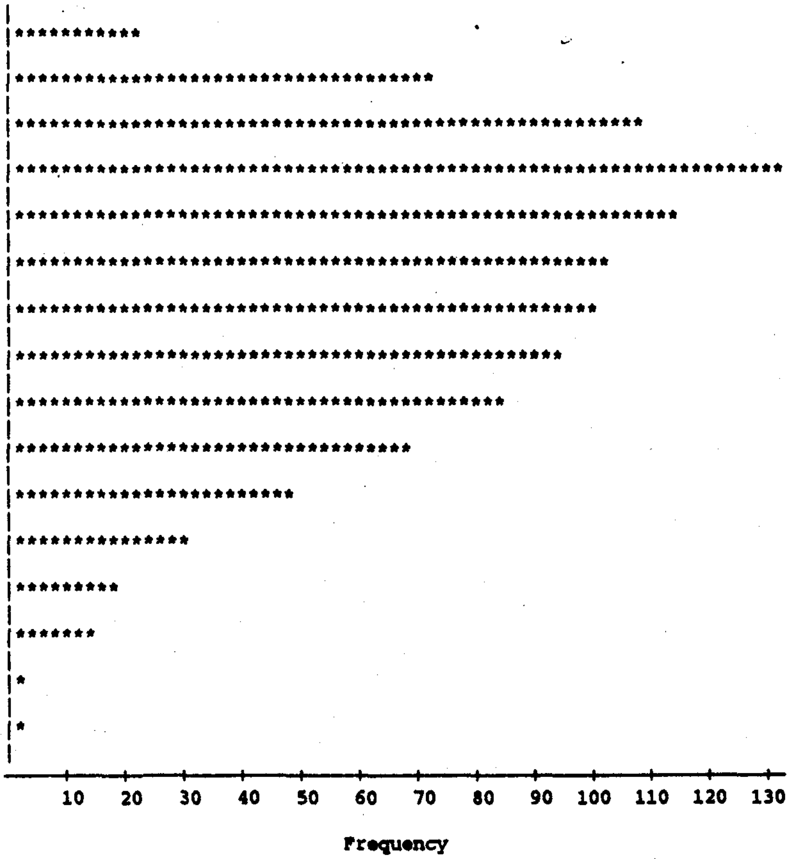
PRM Midpoint	Freq	Cum. Freq	Percent	Cum. Percent
0.75	12	12	1.20	1.20
0.80	59	71	5.90	7.10
0.85	110	181	11.00	18.10
0.90	137	318	13.70	31.80
0.95	118	436	11.80	43.60
1.00	115	551	11.50	55.10
1.05	82	633	8.20	63.30
1.10	85	718	8.50	71.80
1.15	87	805	8.70	80.50
1.20	75	880	7.50	88.00
1.25	49	929	4.90	92.90
1.30	31	960	3.10	96.00
1.35	25	985	2.50	98.50
1.40	14	999	1.40	99.90
1.45	1	1000	0.10	100.00

FIGURE 3. Estimated MSW total returns in 1992 as a proportion of the average 1987-1991 from randomization procedure, based on exploitation rates drawn from uniform distribution of 0.3-0.5, 1000 simulations, assume catch estimates are within 20% of true value.



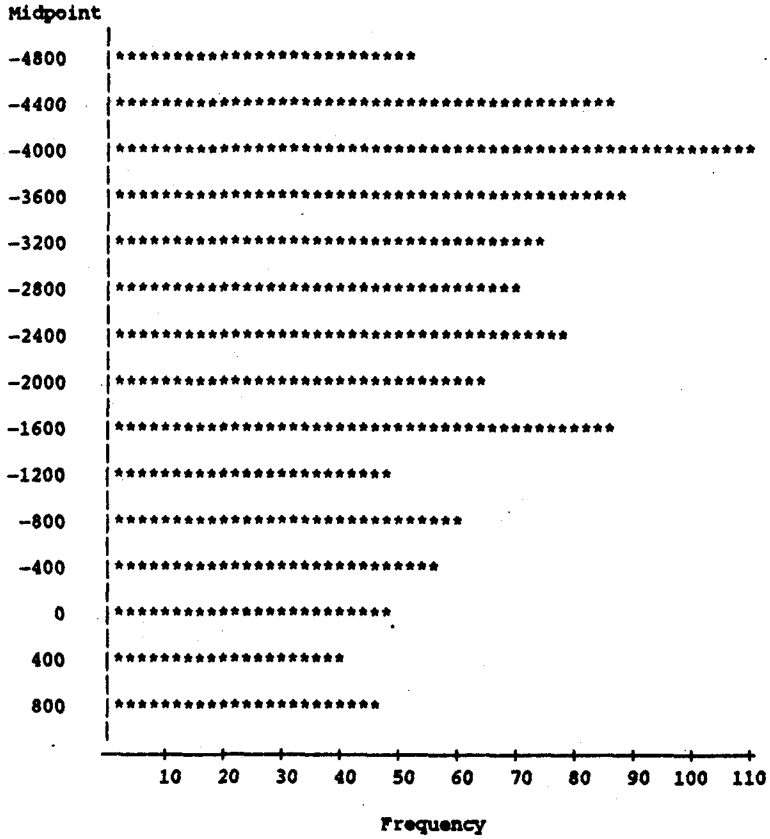
PR1 Midpoint	Freq	Cum. Freq	Percent	Cum. Percent
0.72	2	2	0.20	0.20
0.78	24	26	2.40	2.60
0.84	72	98	7.20	9.80
0.90	131	229	13.10	22.90
0.96	131	360	13.10	36.00
1.02	101	461	10.10	46.10
1.08	122	583	12.20	58.30
1.14	90	673	9.00	67.30
1.20	98	771	9.80	77.10
1.26	77	848	7.70	84.80
1.32	70	918	7.00	91.80
1.38	44	962	4.40	96.20
1.44	20	982	2.00	98.20
1.50	15	997	1.50	99.70
1.56	3	1000	0.30	100.00

FIGURE 4 Estimated 1SW total returns in 1992 as a proportion of the average 1987-1991 from randomization procedure, based on exploitation rates drawn from uniform distribution of 0.3-0.5, 1000 simulations, assume catch estimates are within 20% of true value.



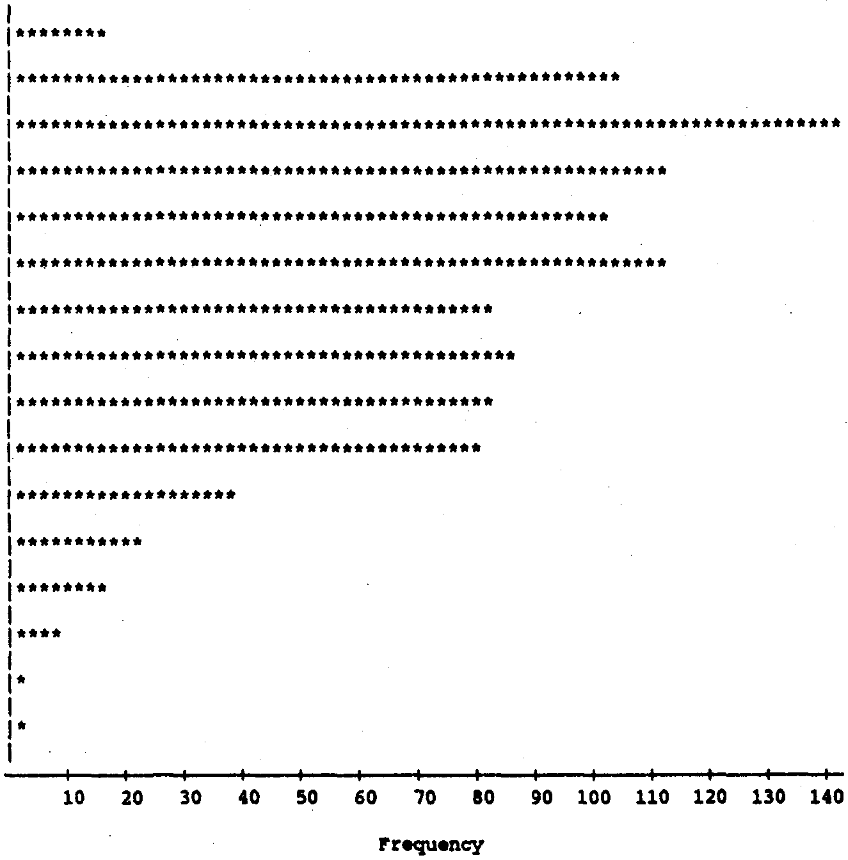
PSM Midpoint	Freq	Cum. Freq	Percent	Cum. Percent
0.72	22	22	2.20	2.20
0.78	72	94	7.20	9.40
0.84	107	201	10.70	20.10
0.90	131	332	13.10	33.20
0.96	114	446	11.40	44.60
1.02	102	548	10.20	54.80
1.08	99	647	9.90	64.70
1.14	93	740	9.30	74.00
1.20	83	823	8.30	82.30
1.26	67	890	6.70	89.00
1.32	48	938	4.80	93.80
1.38	29	967	2.90	96.70
1.44	17	984	1.70	98.40
1.50	13	997	1.30	99.70
1.56	2	999	0.20	99.90
1.62	1	1000	0.10	100.00

FIGURE 5 Estimated MSW spawners in 1992 as a proportion of the average 1987-1991 from randomization procedure, based on exploitation rates drawn from uniform distribution of 0.3-0.5, 1000 simulations, assume catch estimates are within 20% of true value.



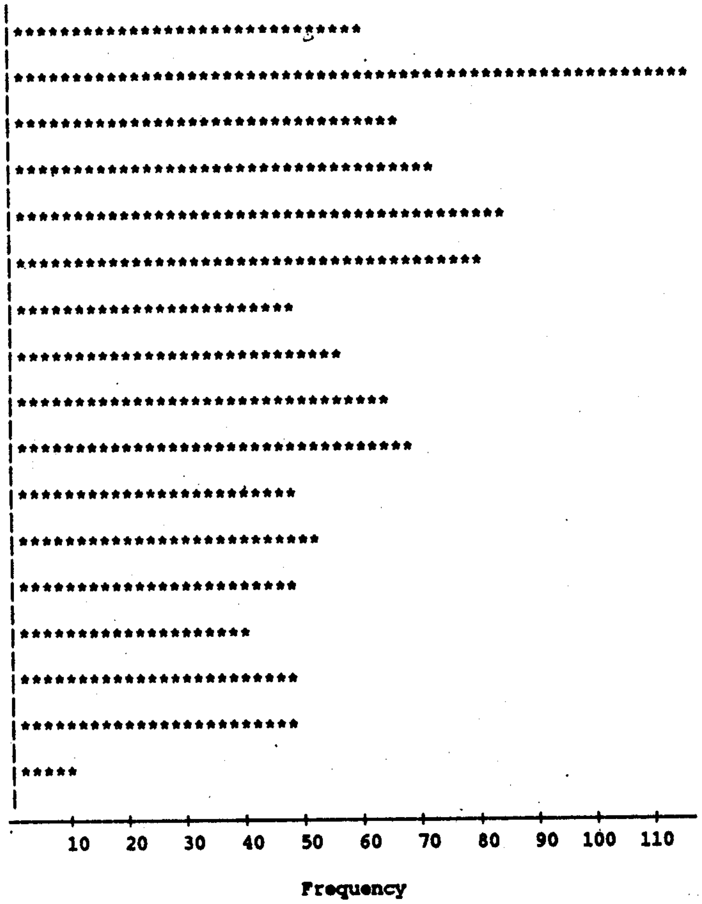
TSM Midpoint	Freq	Cum. Freq	Percent	Cum. Percent
-4800	51	51	5.10	5.10
-4400	86	137	8.60	13.70
-4000	110	247	11.00	24.70
-3600	88	335	8.80	33.50
-3200	73	408	7.30	40.80
-2800	70	478	7.00	47.80
-2400	77	555	7.70	55.50
-2000	64	619	6.40	61.90
-1600	86	705	8.60	70.50
-1200	48	753	4.80	75.30
-800	59	812	5.90	81.20
-400	56	868	5.60	86.80
0	47	915	4.70	91.50
400	40	955	4.00	95.50
800	45	1000	4.50	100.00

FIGURE 6 Estimated MSW spawners in 1992 - spawning target (12,200) from randomization procedure, based on exploitation rates drawn from uniform distribution of 0.3-0.5, 1000 simulations, assume catch estimates are within 20% of true value.



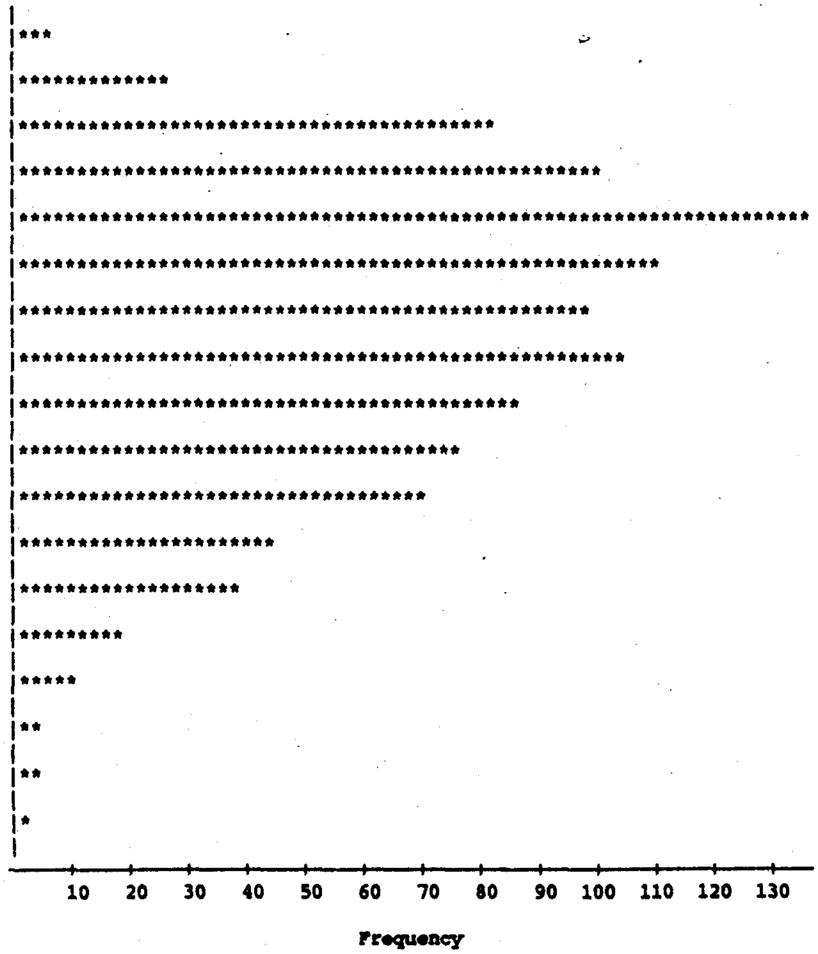
PS1 Midpoint	Freq	Cum. Freq	Percent	Cum. Percent
0.6	16	16	1.60	1.60
0.7	103	119	10.30	11.90
0.8	141	260	14.10	26.00
0.9	112	372	11.20	37.20
1.0	102	474	10.20	47.40
1.1	112	586	11.20	58.60
1.2	82	668	8.20	66.80
1.3	85	753	8.50	75.30
1.4	81	834	8.10	83.40
1.5	80	914	8.00	91.40
1.6	37	951	3.70	95.10
1.7	22	973	2.20	97.30
1.8	16	989	1.60	98.90
1.9	7	996	0.70	99.60
2.0	2	998	0.20	99.80
2.1	2	1000	0.20	100.00

FIGURE 7 Estimated 1SW spawners in 1992 as a proportion of the average 1987-1991 from randomization procedure, based on exploitation rates drawn from uniform distribution of 0.3-0.5, 1000 simulations, assume catch estimates are within 20% of true value.



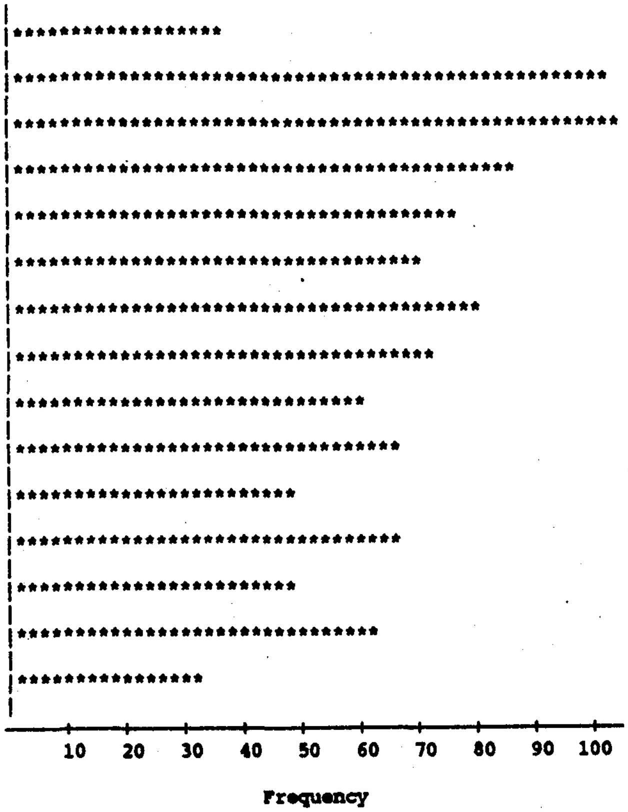
TS1 Midpoint	Freq	Cum. Freq	Percent	Cum. Percent
2200	59	59	5.90	5.90
2600	115	174	11.50	17.40
3000	66	240	6.60	24.00
3400	71	311	7.10	31.10
3800	83	394	8.30	39.40
4200	79	473	7.90	47.30
4600	48	521	4.80	52.10
5000	55	576	5.50	57.60
5400	64	640	6.40	64.00
5800	67	707	6.70	70.70
6200	48	755	4.80	75.50
6600	52	807	5.20	80.70
7000	48	855	4.80	85.50
7400	40	895	4.00	89.50
7800	48	943	4.80	94.30
8200	47	990	4.70	99.00
8600	10	1000	1.00	100.00

FIGURE 8 Estimated 1SW spawners in 1992 - spawning target (2,600) from randomization procedure, based on exploitation rates drawn from uniform distribution of 0.3-0.5, 1000 simulations, assume catch estimates are within 20% of true value.



PE Midpoint	Freq	Cum. Freq	Percent	Cum. Percent
0.66	5	5	0.50	0.50
0.72	25	30	2.50	3.00
0.78	82	112	8.20	11.20
0.84	99	211	9.90	21.10
0.90	135	346	13.50	34.60
0.96	109	455	10.90	45.50
1.02	98	553	9.80	55.30
1.08	103	656	10.30	65.60
1.14	85	741	8.50	74.10
1.20	75	816	7.50	81.60
1.26	69	885	6.90	88.50
1.32	43	928	4.30	92.80
1.38	37	965	3.70	96.50
1.44	18	983	1.80	98.30
1.50	9	992	0.90	99.20
1.56	3	995	0.30	99.50
1.62	4	999	0.40	99.90
1.68	1	1000	0.10	100.00

FIGURE 9 Estimated egg deposition in 1992 as a proportion of the average 1987-1991 from randomization procedure, based on exploitation rates drawn from uniform distribution of 0.3-0.5, 1000 simulations, assume catch estimates are within 20% of true value.



TE Midpoint	Freq	Cum. Freq	Percent	Cum. Percent
-27500000	35	35	3.50	3.50
-25000000	102	137	10.20	13.70
-22500000	104	241	10.40	24.10
-20000000	86	327	8.60	32.70
-17500000	75	402	7.50	40.20
-15000000	70	472	7.00	47.20
-12500000	79	551	7.90	55.10
-10000000	72	623	7.20	62.30
-7500000	60	683	6.00	68.30
-5000000	66	749	6.60	74.90
-2500000	47	796	4.70	79.60
-3.49246E-10	65	861	6.50	86.10
2500000	47	908	4.70	90.80
5000000	61	969	6.10	96.90
7500000	31	1000	3.10	100.00

FIGURE 10 Estimated egg deposition in 1992 - spawning target (71.4 million eggs) from randomization procedure, based on exploitation rates drawn from uniform distribution of 0.3-0.5, 1000 simulations, assume catch estimates are within 20% of true value.

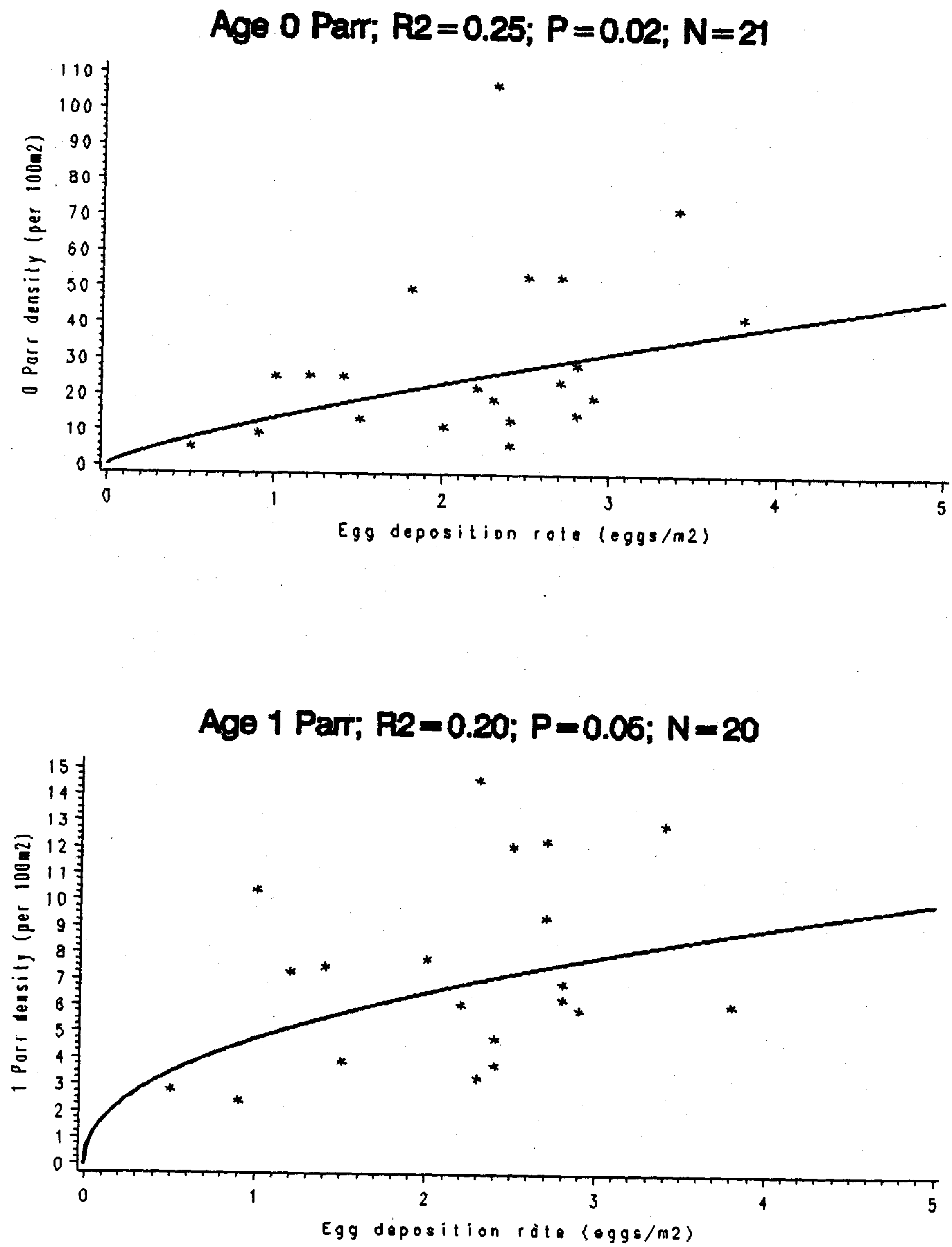


FIGURE 11 Relationship between egg deposition rate and resulting densities of 0+ and 1+ parr in the Restigouche River, 1972- 1992. Egg deposition rates were estimated from angling catch and assumed exploitation rate of 0.3.

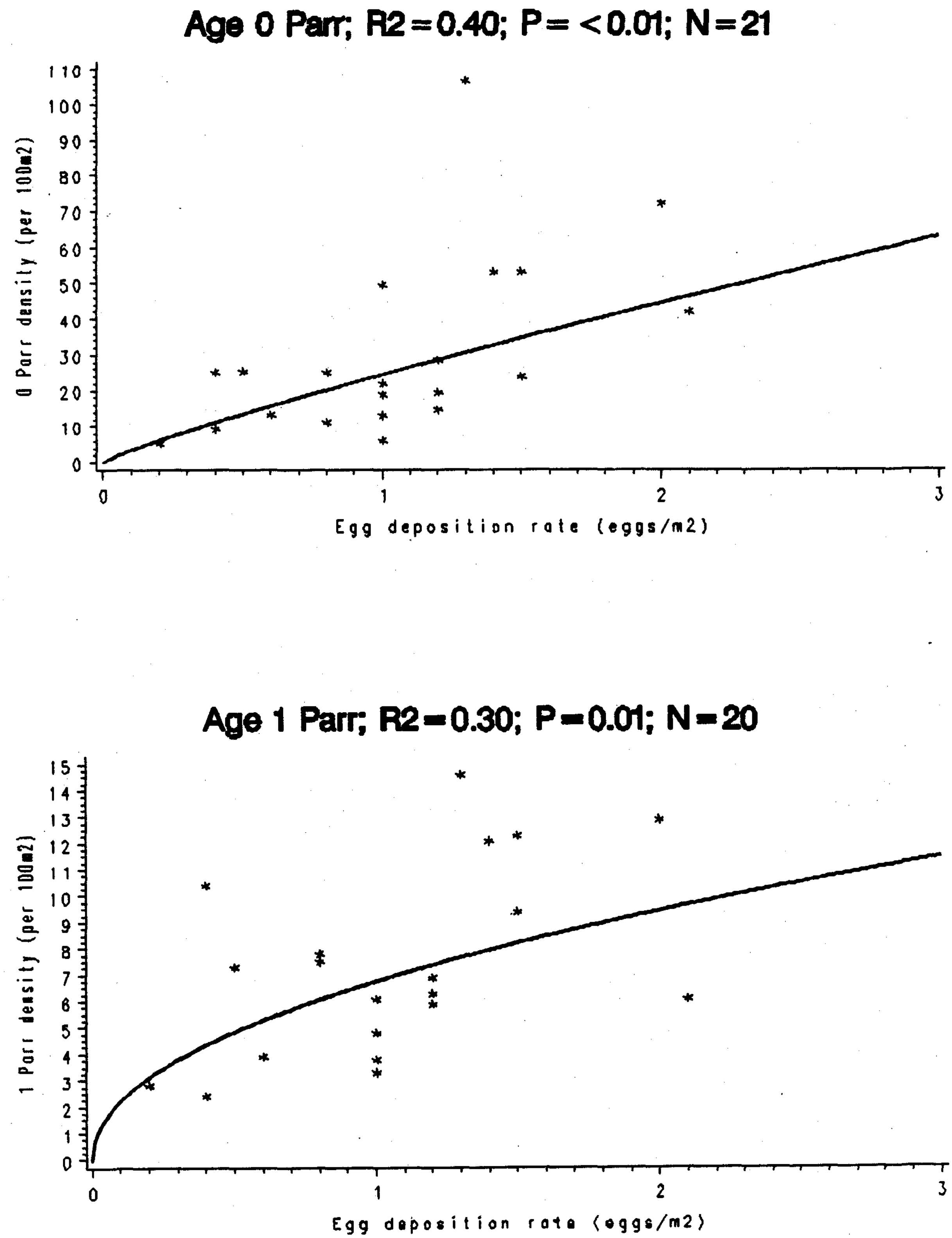


FIGURE 12 Relationship between egg deposition rate and resulting densities of 0+ and 1+ parr in the Restigouche River, 1972-1992. Egg deposition rates were estimated from angling catch and assumed exploitation rate of 0.5.

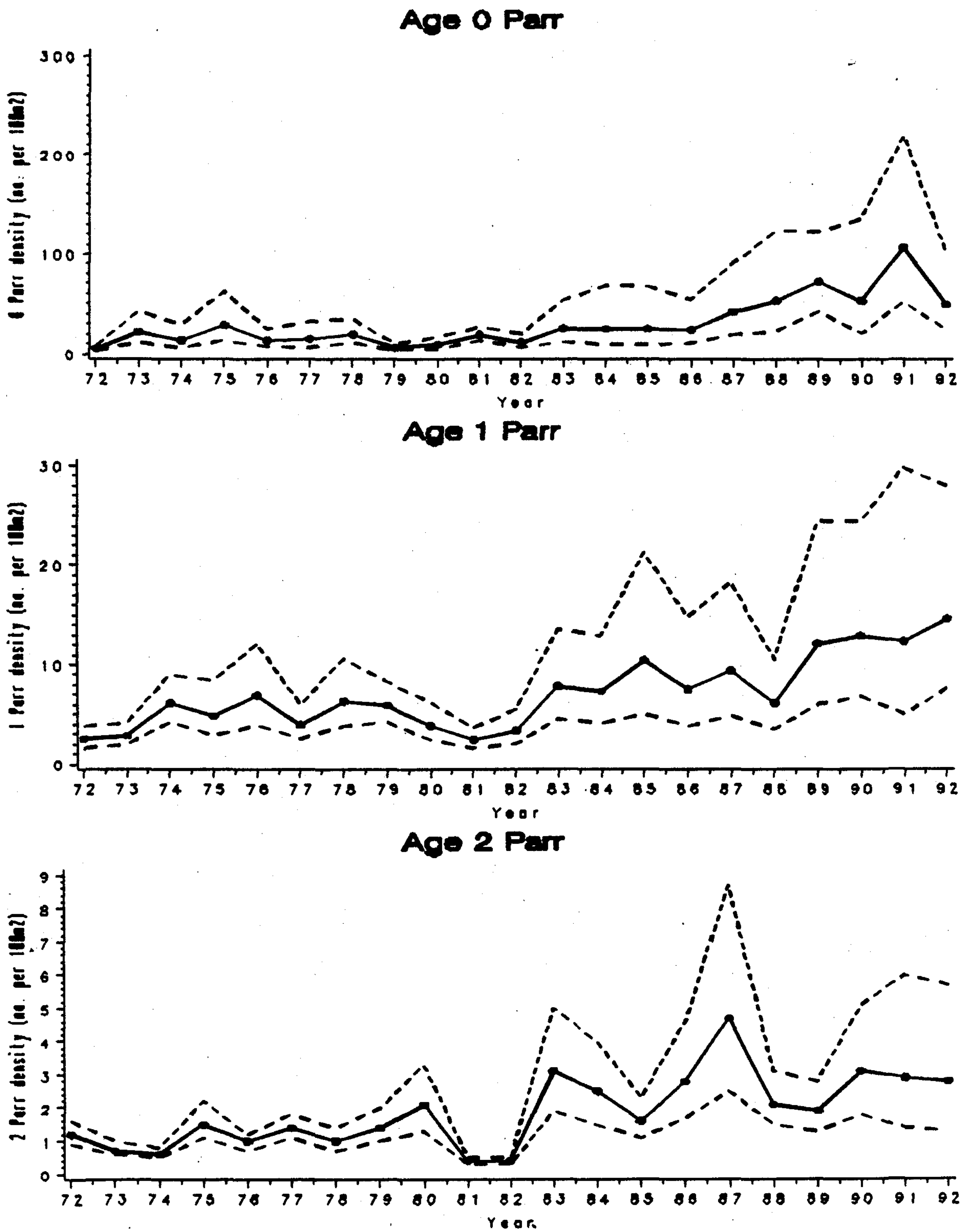


FIGURE 13. Mean densities of 0+, 1+ and 2+ parr in the Restigouche River, 1972-1992 (15 sites, 1972-1990; 8 sites, 1991; 10 sites, 1992). Dashed lines are 95% confidence limits.

General Linear Models Procedure

Dependent Variable: DENS

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	24	207.93510703	8.66396279	12.85	0.0001
Error	243	163.78558287	0.67401474		
Corrected Total	267	371.72068990			

R-Square	C.V.	Root MSE	DENS Mean
0.559385	28.31032	0.82098401	2.89994609

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YEAR	20	152.17130362	7.60856518	11.29	0.0001
SO	3	55.72684334	18.57561445	27.56	0.0001
TRIB	1	0.03696008	0.03696008	0.05	0.8150

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YEAR	20	145.34857892	7.26742895	10.78	0.0001
SO	2	52.89566621	26.44783310	39.24	0.0001
TRIB	1	0.03696008	0.03696008	0.05	0.8150

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		2.815486864 B	9.99	0.0001	0.28196806
YEAR	1972	-2.146322598 B	-6.30	0.0001	0.34082876
	1973	-0.776510709 B	-2.28	0.0234	0.34043005
	1974	-1.496025342 B	-4.33	0.0001	0.34583393
	1975	-0.330306905 B	-0.95	0.3413	0.34639414
	1976	-1.252277145 B	-3.67	0.0003	0.34082876
	1977	-1.087691692 B	-3.09	0.0022	0.35217603
	1978	-1.050023017 B	-3.13	0.0020	0.33566564
	1979	-1.687661370 B	-4.88	0.0001	0.34615675
	1980	-1.483209022 B	-4.29	0.0001	0.34556534
	1981	-0.783095891 B	-2.33	0.0205	0.33566564
	1982	-1.473810726 B	-4.32	0.0001	0.34082876
	1983	-0.601831687 B	-1.74	0.0836	0.34639414
	1984	-0.417026118 B	-1.13	0.2608	0.36996648
	1985	-0.228354397 B	-0.62	0.5375	0.36981673
	1986	-0.565699171 B	-1.60	0.1108	0.35346080
	1987	-0.153559786 B	-0.45	0.6527	0.34082876
	1988	0.281720590 B	0.81	0.4176	0.34695269
	1989	0.436487991 B	1.30	0.1947	0.33566564
	1990	0.056324853 B	0.16	0.8712	0.34695269
	1991	0.774359875 B	1.99	0.0480	0.38958142
	1992	0.000000000 B	.	.	.
SO	5	0.834952081 B	6.08	0.0001	0.13722919
	6	1.388048257 B	8.66	0.0001	0.16021907
	7	0.860484803 B	4.91	0.0001	0.17523755
	10	0.000000000 B	.	.	.
TRIB	LMRR	0.030600153 B	0.23	0.8150	0.13067481
	MRR	0.000000000 B	.	.	.
	ZKR	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 fry (0+) density in 1992 with previous years, in the Restigouche River. Fry densities were measured by electrofishing at 15 standard sites in the river 1972-1990, at 8 of those sites in 1991, and 10 in 1992.

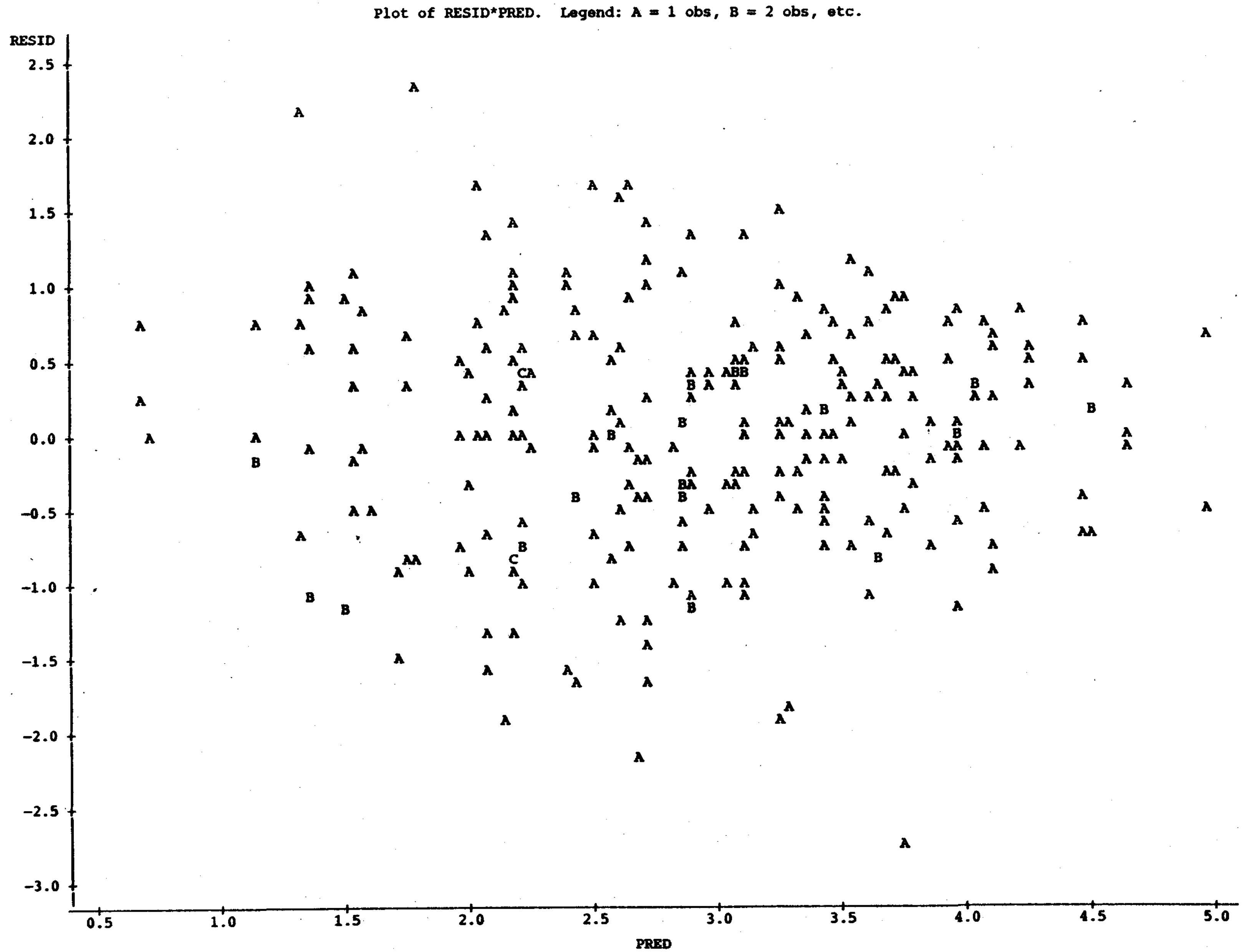


FIGURE 15. Scatterplot of residuals vs predicteds from multiplicative analysis given in FIGURE 14.

General Linear Models Procedure

Dependent Variable: DENS

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	24	81.87298175	3.41137424	7.02	0.0001
Error	237	115.19924097	0.48607275		
Corrected Total	261	197.07222272			

R-Square	C.V.	Root MSE	DENS Mean
0.415447	38.29678	0.69718918	1.82049054

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YEAR	20	39.41238732	1.97061937	4.05	0.0001
SO	3	15.34279456	5.11426485	10.52	0.0001
TRIB	1	27.11779987	27.11779987	55.79	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YEAR	20	41.06642597	2.05332130	4.22	0.0001
SO	2	4.15756857	2.07878429	4.28	0.0150
TRIB	1	27.11779987	27.11779987	55.79	0.0001

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		2.678359961 B	11.17	0.0001	0.23984036
YEAR	1972	-1.496936669 B	-4.99	0.0001	0.29971578
	1973	-1.198876064 B	-4.00	0.0001	0.29974940
	1974	-0.765560525 B	-2.69	0.0077	0.28502870
	1975	-0.987912833 B	-3.29	0.0011	0.30008328
	1976	-0.704895499 B	-2.40	0.0173	0.29413600
	1977	-1.133160286 B	-3.92	0.0001	0.28938671
	1978	-0.880840670 B	-3.09	0.0022	0.28502870
	1979	-0.701554600 B	-2.46	0.0146	0.28502870
	1980	-1.136456856 B	-3.87	0.0001	0.29399139
	1981	-1.355679230 B	-4.52	0.0001	0.30002320
	1982	-1.175717609 B	-3.84	0.0002	0.30584460
	1983	-0.633886332 B	-2.19	0.0293	0.28915881
	1984	-0.571095195 B	-1.94	0.0534	0.29413600
	1985	-0.292866113 B	-0.98	0.3295	0.29974940
	1986	-0.482734170 B	-1.58	0.1157	0.30576551
	1987	-0.556804032 B	-1.89	0.0596	0.29413600
	1988	-0.674144079 B	-2.25	0.0256	0.30008328
	1989	-0.138178928 B	-0.46	0.6452	0.29974940
	1990	-0.335484702 B	-1.16	0.2471	0.28915881
	1991	-0.019193852 B	-0.06	0.9556	0.34411964
	1992	0.000000000 B	.	.	.
SO	5	0.182268504 B	1.60	0.1108	0.11387845
	6	-0.173044246 B	-1.30	0.1963	0.13353630
	7	0.424477887 B	2.90	0.0040	0.14617158
	10	0.000000000 B	.	.	.
TRIB	LMRR	-0.851871089 B	-7.47	0.0001	0.11405053
	MRR	0.000000000 B	.	.	.
	ZKR	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 parr (1+) density in 1992 with previous years, in the Restigouche River. Parr densities were measured by electrofishing at 15 standard sites in the river 1972-1990, at 8 of those sites in 1991, and 10 in 1992.

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Plot of RESID*PRED. Legend: A = 1 obs, B = 2 obs, etc.

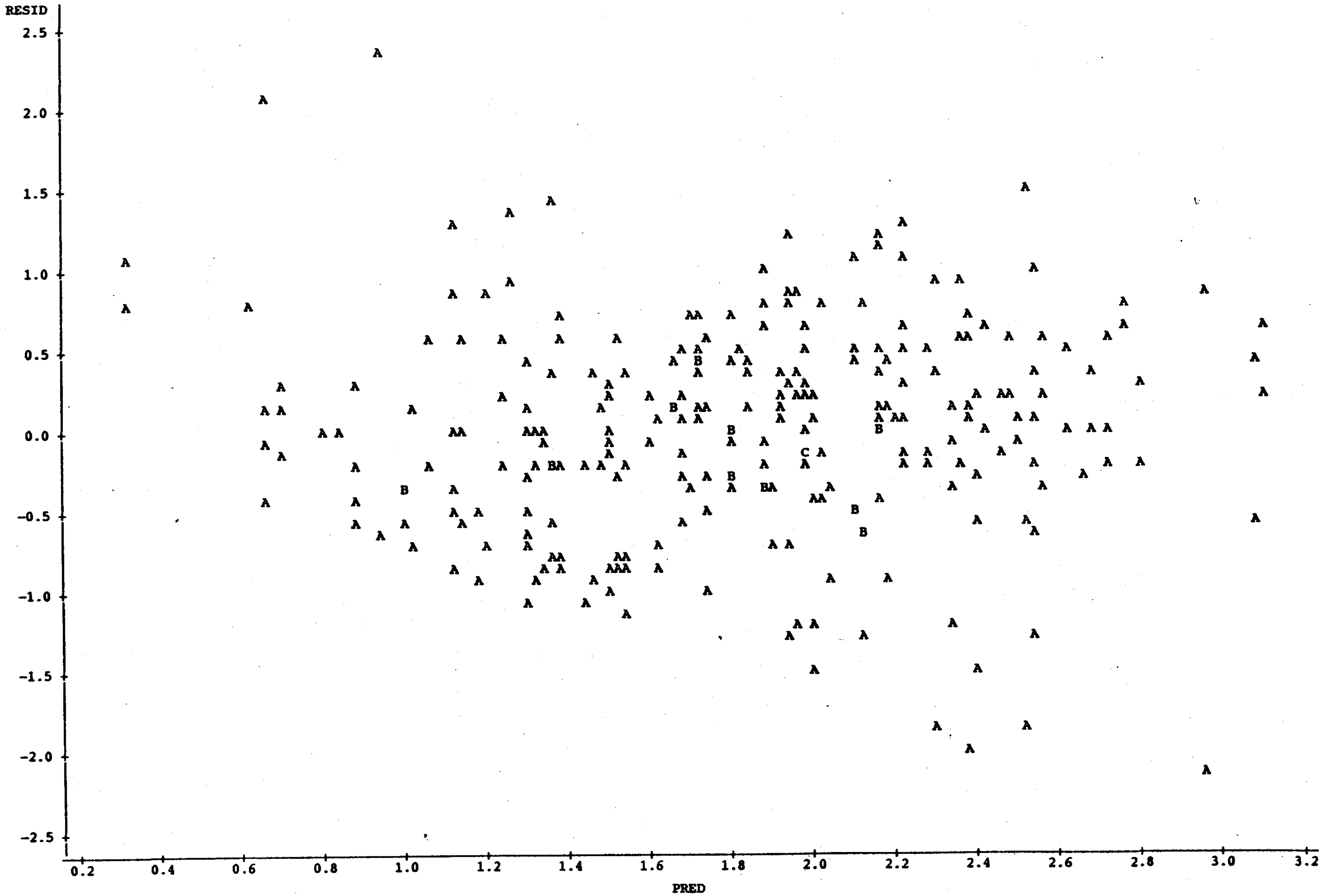

FIGURE 17. Scatterplot of residuals vs predicteds from multiplicative analysis given in FIGURE 16.

General Linear Models Procedure

Dependent Variable: DENS

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	24	29.09194890	1.21216454	3.70	0.0001
Error	178	58.37977027	0.32797624		
Corrected Total	202	87.47171918			

R-Square	C.V.	Root MSE	DENS Mean
0.332587	53.95178	0.57269210	1.06148888

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YEAR	20	21.79653392	1.08982670	3.32	0.0001
SO	3	5.33453739	1.77817913	5.42	0.0014
TRIB	1	1.96087759	1.96087759	5.98	0.0155

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YEAR	20	19.98953167	0.99947658	3.05	0.0001
SO	2	4.94515707	2.47257854	7.54	0.0007
TRIB	1	1.96087759	1.96087759	5.98	0.0155

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		1.675597602 B	6.36	0.0001	0.26327910
YEAR	1972	-0.724801618 B	-2.35	0.0200	0.30887072
	1973	-0.731849459 B	-2.27	0.0247	0.32305183
	1974	-0.818525863 B	-2.53	0.0123	0.32357884
	1975	-0.516779115 B	-1.65	0.0998	0.31233542
	1976	-0.652457433 B	-2.08	0.0390	0.31376115
	1977	-0.537219413 B	-1.76	0.0807	0.30582236
	1978	-0.536239903 B	-1.63	0.1057	0.32979637
	1979	-0.606801793 B	-1.98	0.0493	0.30657824
	1980	-0.356750922 B	-1.11	0.2678	0.32093007
	1981	-0.948606908 B	-2.81	0.0055	0.33747791
	1982	-0.925178879 B	-2.55	0.0117	0.36305195
	1983	0.028850210 B	0.09	0.9275	0.31644915
	1984	-0.127621451 B	-0.40	0.6872	0.31644915
	1985	-0.461822106 B	-1.48	0.1410	0.31234340
	1986	-0.085041216 B	-0.27	0.7884	0.31644915
	1987	0.334142373 B	1.05	0.2945	0.31779889
	1988	-0.313390149 B	-1.02	0.3114	0.30871622
	1989	-0.348442376 B	-1.12	0.2646	0.31133572
	1990	-0.156972406 B	-0.50	0.6159	0.31233542
	1991	-0.153618957 B	-0.44	0.6617	0.35051534
	1992	0.000000000 B	.	.	.
SO	5	-0.182484964 B	-1.83	0.0694	0.09987404
	6	-0.534880503 B	-3.88	0.0001	0.13795300
	7	0.005693908 B	0.04	0.9646	0.12823554
	10	0.000000000 B	.	.	.
TRIB	LMRR	-0.253336912 B	-2.45	0.0155	0.10360827
	MRR	0.000000000 B	.	.	.
	ZKR	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 parr (2+) density in 1992 with previous years, in the Restigouche River. Parr densities were measured by electrofishing at 15 standard sites in the river 1972-1990, at 8 of those sites in 1991, and 10 in 1992.

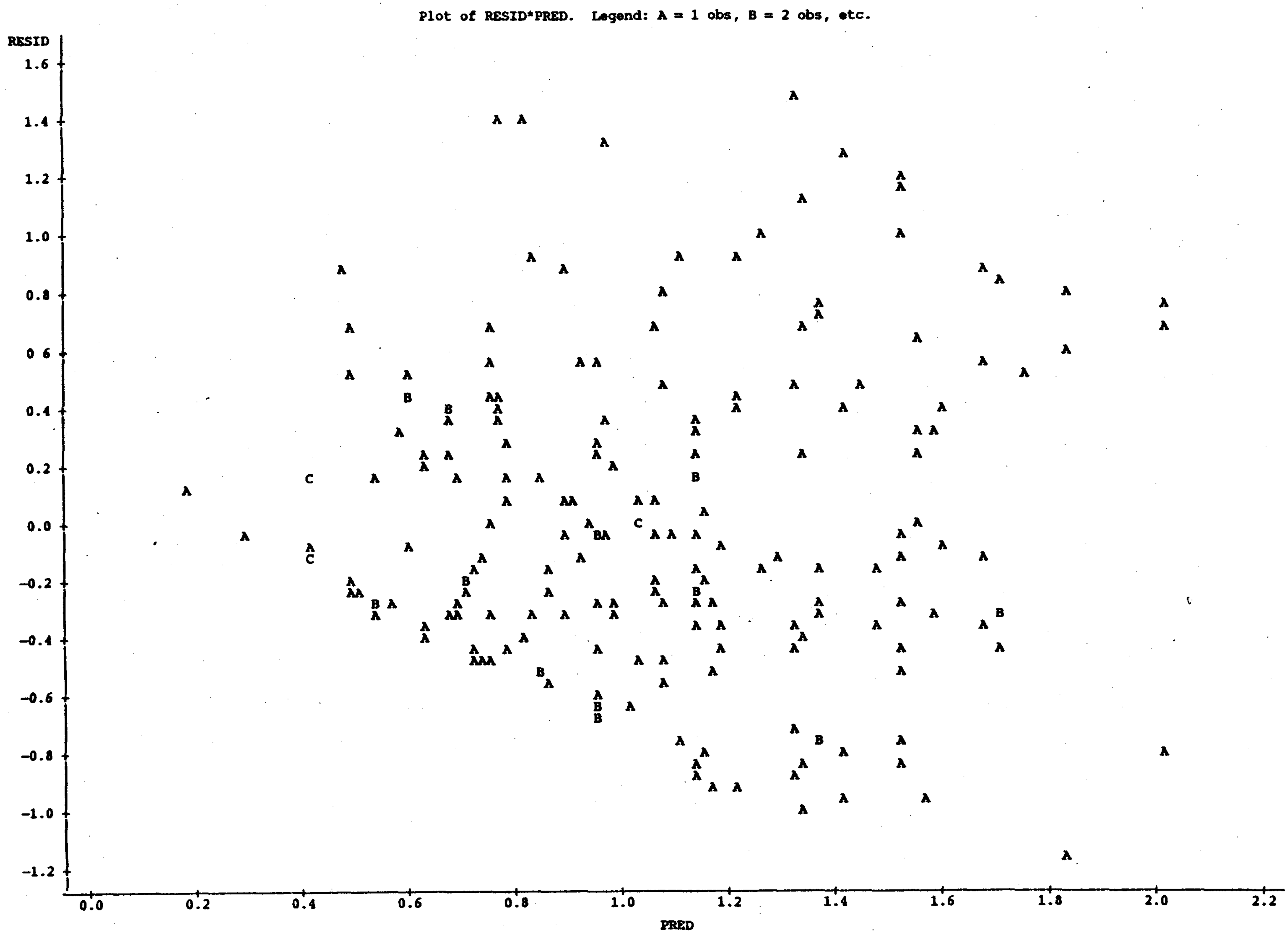

FIGURE 19. Scatterplot of residuals vs predicteds from multiplicative analysis given in FIGURE 18.

APPENDIX 1. SAS program of randomization procedure for comparing estimate of returns, spawners, and egg deposition in 1992, to prior 5 year mean, 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 bsl angcl esthm esthl};
do data ; input yr nbcat nbhrv pqcat pqhrv bsm bsl angcl; append; end;
close s; closefile 'restigouche.dat';

use s;
read all var {yr} into year;
read all var {nbcat pqcat angcl} into ac;
read all var {bsm bsl} into brood;
read all var {nbhrv pqhrv angcl} 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' 'spl91'};
create done from mat0 [ colname=fname];
append from mat0;

/*fname = {'spm91' 'spl91' 'estspm91' 'estspl91'
                'avgm' 'avgl' 'estavgm' 'estavgl'};
create done from mat [ colname=fname];
append from mat*/;

filename store 'sim2.dat';
data upd;
set done;
file store;
put eggsm eggs91 spm91 spl91;
*put spm91 spl91 estspm91 estspl91 avgm avgl estavgm estavgl;
run;

data step1;
infile 'sim2.dat';
/*input spm91 spl91 estspm91 estspl91 avgm avgl estavgm estavgl;
difm=spm91-estspm91;
difl=spl91-estspl91;
difavgm=avgm-estavgm;
difavgl=avgl-estavgl;
proc means;
     var spm91 spl91 estspm91 estspl91 difm difl difavgm difavgl;
run;
proc chart;
     hbar spm91 spl91/midpoints= 0 to 1.5 by .125;
run;
proc chart;
     hbar estspm91 estspl91/midpoints= 0 to 1.5 by .125;
run;
proc chart;
     hbar difavgm difavgl;
run;
*/

input eggsm eggs91  spm91 spl91;
tm=spm91-12200;
tl=spl91-2600;
te=eggs91-71400000;
pe=eggs91/eggsm;
proc means;
     var   eggsm  eggs91  spm91 spl91 tm tl te pe;
/*proc chart;
     hbar tm tl;
run;*/
proc chart;
     hbar te pe;
run;
```

APPENDIX 2. SAS program of multiplicative model for comparing fry (0+) density in 1992 to densities in prior years.

```
* cafsac.sas - restigouche electrofishing data, 0+ fry 1972 to 1992;

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 1992. Data sources given in Appendix 6.

	Matapedia		Upsalquitch		Patapedia		Kedgwick		Little Main		Main Restigouche	
Year	1SW	MSW	1SW	MSW	1SW	MSW	1SW	MSW	1SW	MSW	1SW	MSW
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	318	527	483	346	45	58	149	164	102	27	725	1120
1985	208	708	1175	507	103	85	329	184	163	50	1539	2781
1986	387	1293	1397	630	162	188	565	512	481	155	2421	3403
1987	498	817	819	410	193	77	582	410	407	142	2506	2220
1988	580	948	1296	659	188	104	807	708	524	74	3381	3060
1989	409	962	836	515	71	63	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
Mean (87-91)	545	905	852	431	113	64	436	465	249	86	2191	2240
1992/Mean	+27%	+7%	+38%	+30%	+8%	-11%	-4%	-31%	-4%	+64%	-4%	+3%

a Prior to 1982 Little Main catches included in Main Restigouche.

b Catches of MSW salmon (1984 to 1992) include released fish in New Brunswick.

APPENDIX 4

Native salmon landings from Baie des Chaleurs and Restigouche River, 1975 to 1992. Data sources given in Appendix 6.

	New Brunswick			Quebec			
Year	1SW	MSW	Total	1SW	MSW	Total	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
1987	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
Mean (87-91)	89	543	632	9	996	1005	1638
1992/Mean	-98%	-15%	-26%	+489%	-5%	0%	-10%

APPENDIX 5

Operating dates of Native fisheries in Baie des Chaleurs and Restigouche River, 1979 to 1992. Data sources given in Appendix 6.

	New Brunswick		Quebec
Year	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

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 angling catch 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: for 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 1991 from O'Neil (pers. comm.).

Québec, 1970 to 1991: 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: for 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 1991 from Department of Fisheries and Oceans, Protection and Regulations Branch, (R. Roy, R. MacNair and R. Senechal, pers. comm.).

Québec: for 1976 to 1984 from Gaudreault (1984); 1985 to 1991 from Ministère du Loisir, de la Chasse et de la Pêche, Québec (G. Landry, pers. comm.).

4. All 1992 data are preliminary as described in text.