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DFO Atlantic Fisheries
Research Document 94/3

MPO Pêches de l'Atlantique
Document de recherche 94/3

STATUS OF ATLANTIC SALMON IN THE NEPISIGUIT RIVER, NEW BRUNSWICK IN 1982 - 1993

by

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Abstract

Angling catch of small salmon was 470 removed and 85 released which was the fewest number caught since 1985. Large slmon releases were 258 salmon which was similar to 1992 but was also the fewest number caught since 1985. Spawning requirements for the Nepisiguit River are 1363 large salmon and 690 small salmon. Total returns were based on fence counts, adjusted for periods of non-operation based on angling catch, estimates of spawning below the fence based on redd counts, angling catch, and other removals. Fence counts of large salmon in 1993, were similar to 1990 and 1991 and nearly twice 1992. For small salmon fence counts were less than 1990-1992. Large salmon spawners did not meet requirements in 1993 but were more than twice the number of spawners in 1992. Small salmon requirements were exceeded by twice the target escapement. Large salmon targets have been met twice since 1982, while small salmon targets have been met nine times out of 12 since 1982. A Ricker stock recruitment curve was developed that indicated maximum recruitment for large salmon plus small salmon occurs at less than 2.4 eggs/m^2. Large salmon maximum recruitment alone occurs at less than 2.0 eggs/m^2. Pre-season forecasts based on the Ricker curve and a probability distribution function model indicate that large requirements will probably not be met in 1994. In-season management seems to be possible for the Nepisiguit River.

Résumé

Les prises de petit saumon par les pêcheurs à la ligne, les plus basses depuis 1985, s'établissaient à 470 retraits et 85 captures avec remise à l'eau. Pour ce qui est du grand saumon, les remises à l'eau se chiffraient à 258, soit le même nombre qu'en 1992 et aussi le plus bas depuis 1985. Dans la rivière Nepisiguit, les besoins de géniteurs se chiffrent à 1 363 grands saumons et à 690 petits saumons. Les remontées totales ont été établies d'après le décompte effectué à la barrière de dénombrement, corrigé pour les périodes où celle-ci n'était pas en fonctionnement (telles que révélées par les prises de la pêche à la ligne), d'après les estimations de frai en aval de la barrière (telles que révélées par le dénombrement des sillons), d'après les prises des pêcheurs à la ligne et d'après les autres retraits. En 1993, les dénombrements de grands saumons à la barrière étaient comparables à ceux de 1990 et de 1991 et atteignaient presque le double de ceux de 1992. Dans le cas du petit saumon, ces dénombrements étaient inférieurs à ceux de la période 1990-1992. Chez les grands saumons, on n'a pas atteint les besoins de géniteurs en 1993, mais le nombre de ces derniers représentait plus du double de celui de 1992. Le nombre de géniteurs parmi les petits saumons correspondait au double des besoins-cibles. En ce qui concerne les géniteurs, depuis 1982 la cible a été atteinte deux fois chez les grands saumons et neuf fois sur douze chez les petits saumons. Une courbe de recrutement de Ricker situait le recrutement maximal des saumons, grands et petits confondus, à moins de 2,4 oeufs/m^2 et celui des grands saumons exclusivement à moins de 2,0 oeufs/m^2. Selon les prévisions d'avant-saison fondées sur la courbe de Ricker et selon un modèle de la densité de probabilité, les besoins-cibles importants ne seront sans doute pas comblés en 1994. La gestion en saison paraît possible en ce qui concerne la rivière Nepisiguit.

1. Introduction

Atlantic salmon naturally occur in the lower 32 km of the Nepisiguit River as well as in its tributaries, Pabineau River and Gordon Meadow Brook. In 1969, a waste sulfide spill from a mining operation killed many juvenile salmon and caused returning adults to avoid the river.

Stocking of juvenile salmon to the Nepisiguit system commenced in 1974 with the objective of restoring the population. Most of the juveniles originated from the Charlo hatchery but in the 1970's some were stocked from the Miramichi hatchery. Since 1985 the Nepisiguit Salmon Association has supplemented this stocking effort by streamside incubation of eggs supplied by the Charlo hatchery. To date, approximately 7 million juvenile salmon ranging in age from swim-up fry to smolt have been stocked to the Nepisiguit and its tributaries (Table 1).

In the early years of the project, most of the stocked fish were descended from Restigouche and to a lesser extent from Miramichi broodstock. One reason for the use of Restigouche River salmon was to enhance the early run of salmon in the Nepisiguit River. Since 1987 all of the broodstock have been collected from the Nepisiguit.

Until 1985, juveniles were stocked both upstream and downstream of Grand Falls. The Nepisiguit River and its tributaries upstream of Grand Falls contain suitable juvenile rearing habitat but are not utilized for spawning because the falls are impassable to salmon. Since 1986, juveniles have been stocked only in the part of the system naturally accessible to salmon.

Since 1982, a salmon counting fence has been operated on the river by the Nepisiguit Salmon Association (in 1992 and 1993, in collaboration with Pabineau First Nation). The data from this fence, combined with angling and commercial fishery data, provide an opportunity to assess returns to the river and review the stocking program. Formal population assessments have been published only for the 1983 and 1984 seasons (Lutzac 1984, 1985). This report provides an overview of the restoration project and presents an assessment of salmon returns to the river from 1982 to 1993. Historical angling and commercial data are also summarized.

Unless otherwise noted, the data used in this review were obtained from the annual reports submitted to D.F.O. by the Nepisiguit Salmon Association, which supervised operation of a counting fence, redd counts and collection of angling and electrofishing data from 1982-1991, and jointly with the Pabineau First Nation in 1992 and 1993. Other sources of data include angling and commercial fishery data reports published by D.F.O. ((Dunfield, 1973, 1974, 1975, 1976, 1977; Mitham and Bernard 1978, 1979; O'Neil and Bernard 1983; O'Neil and Swetnam 1984; O'Neil et al. 1984, 1985a,b, 1986 1987, 1989, 1991; Smith 1981; Smith and Bernard 1980; Swetnam and Bernard 1981, 1982; Swetnam and O'Neil 1984, 1985; Wykes and Dunfield 1971, 1972; Wykes 1970a,b,c)

2. Terminology

This report will use the term 'small salmon' for adults less than 63 cm in fork length. This category includes 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).

3. Egg deposition requirements

The target egg deposition for the Nepisiguit River is **9.535 x 10^6 eggs (1,363 large, 690 small salmon)**. This estimate is based on the following;

- accessible rearing habitat = 3.973 x 10^6 m^2 (Anon. 1978)
- optimal egg deposition = 2.4 eggs·m^{-2} (Elson 1975)
- average fecundity of females = 1,760 eggs.kg^{-1} (Appendix 1)
- proportion of females in large salmon population = 0.71 (Appendix 1)
- mean weight of large salmon = 5.6 kg (weights estimated at fence)

4. Methods

4.1. Estimation of salmon abundance

4.1.1 Salmon counts at the fence

The counting fence was operated from 1981 to 1993, generally from late May or early June until late October or early November (Table 2). In 1981 many fish avoided capture in the fence, which only partially blocked the river. Consequently population abundance was not assessed in this year. In subsequent years the fence spanned the entire river. From 1982 to 1991, the fence was located at Sucker Pool, 1.5 km below the mouth of the Pabineau River. In 1992 and 1993, the fence was operated jointly by the Nepisiguit Salmon Association and the Pabineau First Nation, and was moved to a location on the reserve, 0.5 km below the mouth of the Pabineau River, just above Long Pool (Figure 1). The width of the river is 129 m at the 1981-91 site and 110 m at the 1992 and 1993 site.

Salmon captured at the fence during their upstream migration were counted, measured, a scale sample was collected and fish were externally sexed. The presence of nose tags, Carlin tags or adipose fin clips, indicating hatchery origin, was noted. Salmon were released above the fence or retained as broodstock for the Charlo hatchery.

Interruptions in the operation of the fence in several years mean that more fish reached the upstream side of the fence than were actually counted. For example, in each of 1984, 1987, 1989 and 1990 the fence was not blocking the river continuously (Table 2), usually for several days at a time because of heavy rains or to reduce physiological stress on fish during low or warm water conditions. More serious interruptions occurred in 1991, when the fence operated only four days a week through July and August. In both 1990 and 1991, the fence operated only until early September, thus the fall run of fish was not counted. In 1993, bent conduit severely compromised the fishing efficency of the trap during a large part of the season.

For the 1990, 1991 and 1993 seasons, total counts at the fence have been estimated using the relationship of counts at the fence to angling catch above the fence.

4.1.2. Sources of mortality

Angling data were collected for the entire system, and the distribution of angling above and below the fence was calculated based on returns of scale samples by anglers. Angling mortality of released fish was calculated taking into account an assumed 3% hook-and-release mortality rate. Angling statistics used for 1951-1983 and 1985 were those collected by D.F.O. Conservation and Protection (C&P) Branch. Statistics for 1984 and 1986-1993 were collected by the Nepisiguit Salmon Association.

A commercial salmon fishery was conducted locally until 1984, with a closure from 1972-1980. Other local sources of salmon mortality include bycatch mortalities in other commercial fisheries, and First Nation harvest. The extent of the latter two sources of mortality is unrecorded for the years 1981-1992. In this assessment, First Nation harvest for this period is assumed to be 200 fish per year, targetted 75% on large salmon, and distributed above and below the fence in the same proportions as the angling catch. Commercial catches from 1972-1980 are estimated by-catch during the closure.

4.1.3. Redd counts

Salmon spawn both upstream and downstream of the fence. In most years, redds were counted in early November, in the Nepisiguit River both above and below the fence and in two tributaries, Pabineau River and Gordon Meadow Brook. Relative numbers of redds above and below the fence were used to estimate the number of spawners below the fence, assuming that fish spawning in the two areas produce similar numbers of redds per fish. Absolute numbers of redds were not used to determine the total number of spawners since the area surveyed was not constant from year to year.

The relationship between number of redds counted above the fence, and number of fish counted at the fence was determined using redd counts from Knight's Brook to the fence, an area which was consistently surveyed in 1983-1989. Sex ratios of 71% females for large salmon, and 17% females for small salmon were assumed (Appendix 1). It was further assumed that large and small individuals would produce similar numbers of redds per female. The total number of redds counted was regressed on the number of female salmon counted at the fence.

4.2. Calculation of spawning escapement and returns

(1) Spawning escapement above the fence

Spawners = salmon counted at fence - (broodstock removals + mortalities at fence + angling mortality + First Nation harvest)

(2) Spawning escapement below the fence

Spawners = (spawners above fence) x average (redd count below fence) / (redd count above fence)

(3) Returns = spawners + angling mortality + First Nation harvest + commercial harvest.

Returns and spawning escapement prior to 1982 were determined using commercial and angling catches. Commercial catches from 1967-1971 were assumed to be 90% large salmon based on the similarity to mean weights in other areas (Gulf Nova Scotia) which harvested this percentage of large salmon at this time. From 1972-1984 commercial catches were assumed to be 71.3% small salmon based on Lutzac (1985). Proportion of commercial catch of Nepisiguit River origin as determined by Lutzac (1985) was used to estimate this portion of total returns. The mean angling exploitation rate for 1982-1992 (30%) was used to estimate in-river returns for 1967-1981. These values were added together to obtain total returns. Total potential spawners were estimated by subtracting removals from the total return estimate.

Lutzac (1985) had reported 2 year old smolts to predominate on the Nepisiguit (80% of total). Therefore, recruits from spawners were lagged 4 years for small salmon and 5 years for large salmon.

4.3. Egg production relative to CAFSAC guidelines

The calculated spawning escapement was used to calculate the total number of eggs spawned, which was then compared to the CAFSAC requirement for egg production, 9.535×10^6 eggs. Number of eggs spawned was calculated as:
(large spawners x 5.6 kg x 71% females x 1760 eggs/kg) + (small spawners x 1.4 kg x 17% females x 1760 eggs/kg).

Total egg depositions were divided by rearing habitat to convert them to eggs/m^2 in the evaluation of spawning requirements.

4.4. Juvenile abundance

Estimates of juvenile abundance were obtained from electrofishing surveys of 10 to 35 sites in the Nepisiguit River and its tributaries. Densities were calculated by the removal method (Zippin 1956). Data from 19 sites which were sampled five or more times between 1982 and 1993 were used to examine trends in abundance over time. Abundances were also compared among tributaries (Pabineau River and Gordon Meadow Brook) and the Nepisiguit River below Grand Falls, the upper limit of natural salmon spawning.

4.5. Run timing

Early and late runs were distinguished by plotting the average proportion of returns to the fence, by week, averaged over all years but 1990, 1991 and 1993 for weeks 25 to 42 (these weeks were sampled fairly consistently in each year).

Annual variations in run timing were examined by (1) plotting the returns of salmon to the fence for each of the years 1982-1993, and (2) determining the date on which 50% of the salmon returning to the fence in each year had been counted.

4.6. Returns and run timing of hatchery-stocked salmon

Counts of adipose-clipped salmon returning to the fence were used to estimate the returns of hatchery stock. These are conservative estimates of hatchery returns since not all hatchery fish were marked (Table 1). All stocked parr and smolt were adipose fin-clipped. Fingerling (7 cm) fry were marked in some but not all years, and no smaller (swim-up or feeding) fry were marked.

Run timing of adipose-clipped fish was compared to that of the whole population.

4.7. Trends in angling catch and effort

Angling exploitation rate was calculated in two ways:

(1) Exploitation rate for the whole river = total angling mortalities / total returns

(2) Exploitation rate above the fence = angling mortalities above the fence / number of fish released from the fence.

Angling mortalities above the fence were calculated as: total angling mortalities x proportion of total angling which occurred above the fence.
Number of fish released from the fence = total counts at fence - mortalities at fence - broodstock removals.

Catch per unit effort (CPUE) was calculated for bright fish only. Fish angled in April and May were assumed to be kelts. Total CPUE was determined by dividing the total retained catch of large and small bright salmon by the total rod-days.

Monthly angling catches recorded by D.F.O. C&P were used to assess the early run component of angling catch. The proportion of angling catch attributable to early-run fish (following section 4.5) was calculated for each year. CPUE of early-run fish was also calculated.

4.8 Spawning Requirements

A Ricker functional relationship between eggs and recruits as Recruits=Eggs*exp(**a***(1-(Eggs/**b**)) was used to examine spawning requirements; **a** and **b** are Ricker parameters describing the initial slope and equilibrium conditions (Hilborn and Walters 1992).

4.9 Forecasts

Three methods were compared for the ability to provide pre-season forecasts of large salmon returns. The first used grilse in one year to predict salmon the next year with a probability distribution function model as is used for the Miramichi River (Claytor et al. 1993). Returns based only on counting fence data from 1982-1993 were used in this analysis. The second also used a probability distribution function model but used total eggs/m^2 to predict large salmon recruits. The third method also used the eggs to recruit relationship but assumed a Ricker functional relationship and used Bayesian techniques to estimate the parameters (Hilborn and Walters 1992). Each of these methods has the advantage of being able to report the results in terms of probabilities rather than point estimates.

The capability of providing in-season forecasts was evaluated using a probability distribution function model, similar to that used for the Miramichi River (Claytor et al. 1993). This model utilizes returns seen to date to predict future returns. It weights the pre-season forecast more heavily at the beginning of the season and less as in-season information accumulates. Data from 1982-1992 was used for this analysis as 1993 run-timing data was not available.

5. Results

5.1. Estimation of salmon abundance

5.1.1. Salmon counts at the fence

The relationship between angling catch above the fence and salmon counted at the fence in 1982-1989 and 1992 was significant, and consequently the regression equations were used to estimate counts at the fence for 1990, 1991 and 1993. For large salmon, the R^2 was 0.92, and the resultant equation was:

FENCE COUNT = 6.47 (ANGLING ABOVE FENCE)

For small salmon, the R^2 was 0.81 and the regression equation was:

FENCE COUNT = 3.18 (ANGLING ABOVE FENCE).

Counts of salmon at the fence during the past decade have varied considerably. Salmon abundance was highest in 1986-1988 with maximum total counts of 2417 small and 1852 large salmon in 1988 (Table 3). Counts were substantially lower in 1989, particularly for small salmon, which declined to 476, but even large salmon were reduced by almost half to 1080. Small salmon numbers recovered in

1990 and 1991 (with the second-highest number of small salmon, 1796, being estimated for 1991), but large salmon numbers were similar to 1985-1986. Counts of small salmon in 1992 were 50% of those in 1990-1991 but 1993 fence counts were similar to 1990-1991.

5.1.2. Sources of mortality

Angling removals peaked in 1988, with 1000 small salmon being removed from the system (Table 4). Angling catch of small salmon in 1993 was the smallest in the past eight years, i.e. 47% of the maximum catch in 1988. The distribution of angling catch in the river (Table 5) has varied annually, with 22% to 50% of the catch being taken above the site of the counting fence. On average, 39.5% of fish were angled above the fence.

Both large and small salmon have been removed to the Charlo hatchery as broodstock (Table 6). Most of the fish used as broodstock have been collected at the counting fence during the early run, in an attempt to enhance the numbers of fish in the early run. Broodstock removals for the Charlo hatchery varied from 0 to 84 small salmon, and 68 to 164 large salmon (Table 6).

Few mortalities have been observed at the fence (Table 6).

A commercial harvest of up to 474 small and 68 large fish occurred from 1981 to 1984 (Tables 7,8).

Prior to 1993 there was no official estimate of First Nation harvest but it was believed to vary from 125-250 fish annually and to occur both above and below the counting fence. First Nation harvest for this period is assumed to be 200 fish per year, targetted 75% on large salmon, and distributed above and below the fence in the same proportions as the angling catch,

Large salmon: Above fence: 200 x .75 x .395 = 58
Below fence: 200 x .75 x (1-.395) = 92

Small salmon: Above fence: 200 x .25 x .395 = 19
Below fence: 200 x .25 x (1-.395) = 31

In 1993, harvest estimates made by First Nation fishery guardians were 200 (80%) small salmon and 50 (20%) large salmon. Distribution of 1993 harvest was calculated in the same fashion as previous years.

5.1.3. Redd counts

Despite changes in the area surveyed from year to year, the proportion of redds counted above and below the fence has varied relatively little (Table 9). The mean proportion (68.7%) of redds occurring above the fence was used in the calculation of spawning escapement. The most recent complete redd count data were collected in 1988.

Regression analysis of redd count above the fence on female salmon counted at the fence was significant with an R^2 of 0.68. The relationship was:

REDD = 504.541 + 1.0478 FEMALES.

5.2. Spawning escapement and returns

Calculated spawning escapements and returns for all years are summarized in Tables 10 and 11.

According to these calculations, spawning escapement in 1993 was 925 large and 836 small salmon (Table 12); thus, large salmon spawning requirements were not met, but small salmon requirements were exceeded. Large salmon requirements have been met only twice, in 1987 and 1988. Small salmon requirements have been met in 9 of 11 years.

5.3. Egg production relative to CAFSAC guidelines

Egg production has exceeded CAFSAC guidelines in only 1987 and 1988 (Table 13). Egg production of 60-90% of the guideline requirements occurred in 1985-1986, 1989-1991 and 1993. In 1982-1984 and again in 1992, egg production was approximately 30% of requirements or lower.

5.4. Juvenile densities

0+ parr, have shown an increased mean abundance in the past few years, however, no strong time trend in 1+ or 2+ parr abundance was shown (Fig. 2). Significant differences between tributaries occurred for both 0+ (mean abundance in Nepisiguit R. > Gordon Meadow Br. > Pabineau R.) and 2+ (Pabineau R. > Gordon Meadow Br. > Nepisiguit R.) parr (Appendix 2).

5.5. Run timing

Mean weekly fence counts of large and small salmon are presented in Figures 3 and 4. In both cases early and late runs were noted with the demarcation occurring at week 32 or 33 (i.e. at the end of August).

Run timing for the early returning large salmon was similar between hatchery and wild salmon. Timing of 50% of the run usually varies between day 180 and day 200, with some years as late as day 220 (Fig. 5). Similar trends have been observed for small salmon (Fig. 6). Run timing of early returning large salmon in 1991 was the latest in the time series with 1992 and 1993 being very similar (Fig. 5). For small salmon, early returning fish were also late in 1991 with 1989-1990 and 1992-1993 very similar (Fig. 6).

5.6. Returns of hatchery-stocked salmon

From 3 to 38% of large salmon, and 13 to 42% of small salmon returning to the fence were fin-clipped (Table 14). It is not possible to relate these numbers to real trends in the proportion of wild:hatchery salmon because of the variable proportion of marked salmon among the hatchery stock over time. The proportions presented in Table 14, however, underestimate the contribution of hatchery salmon because not all were fin-clipped.

5.7. Trends in angling catch and effort

Calculated exploitation rates for small salmon ranged from 8.5 to 62.3% for the whole river, and 5.1 to 50.0% for the area above the fence (Table 15). In 1982 and 1983, exploitation rates for large salmon were greater than those for small salmon (Table 15).

Exploitation of small salmon was highest in 1989, the year after peak returns were observed. Exploitation was also high in 1992, with approximately 41% of returning small salmon being removed, but declined in 1993 to 31%.

Total angling catch (released and retained) decreased sharply by the late 1960's and remained low until the early 1980's (Figure 7). Catch per unit effort (CPUE) was highest in the 1960's and lowest in 1970. CPUE has increased slightly in the past decade compared to pre-1980 levels.

The proportion of early-run salmon in the total retained small salmon catch has fluctuated between 0% and 50% since 1960 (Fig. 8). On average, the proportion increased in the early 1970's, but declined from 1985 to 1989. In contrast, CPUE of early-run fish increased slightly during the decade from 1978-1988 (Fig. 9). Monthly catch data are shown in Appendix 3.

5.8 Evaluating Spawning Requirements

Ricker relationships indicate that recruits are maximized at 2.4 eggs/m^2 or less for total returns, large salmon, and small salmon returns (Fig. 10).

5.9 Forecasts

High grilse returns are not indicative of high salmon returns and the relationships between grilse (year i) and salmon (year i+1) were not significant (Fig. 11).

In contrast, the two models utilizing eggs to salmon returns provided pre-season forecasts that were better than the mean. The probability distribution function model predicts about 800 salmon returning at egg depositions above 0.5/m^2 (Fig. 12). This model indicates a 40% probability of exceeding 1993 salmon returns in 1994.

The Ricker analysis predicts a decline in salmon returns with increasing egg depositions (Fig. 13). The probability distribution of the parameter estimates was used to determine the probability of exceeding last years returns with this model. This forecast was more pessimistic than the probability distribution function model and indicates a 30% chance of exceeding 1993 returns in 1994.

The in-season forecasting method provided improved forecasts over the pre-season forecasts for both early and total returns (Fig. 14). The best method for in-season forecasting is to provide a forecast of the early returns (prior to week 34) beginning in week 30 (July 23). Total returns to the river can be made beginning in week 36 (Sept. 3) (Fig. 14). An example of how these forecasts could be reported is provided in Fig. 15. This example indicates that as of week 36 this year there is a 50% chance of exceeding 1992 fence returns in 1993 (Fig. 15).

6. Conclusions

- Spawning escapement in 1993 was 925 large and 836 small salmon; thus, large salmon spawning requirements were not met, but small salmon requirements were exceeded. Egg deposition was 64% of requirements.

- CAFSAC egg deposition requirements have been exceeded in only 1987 and 1988, but egg deposition was at least 70% of requirements from 1985-1991.

- Large salmon requirements have been met only twice, in 1987 and 1988.

- Small salmon requirements have been met in most years.

- Hatchery stock have been 0-50% of small salmon early-run returns to the fence since 1982.

- Although total angling catches were higher in the 1980's, CPUE did not increase much relative to earlier decades, reflecting an increase in angling effort in the river.

- at least 50% of fish return to the Nepisiguit River after the end of August, during the late run period. Future assessment projects, including the counting fence, should take this into account and operate at least to mid-October.

- there is no evidence to increase spawning egg deposition targets from the current value of $2.4/m^2$.

- pre-season forecasts are improved by in-season models, further analysis is required to determine if predictions earlier than the end of July are possible.

7. Acknowledgements

Much of the data used in this report was collected by the Nepisiguit Salmon Association (1981-1993), in cooperation with the Pabineau First Nation (1992-1993). These projects were funded by Fisheries and Oceans, Canada Employment and Immigration Commission, N.B. Department of Labour, N.B. Salmon Council, N.B. Department of Natural Resources, Brunswick Mining and Smelting, and the Atlantic Salmon Federation. Tim Lutzac acted as the scientific authority for the projects.

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STOCK: Nepisiguit River, SFA 15
TARGET: 9.6 million eggs (1363 large salmon, 690 small salmon)
REARING AREA: 3,973,000 m^2, 30% of SFA 15, 4% of Gulf New Brunswick

	1988	1989	1990	1991	1992	1993	MIN[1]	MAX[1]	MEAN[2]
Angling									
Large (Released)	600	490	300	300	270	258	0	600	392
Small (Retained)	1000	600	500	700	800	470	0	1000	720
First Nations' Harvest									
Large	n/a	n/a	n/a	n/a	n/a	50			
Small	n/a	n/a	n/a	n/a	n/a	200			
Spawning escapement									
Large	2381	1239	1117	1026	336	925	109	2381	1220
Small	2900	309	1593	2164	1092	836	309	2900	1612
Total returns									
Large	2700	1568	1390	1290	642	7084	545	2700	1518
Small	4057	968	2152	2930	1974	1511	562	2930	2416
% egg target met									
	187	92	89	85	29	72	9	187	96

[1] Min, Max for the period from 1982 to 1993.
[2] Mean for the period from 1988 to 1992.

__Landings__: Small and large salmon recreational catches were the lowest since 1986.

__Data and assessment__: Salmon population and spawning escapement of the Nepisiguit has been estimated from returns to a counting fence in conjuction with harvest statistics. For the years 1990, 1991, and 1993 counting fence returns were estimated using the relationship between fence counts and angling catch above the fence. Spawning escapement above the fence was estimated using the distribution of spawning redds. Total returns below the fence were then calculated as the sum of spawning escapement plus removals.

__State of the stock__: The estimated spawning escapement of large salmon was 336 in 1992 and 925 in 1993, well below requirements for the system. In contrast, escapements of small salmon have exceeded requirements in the last four years.

__Forecast__: Ricker curve and probability distribution models indicate that returns in 1994 will most likely be between 800 to 1000 large salmon.

Table 1. Number of juvenile salmon stocked to the Nepisiguit system. Value in parentheses is percentage of salmon marked (AC=adipose fin clip, NT = magnetic wire nose tag, CT = Carlin tag). Source: 1976-1981, Newbould 1983; 1982-1993, Nepisiguit Salmon Association). Swim-up fry from streamside incubation boxes, all other life stages from hatcheries.

Year	Swim-up fry	Feeding fry (3 cm)	Fingerling fry (7 cm)	1+ parr	2+ smolt	YEARLY TOTAL
1974	---	numbers as yet undetermined				
1975	---	numbers as yet undetermined				
1976	----	----	78,196 (unmarked)	----	33,101 (100% AC)	111,297
1977	----	----	----	----	----	0
1978	----	----	166,283 (100% AC)	5,320 (100% AC)	----	171,603
1979	----	138,600 (unmarked)	86,947 (100% AC)	4,229 (100% AC)	2,002 (100% AC&CT)	231,778
1980	----	----	178,047 (100% AC)	6,978 (100% AC)	23,588 (100% AC&NT)	208,613
1981	----	176,440 (unmarked)	498,301 (100% AC)	3,819 (100% AC)	7,635 (100% AC&NT)	686,195
1982	----	----	293,140 (100% AC)	2,980 (100% AC)	----	296,120
1983	----	216,172 (unmarked)	298,453 (100% AC)	10,645 (100% AC)	10,454 (100% AC)	535,724
1984	----	65,576 (unmarked)	261,141 (100% AC)	18,667 (100% AC)	10,752 (100% AC&NT)	356,136
1985	25,669 (unmarked)	----	316,618 (100% AC)	11,153 (100% AC)	10,650 (100% AC)	364,090
1986	48,312 (unmarked)	98,734 (unmarked)	268,277 (unmarked)	2,540 (100% AC)	72,937 (100% AC&NT)	490,800

Table 1 (con't)

Year	Streamside incubation	Feeding fry (3 cm)	Fingerling fry (7 cm)	1+ parr	2+ smolt	YEARLY TOTAL
1987	144,450 (unmarked)	82,306 (unmarked)	206,814 (unmarked)	1,872 (100% AC)	10,706 (100% AC&NT)	446,148
1988	293,465 (unmarked)	141,000 (unmarked)	208,000 (unmarked)	----	10,000 (100%AC&NT)	652,465
1989	335,533 (unmarked)	----	284,004 (28% AC)	----	10,000 (100%AC&NT)	629,537
1990	342,981 (unmarked)	----	400,000 (35% AC)	6,500 (100%AC)	11,700 (100% AC&NT)	761,181
1991	243,016 (unmarked)	----	177,000 (100% AC)	----	9,700 (100% AC&NT)	429,716
1992	335,801 (unmarked)	118,542 (unmarked)	146,950 (10% AC)	12,441	11,641 (100% AC)	625,375
1993	336,277 (unmarked)	----	149,522 (65% AC)	30,944 (100% AC)	----	516,743

TOTAL STOCKED, 1976 - 1993: 7,513,521

Table 2. Dates of operation of the Nepisiguit counting fence, 1982-1993.

YEAR	OPERATION DATES
1982	May 28-Nov. 1
1983	May 26-Nov. 4
1984	May 27-30, June 4-Nov. 7
1985	May 30-Nov. 8
1986	June 2-Nov. 5
1987	June 4-July 12, July 17-Nov. 5
1988	June 3-Oct. 23
1989	June 5-Aug. 14, Aug. 17-Nov. 6
1990	June 15-July 25, Aug. 4-11, Aug. 26-Sept. 4
1991	July 22-July 5, July 9-12, July 16-19, July 23-26, July 30-31, Aug. 1-2, Aug. 6-9, Aug. 13-15, Aug. 19-22, Aug. 26-30, Sept. 3-13
1992	June 25-Oct. 23
1993	July 2-Oct. 25

Table 3. Salmon counts at the fence, subdivided into adipose fin-clipped (AC) and unclipped salmon.

	Small salmon			Large salmon		
Year	AC	not AC	Total	AC	not AC	Total
1982	211	784	995	138	234	372
1983	70	236	306	29	262	291
1984	125	831	956	102	310	412
1985	160	349	509	194	627	821
1986	496	913	1409	363	581	944
1987	734	1000	1734	477	905	1382
1988	552	1865	2417	460	1392	1852
1989	90	386	476	323	757	1080
1990*	65 (564)	87 (755)	152 (1319)	59 (303)	125 (641)	184 (944)
1991*	15 (226)	104 (1570)	119 (1796)	22 (175)	88 (698)	110 (873)
1992	182	930	1112	13	428	441
1993*	14 (100)	104 (742)	118 (842)	20 (80)	177 (709)	197 (789)

* bracketed numbers are adjusted counts at fence, obtained by regression analysis as explained in the text.

Table 4. Angling catch in the Nepisiguit River, 1951-1992. Based on DFO (C&P) statistics in 1951-1983 and 1985, Nepisiguit Salmon Association statistics in 1984 and 1986-1992.

(a) Data for bright and kelt fisheries, collected by DFO C&P, 1951-1983. All fish caught are assumed to have been killed.

Year	Bright Fish			Kelts			Total rod-days
	Small	Large	Total	Small	Large	Total	
1951	.	.	286	.	.	40	1776
1952	.	.	415	.	.	30	1765
1953	.	.	595	.	.	42	2035
1954	.	.	1255	.	.	42	1640
1955	.	.	783	.	.	148	2275
1956	.	.	389	.	.	117	1686
1957	.	.	590	.	.	135	3130
1958	.	.	963	.	.	85	3540
1959	.	.	376	.	.	85	2150
1960	.	.	193	.	.	50	905
1961	.	.	313	.	.	25	1360
1962	.	.	446	.	.	70	1570
1963	.	.	334	.	.	10	878
1964	.	.	232	.	.	213	557
1965	473	20	493	120	6	126	371
1966	407	38	445	.	.	354	818
1967	410	46	456	.	.	42	604
1968	189	5	194	.	.	55	551
1969	38	5	43	.	.	32	480
1970	2	0	2	.	.	0	97
1971	16	1	17	.	.	0	192
1972	16	10	26	.	.	0	165
1973	0	95	95	.	.	0	1000
1974	28	140	168	.	.	7	1227
1975	77	95	172	8	14	22	1457
1976	335	100	435	3	0	3	576
1977	28	38	66	0	0	0	678
1978	40	69	109	0	0	0	1215
1979	44	6	50	0	15	15	614
1980	135	103	238	.	.	.	1515
1981	130	179	309	46	62	108	1730
1982	130	187	317	25	30	55	1780
1983	117	176	293	.	.	.	1343

Table 4 (con't)

(b) Angling data collected by Nepisiguit Salmon Association (except 1985, which is based on DFO C&P data), showing removals and releases for the bright fishery.

	Removed		Released		
Year	Small salmon	Large salmon	Small salmon	Large salmon	Rod days
1984	600	0	150	150	3015
1985	229	0	--	--	1734
1986	800	0	400	500	3600
1987	800	0	550	500	4250
1988	1000	0	400	600	5000
1989	600	0	100	490	4000
1990	500	0	100	300	3400
1991	700	0	150	300	3700
1992	800	0	330	270	4700
1993	470	0	85	258	3300

Table 5. Distribution of angling above and below the fence, based on angler scale data returns.

	Large salmon		Small salmon		
Year	Above fence	Below fence	Above fence	Below fence	Combined % Above fence
1982	5	21	19	64	22.0
1983	3	8	5	4	40.0
1984	-	-	-	-	--
1985					
1986	-	-	15	43	25.9
1987	-	-	20	25	44.4
1988	-	-	16	28	36.4
1989	-	-	18	32	36.0
1990	-	-	26	33	44.1
1991	-	-	20	21	48.8
1992	-	-	36	36	50.0
1993	-	-	22	24	47.8

MEAN = 39.5 %

Table 6. Above-fence removals of salmon.

Year	Mortalities observed at fence		Broodstock removals	
	Small salmon	Large salmon	Small salmon	Large salmon
1982	0	0	84	68
1983	0	0	17	87
1984	7	1	4	92
1985	0	0	4	111
1986	1	0	5	104
1987	0	0	6	150
1988	0	0	5	151
1989	0	0	6	164
1990	0	0	6	114
1991	1	1	10	104
1992	6	1	16	147
1993	2	3	0	128

Table 7. Commercial catch in SD 65 of Nepisiguit River salmon, 1981-1984. Harvest statistics and estimated 1984 landings from Lutzac (1985). Landings for 1981-1983 estimated assuming 7.5% of small and 5% of large salmon harvest from SD 65 were Nepisiguit stock, and 71.3% of fish landed in 1981-1982 were small salmon (Lutzac 1985).

	Harvest in SD 65			Estimated Nepisiguit salmon	
Year	Small salmon	Large salmon	Total	Small salmon	Large salmon
1981	---	---	2576	138	37
1982	---	---	940	50	14
1983	700	462	1162	53	23
1984	6361	1365	7726	474	68

Table 8. Commercial catch in SD 65

Year	Monthly catch (kg)							Estim.	Nos.	Ave. wt.
	April	May	June	July	Aug.	Sept.	Oct.	Total		of fish(kg)
1967	0	0	6030.9	10226.6	4329.5	0	0	20587.0	4064	5.0
1968	0	95.0	5729.1	10018.2	3150.9	0	0	18993.2	3978	4.8
1969	0	0	3643.6	7576.8	1118.6	0	0	12339.1	3181	3.9
1970	0	88.4	2677.5	2783.6	325.0	0	0	5874.5	1287	4.5
1971	0	9.1	1410.5	4935.7	278.2	9.1	0	6642.5	1520	4.4
1972	0	0	90.0	0	0	0	0	90.0	36	2.5
1973	0	0	295.5	490.9	1181.8	750.0	0	2718.2	-	-
1974	0	0	8.6	47.7	0	0	0	56.4	16	3.5
1975	0	0	0	1315.9	1708.2	0	0	3024.1	876	3.5
1976	0	0	76.8	4905.0	1684.1	0	0	6665.9	3590	1.9
1977	0	46.4	706.8	1065.2	628.2	51.4	0	2497.7	898	2.8
1978	0	0	357.4	736.2	229.1	680.4	44.0	2047.1	1007	2.0
1979	0	0	339.7	386.5	365.1	18.1	0	1109.5	318	3.5
1980	0	0	596.2	1986.8	708.1	114.3	0	3405.5	1560	2.2
1981	0	0	1896.9	5056.0	57.2	0	0	7010.0	2777	2.5
1982	0	0	1736.5	2094.7	204.1	0	0	4035.3	1441	2.8
1983	0	0	1389.5	1937.3	0	0	0	3326.8	1162	2.9
1984	0	0	0	15006.6	0	0	0	15006.6	7726	1.9

Table 9. Redd counts in the Nepisiguit River and tributaries. Both tributaries are located below the fence. (--) indicates that no obsercations were made.

	Nepisiguit River				
Year	Above fence	Below fence	Pabineau River	Gordon Meadow Brook	% of redds above fence
1981	---	--	17	8	
1982	149	87	52	66	63.1
1983	1164	414	--	--	73.8
1984	1014	564	--	--	64.3
1985	1341	513	--	--	72.3
1986	2250	692	337	91	76.5
1987	2447	1383	158	64	63.9
1988	3017	1468	177	39	67.3
1989	732[a]	43[a]	--	--	--
1990	--	--	--	--	--
1991	--	--	--	--	--
1992	--	--	--	--	--
1993	1647	--	--	--	--
					Mean = 68.7%

[a] Incomplete counts

Table 10. Calculations of total returns and spawners for large salmon.

(a) Above the fence.

Year	[1] Returns to fence	[2] Brood-stock	[3] Mortality at fence	[4] Native harvest	[5] Angling mortality	[6]=[1]-[2] -[3]-[4]-[5] Spawners
1982	372	68	0	59	74	171
1983	291	87	0	59	70	75
1984	412	92	1	59	2	258
1985	821	111	0	59	0	651
1986	944	104	0	59	6	775
1987	1382	150	0	59	6	1167
1988	1852	151	0	59	7	1635
1989	1080	164	0	59	6	851
1990	944	114	0	59	4	767
1991	873	104	1	59	4	705
1992	441	147	1	59	3	231
1993	789	128	3	20	3	635

(b) Below the fence.

Year	[6] Spawners above fence	[7]=[6] x 0.425 Spawners below fence	[8] Angling mortality	[9] Native harvest	[10] Commer-cial harvest	[11]=[7]+[8] +[9]+[10] Returns below fence
1982	171	78	113	91	14	296
1983	75	34	106	91	23	254
1984	258	118	3	91	68	280
1985	651	297	0	91	0	397
1986	775	353	9	91	0	453
1987	1167	532	9	91	0	632
1988	1635	746	11	91	0	848
1989	851	388	9	91	0	488
1990	767	350	5	91	0	446
1991	705	321	5	91	0	417
1992	231	105	5	91	0	201
1993	635	290	5	30	0	295

Table 11. Calculations of total returns and spawners for small salmon.

(a) Above the fence.

Year	[1] Returns to fence	[2] Brood-stock	[3] Mortality at fence	[4] Native harvest	[5] Angling mortality	[6]=[1]-[2]-[3]-[4]-[5] Spawners
1982	995	84	0	20	51	840
1983	306	17	0	20	46	223
1984	956	4	7	20	239	686
1985	509	4	0	20	90	395
1986	1409	5	1	20	321	1062
1987	1734	6	0	20	323	1385
1988	2417	5	0	20	400	1992
1989	476	6	0	20	238	212
1990	1319	6	0	20	199	1094
1991	1796	10	1	20	279	1486
1992	1112	16	6	20	320	750
1993	842	0	2	79	187	574

(b) Below the fence.

Year	[6] Spawners above fence	[7]=[6] x 0.425 Spawners below fence	[8] Angling mortality	[9] Native harvest	[10] Commer-cial harvest	[11]=[7]+[8]+[9]+[10] Returns below fence
1982	840	383	79	30	50	542
1983	223	102	71	30	53	256
1984	686	313	366	30	474	1183
1985	395	180	139	30	0	349
1986	1062	484	491	30	0	1005
1987	1385	632	494	30	0	1156
1988	1992	908	702	30	0	1640
1989	212	97	365	30	0	492
1990	1094	499	304	30	0	833
1991	1486	678	426	30	0	1134
1992	750	342	490	30	0	862
1993	574	262	286	121	0	669

Table 12. Summary of total returns and total spawners for large and small salmon. Spawner numbers in bold type exceeded CAFSAC spawning escapement requirement (1363 large salmon, 690 small salmon).

Year	Large salmon		Small salmon	
	Returns	Spawners	Returns	Spawners
1982	668	249	1537	**1223**
1983	545	109	562	325
1984	692	376	2139	**999**
1985	1218	948	858	575
1986	1397	1128	2414	**1546**
1987	2014	**1699**	2890	**2017**
1988	2700	**2381**	4057	**2900**
1989	1568	1239	968	309
1990	1390	1117	2152	**1593**
1991	1290	1026	2930	**2164**
1992	642	336	1974	**1092**
1993	1084	925	1511	**836**

Table 13. Summary of egg production relative to CAFSAC spawning requirements of 9.535 x 10^6 eggs.

Year	No. of eggs ($x10^6$) Large salmon	Small salmon	Total	% of CAFSAC requirement met
1982	1.742	0.512	2.254	24
1983	0.763	0.136	0.899	9
1984	2.631	0.418	3.049	32
1985	6.634	0.241	6.875	72
1986	7.893	0.648	8.541	90
1987	11.889	0.845	12.734	134
1988	16.662	1.215	17.877	187
1989	8.670	0.129	8.799	92
1990	7.816	0.667	8.483	89
1991	7.180	0.906	8.086	85
1992	2.351	0.457	2.808	29
1993	6.472	0.350	6.822	72

Assumptions:
Mean weight (kg): large salmon, 5.6; small salmon, 1.4
% females: large salmon, 71; small salmon, 17
fecundity: 1760 $eggs.kg^{-1}$

Table 14. Monthly returns to the fence of adipose fin-clipped salmon. Numbers in parentheses are percentages of nose-tagged fish (included in adipose-clipped percentages).

(a) Percentage of adipose-clipped fish relative to all large salmon counted at the fence, by month.

	May	June	July	Aug.	Sept.	Oct.	Nov.	Total
1982	100	65 (3)	51 (3)	29 (3)	26	19 (1)	40	37
1983	100	5	13 (3)	29 (18)	9	11 (2)	0	10
1984	--	19	34	38	18	19	14	25
1985	--	48	32	21	13	12	0	24
1986	--	72	61	34	18	16	14	38
1987	--	58	58	36	30	22	0	34
1988	--	66	46	23	25	13	--	25
1989	--	62	36	35	23	15	12	30
1990	--	42	32	13	20	--	--	32
1991	--	40	29	21	7	--	--	20
1992	--	4	5	0	2	0	--	3
1993	--	--	15	7	6	0	--	10

(b) Percentage of adipose-clipped fish relative to all small salmon counted at the fence, by month.

	May	June	July	Aug.	Sept.	Oct.	Nov.	Total
1982	0	39 (11)	18 (2)	19	21 (3)	21 (3)	12	21
1983	--	18 (9)	37 (8)	25 (8)	19	8	0	23
1984	--	7	19	10	4	4	0	13
1985	--	100	49	12	13	3	0	31
1986	--	37	42	34	36	26	33	35
1987	--	78	62	48	26	17	0	42
1988	--	61	41	29	24	8	--	23
1989	--	54	32	6	15	15	0	19
1990	--	44	61	14	20	--	--	43
1991	--	0	0	14	7	--	--	13
1992	--	41	26	7	1	2	--	16
1993	--	--	20	4	0	5	--	13

Table 15. Angling exploitation rates calculated (1) for the whole river and (2) for the area above the fence.

	Large salmon exploitation (%)		Small salmon exploitation (%)	
Year	Whole river	Above fence	Whole river	Above fence
1982	28.0	19.9	8.5	5.1
1983	32.2	24.1	20.8	15.0
1984	----	----	28.3	25.0
1985	----	----	26.7	17.7
1986	----	----	33.6	22.8
1987	----	----	28.3	18.6
1988	----	----	27.2	16.5
1989	----	----	62.3	50.0
1990	----	----	23.4	15.1
1991	----	----	24.1	15.5
1992	----	----	41.0	28.8
1993	----	----	31.3	22.2

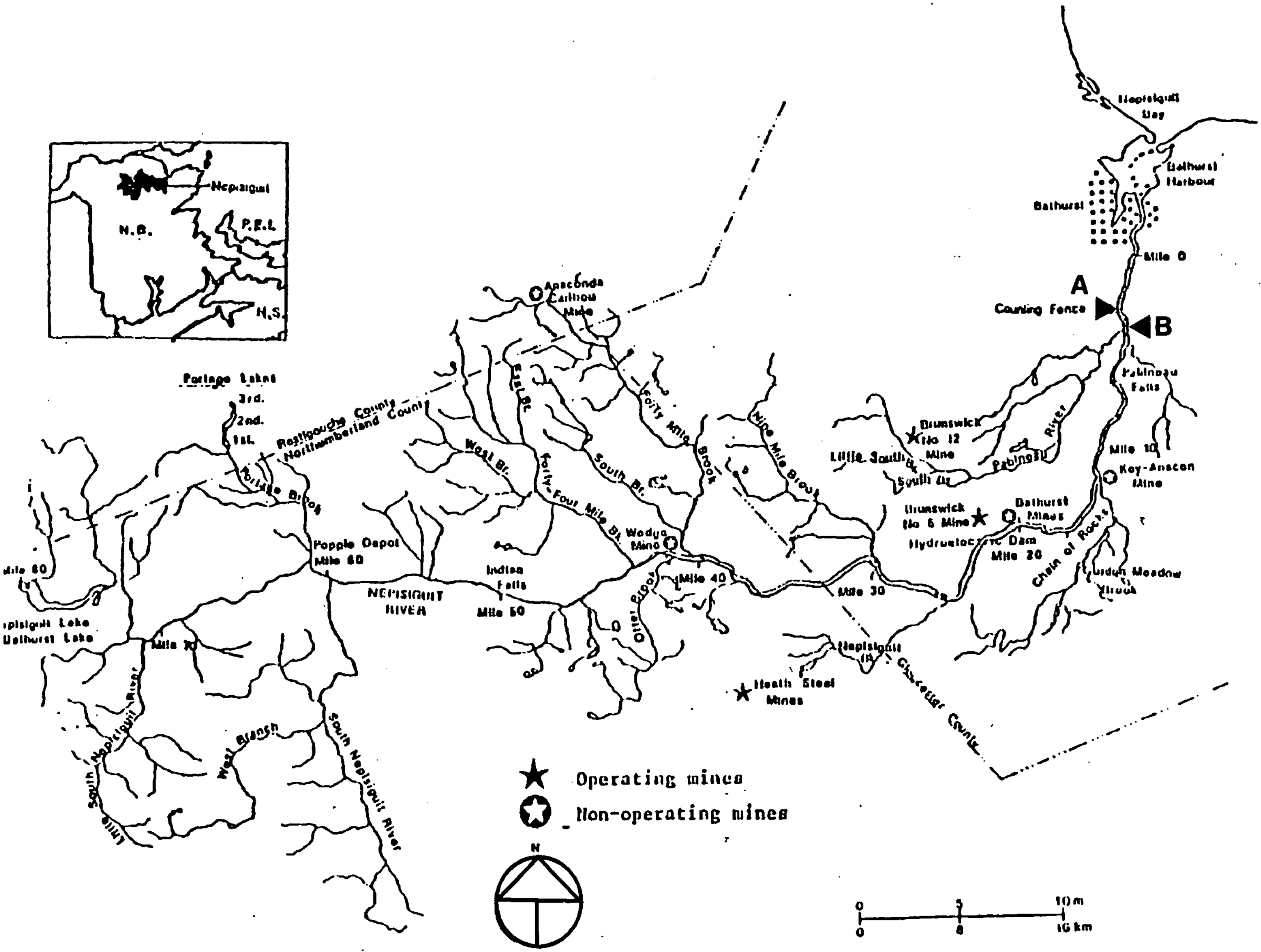


Figure 1. Map of the Nepisiquit River system, showing locations of the fence in 1981 - 1991 (A) and 1992-1993 (B).

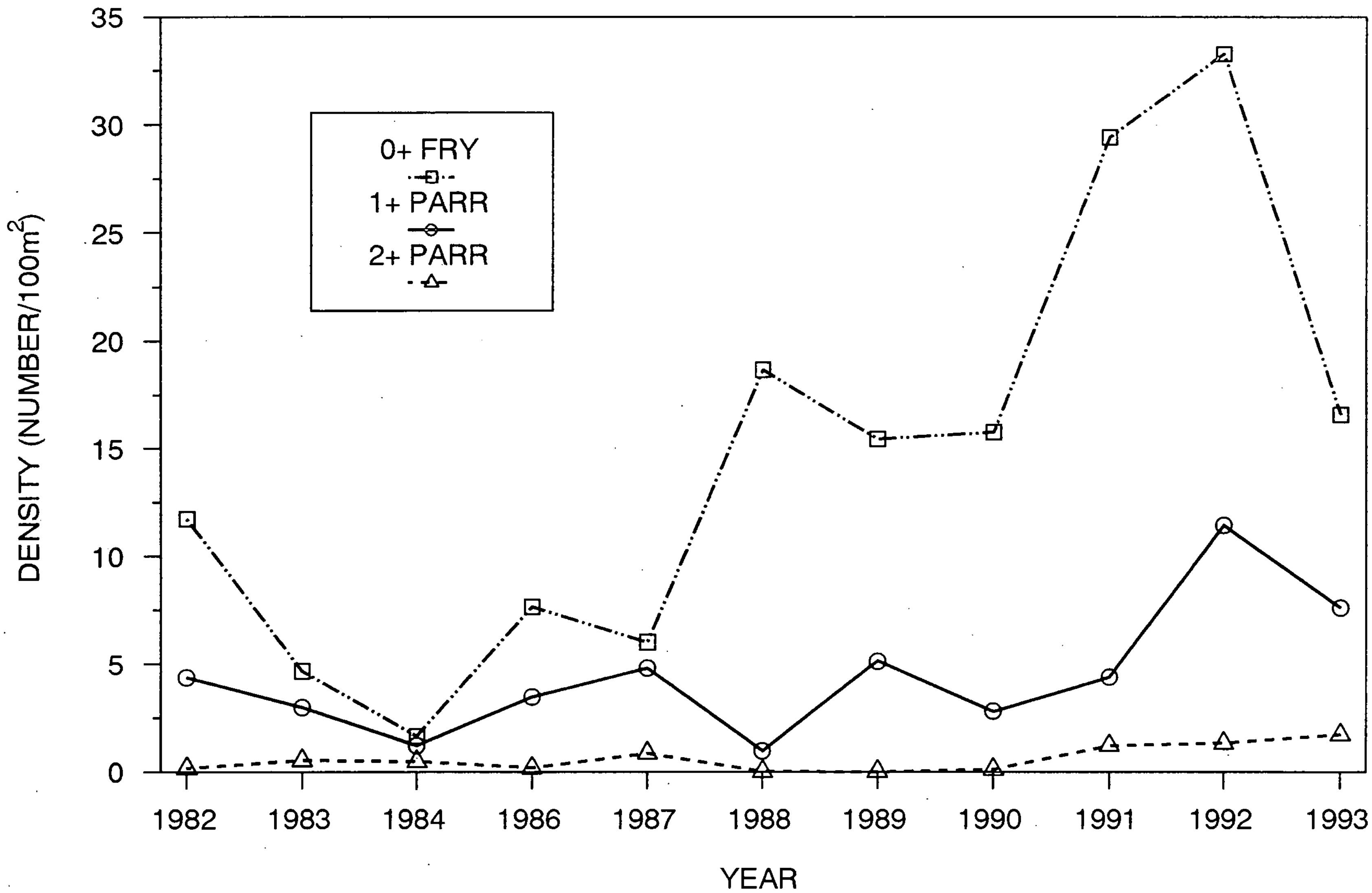


Fig. 2 Mean juvenile abundance at 19 electrofishing sites on the Nepisiguit River (below the dam), Pabineau River and Gordon Meadow Brook, sampled in at least five years from 1982-1993.

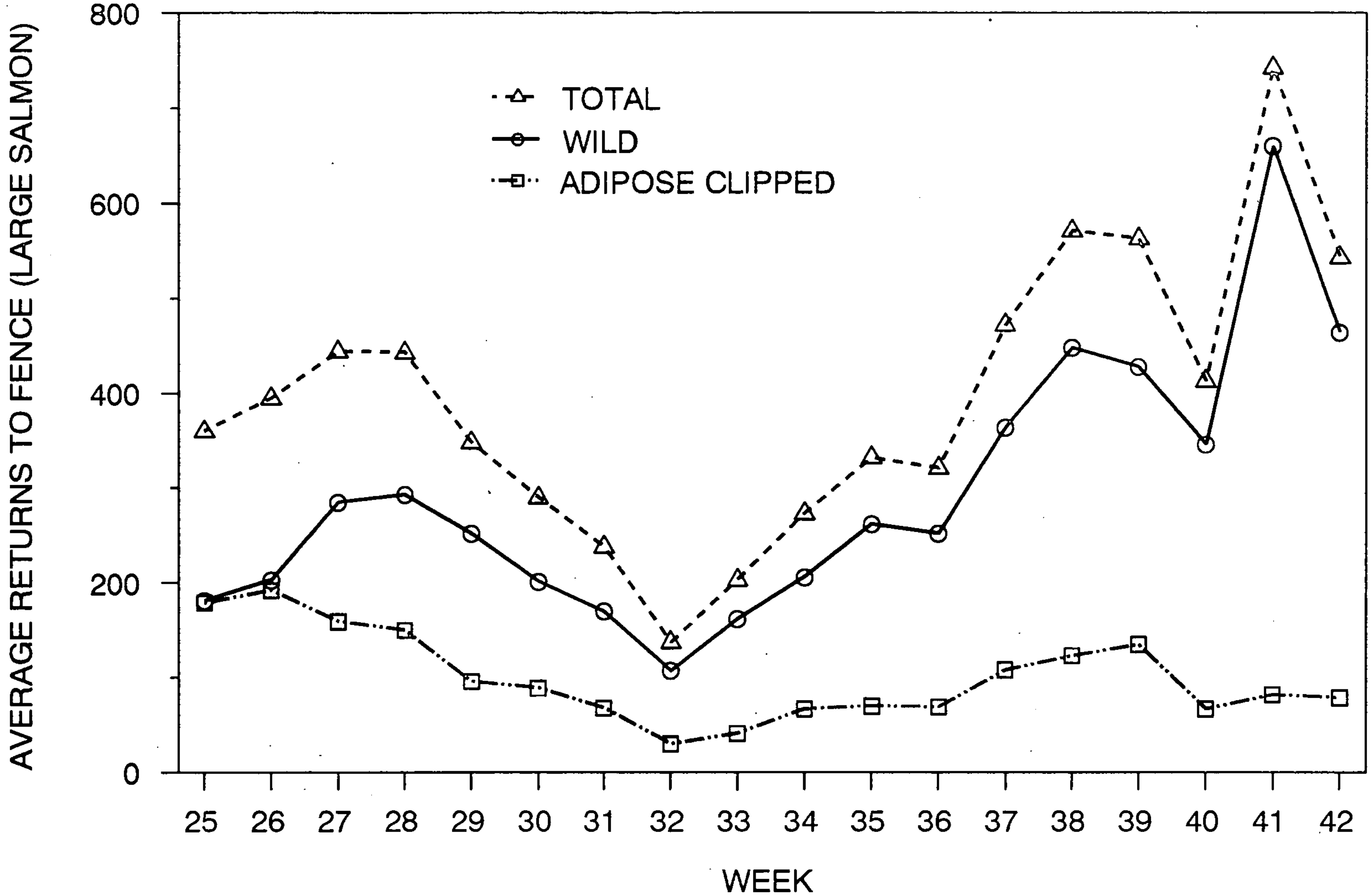


Fig. 3 Mean number of wild and hatchery large salmon returns to counting fence by week (1981-1993).

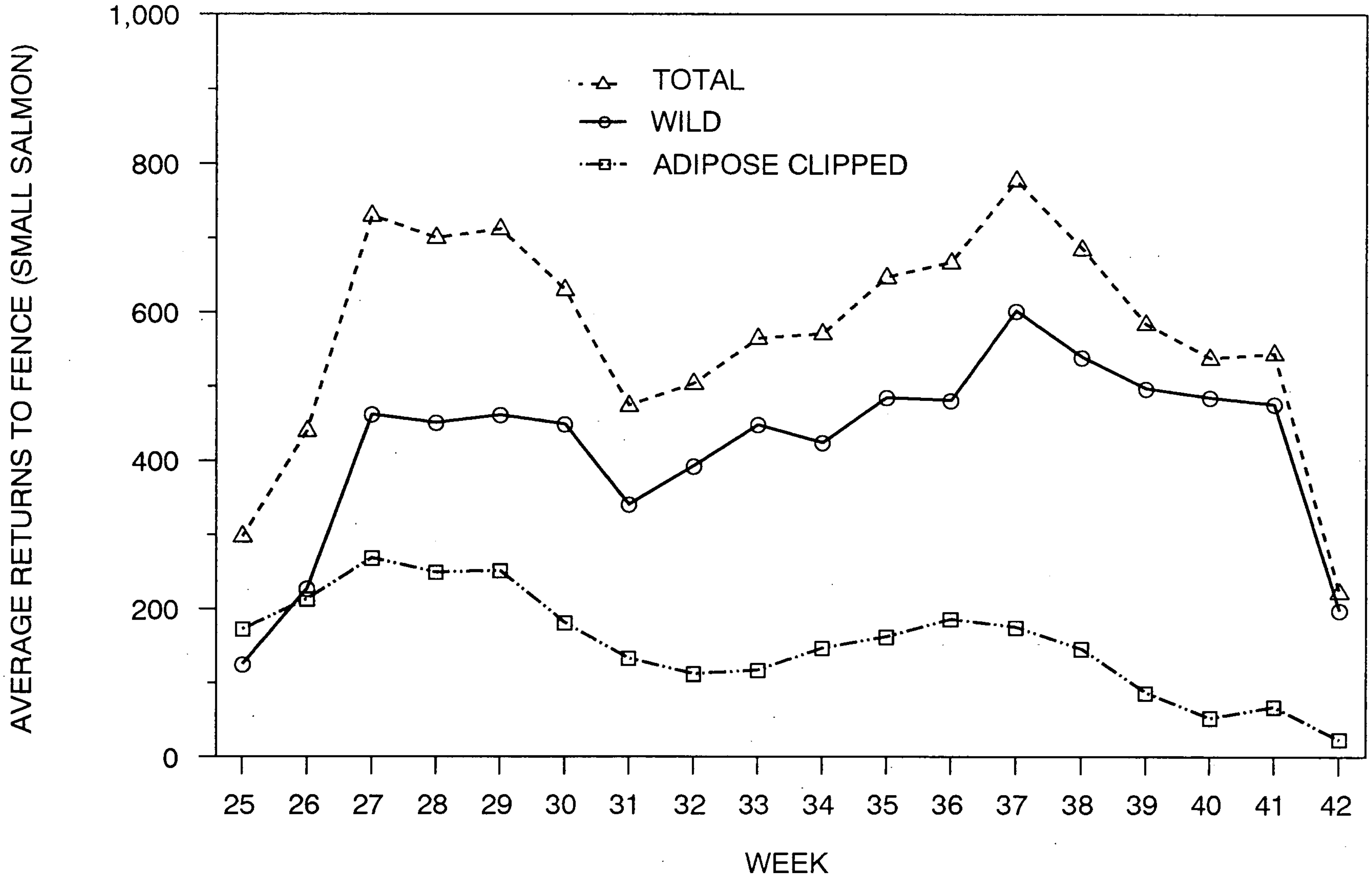


Fig. 4 Mean returns of wild and adipose clipped small salmon to counting fence by week (1981-1993).

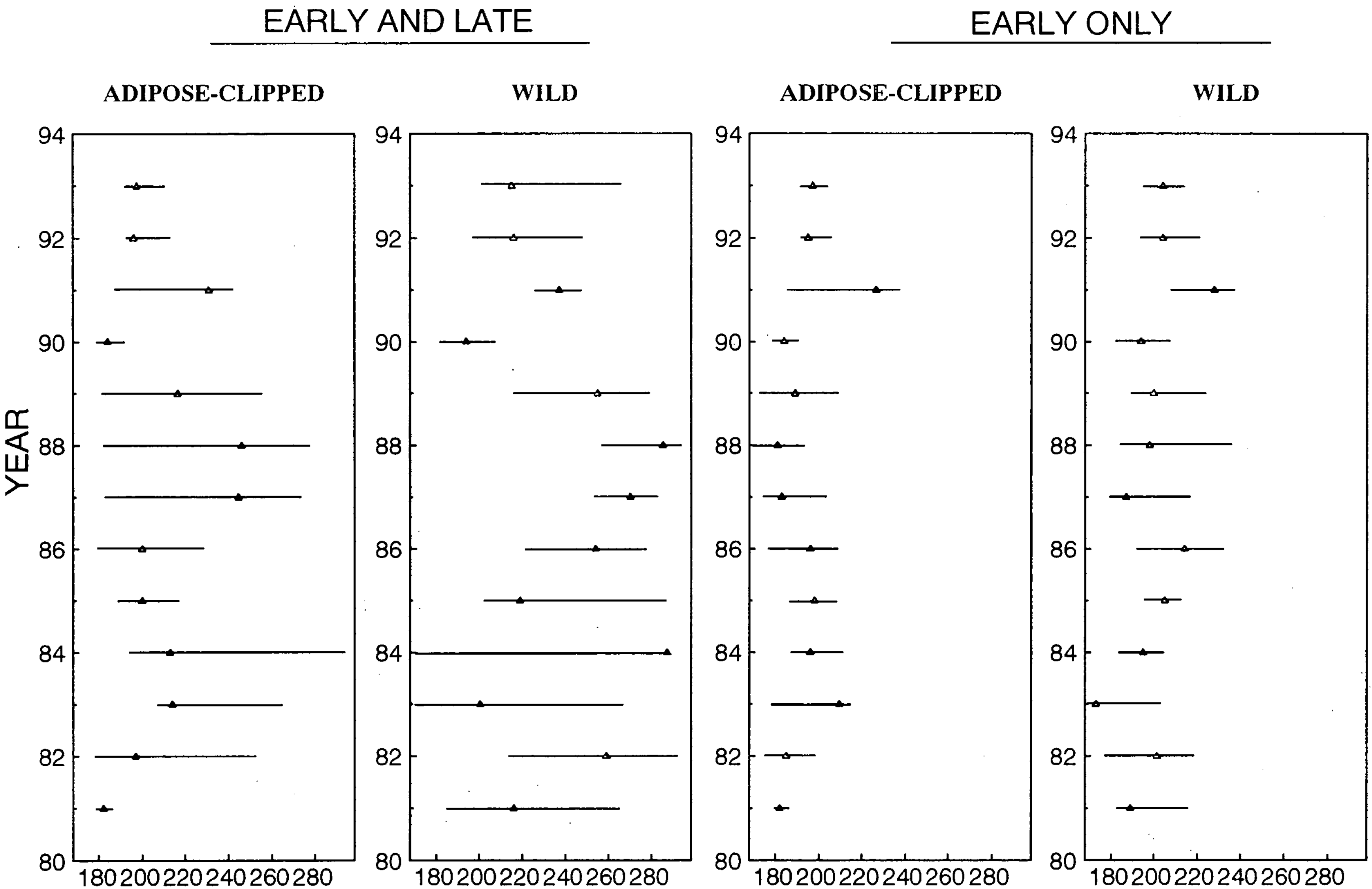


Fig 5. Timing of 50 % of large salmon counts (adipose clipped and wild) at fence for two time periods (1981-1993). Lines indicate the dates when 25% and 75% of total counts were attained.

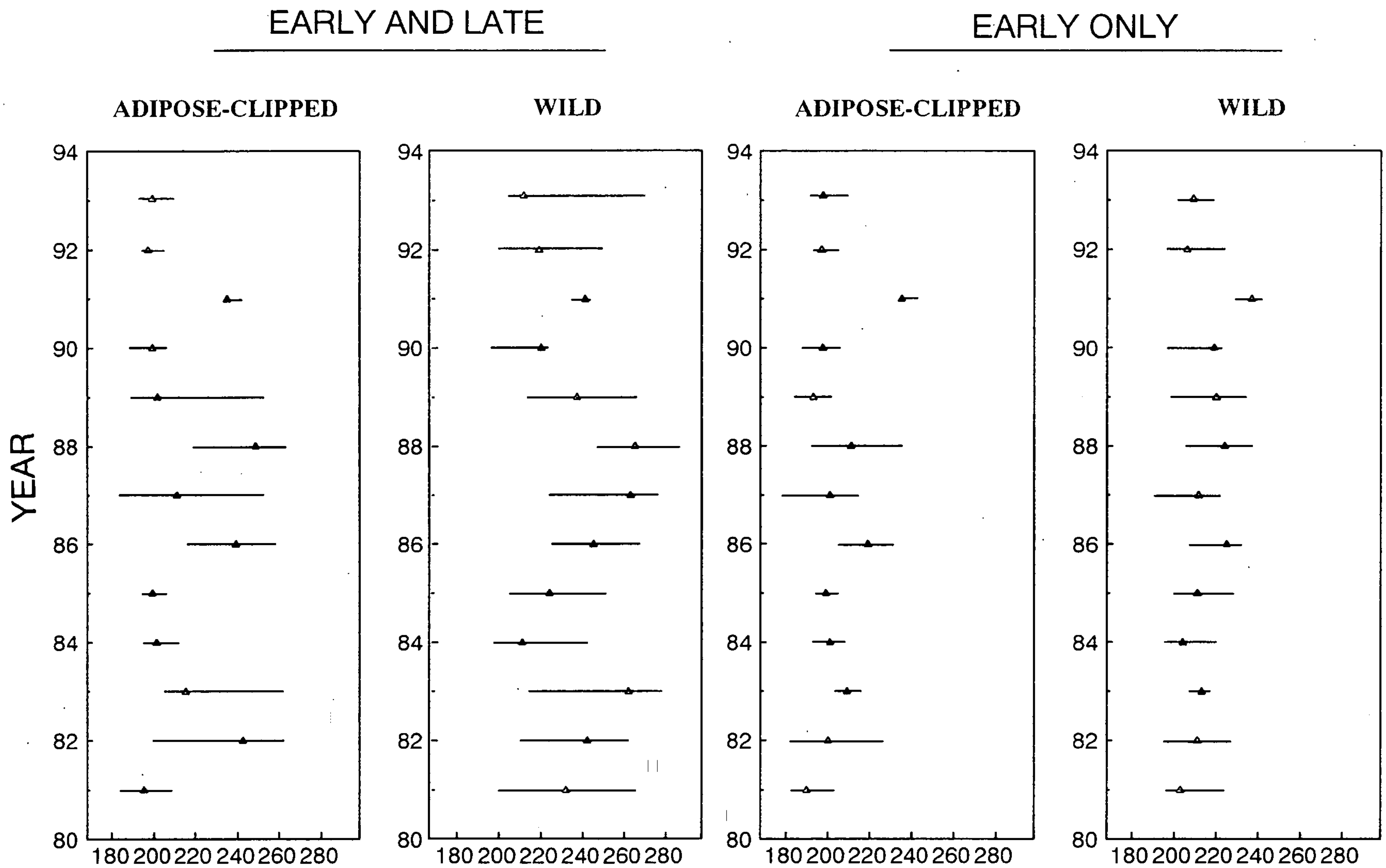


Fig 6. Timing of 50 % of small salmon counts (adipose clipped and wild) at fence for two time periods (1981-1993). Lines indicate the dates when 25% and 75% of total counts were attained.

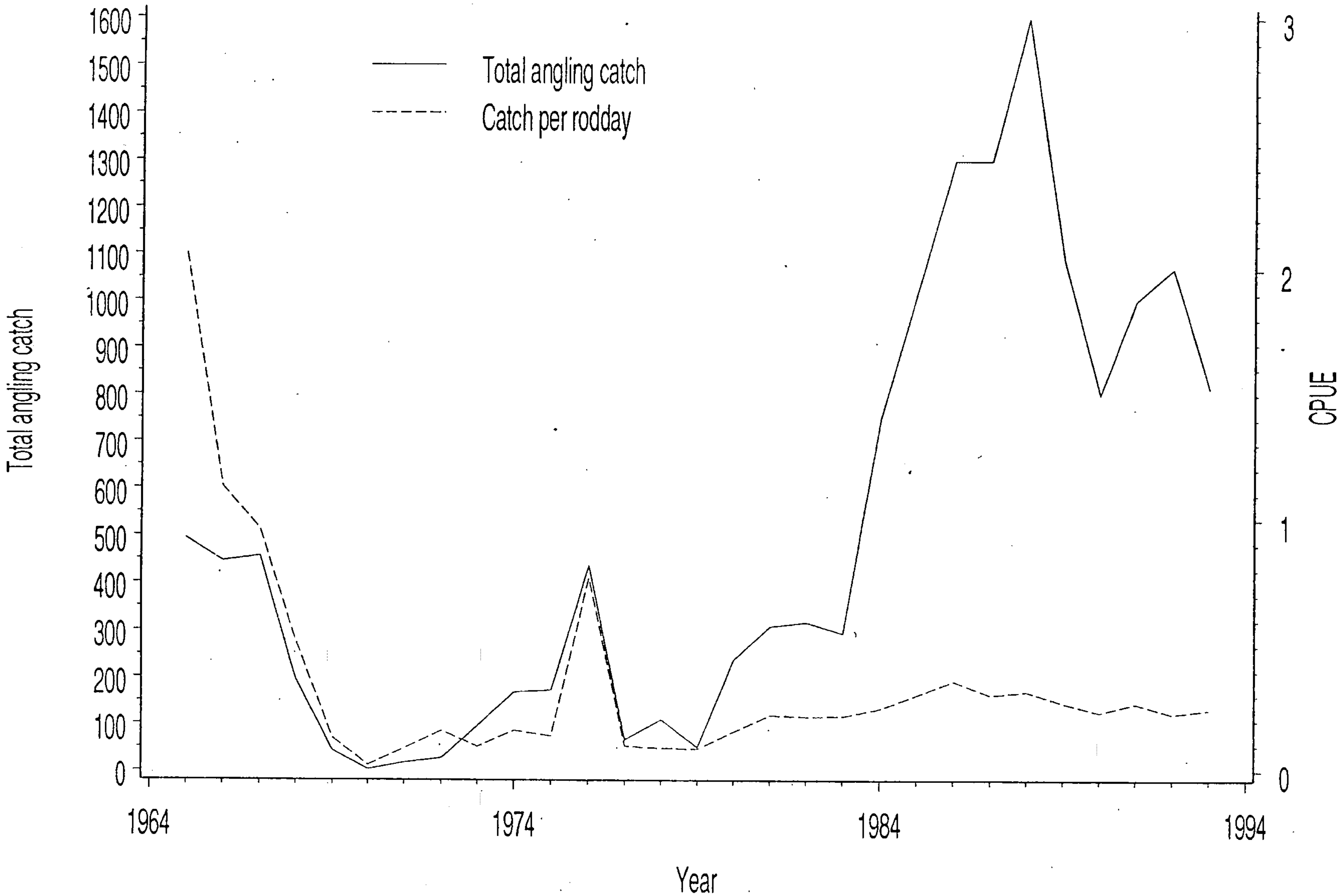


Fig. 7 Total angling catch and catch-per-rodday of Atlantic salmon on the Nepisiguit River, 1965-1993.

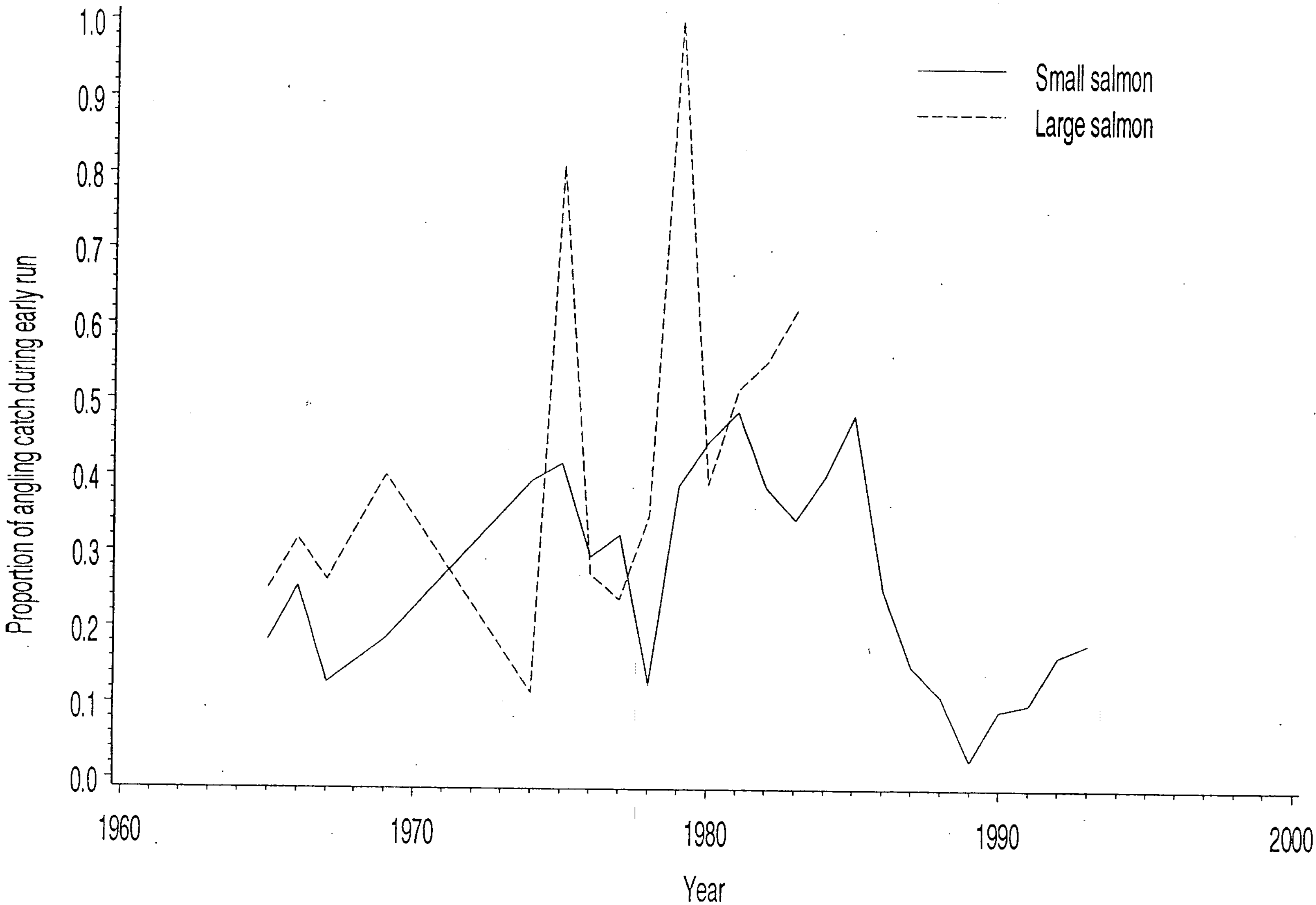


Fig. 8 Proportion of small and large salmon angling catches obtained during the early-run on the Nepisiguit River, 1965-1993.

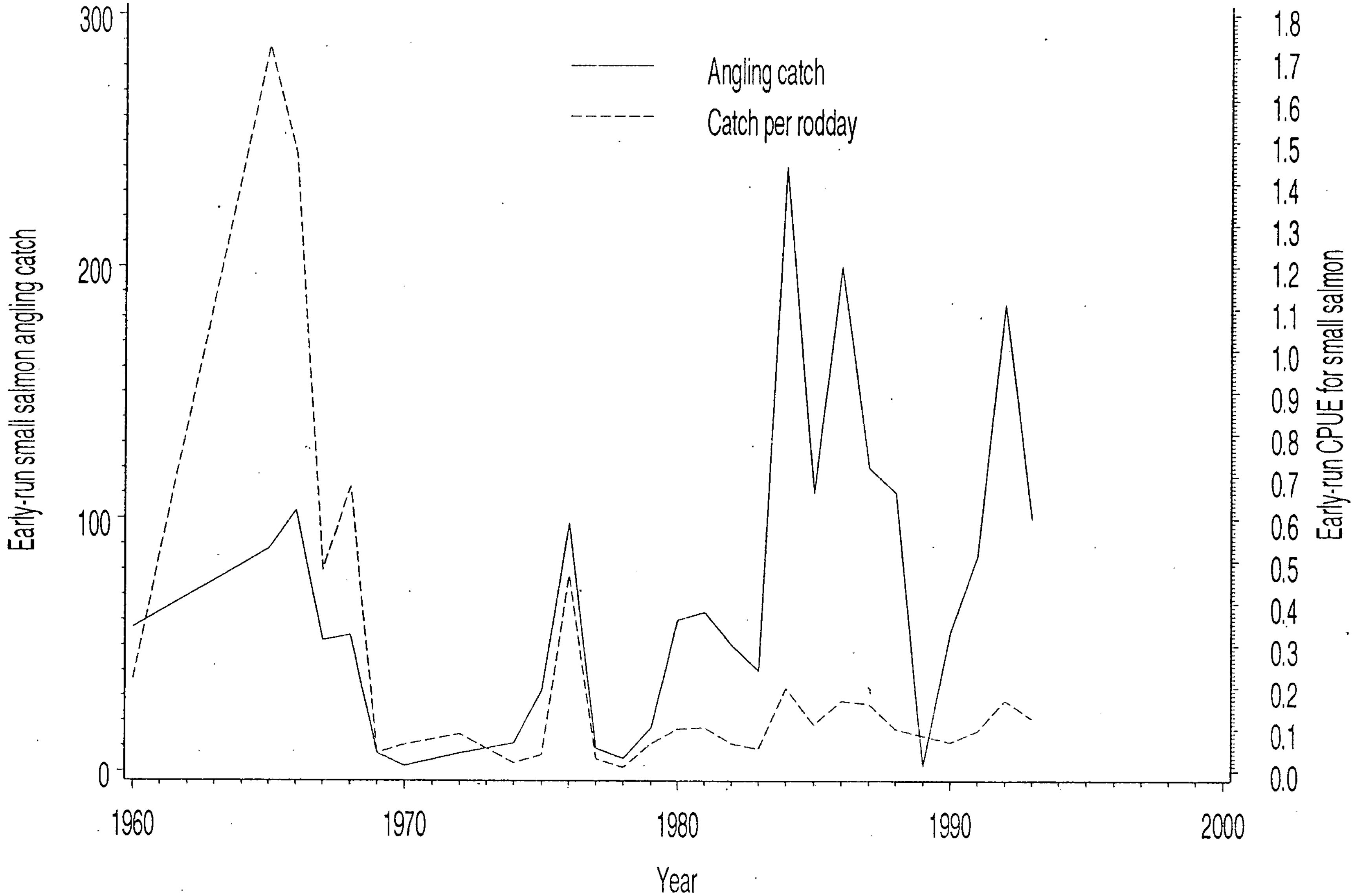


Fig. 9 Total angling catch and catch-per-rodday of early-run Atlantic salmon on the Nepisiguit River, 1965-1993.

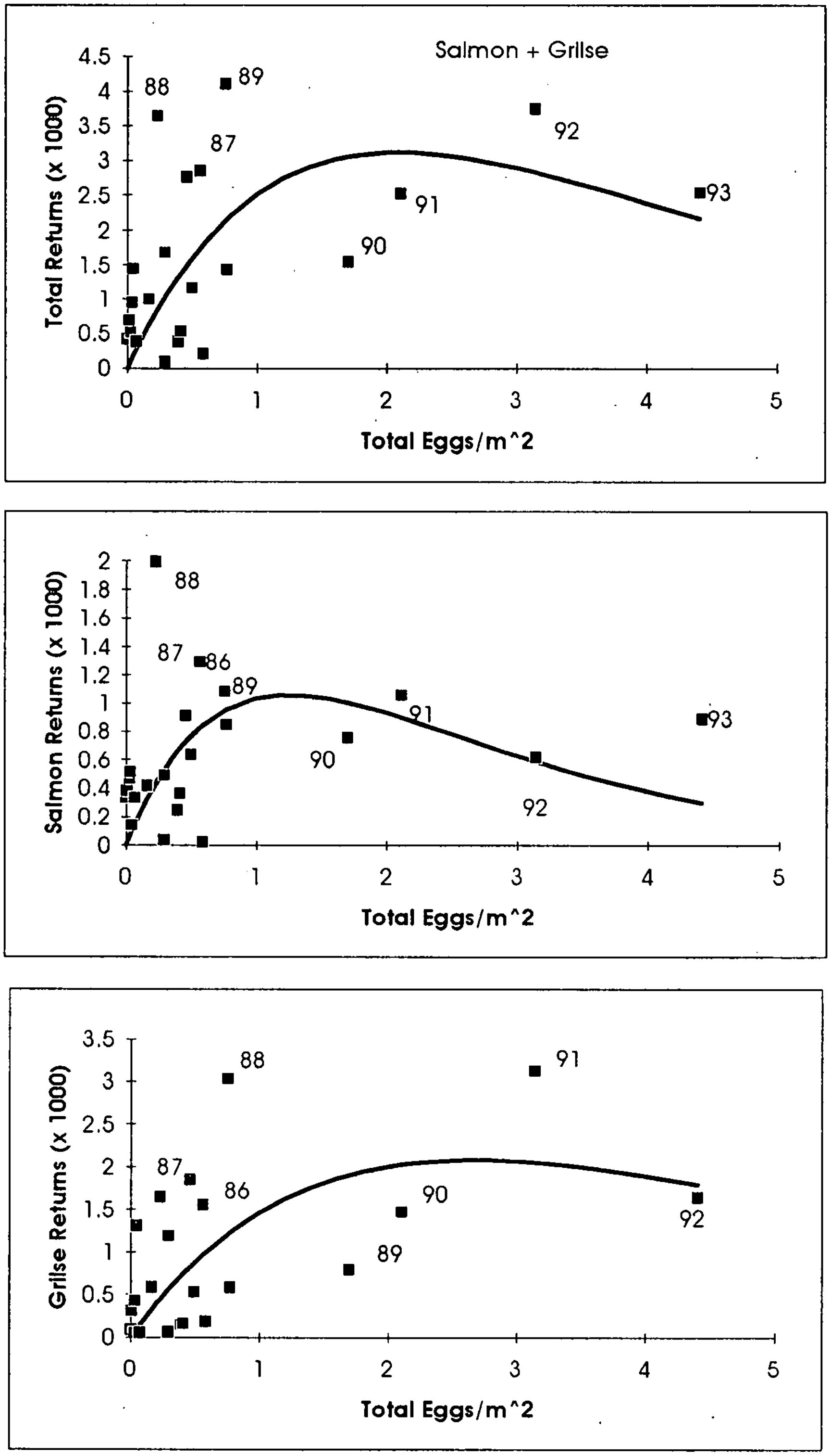
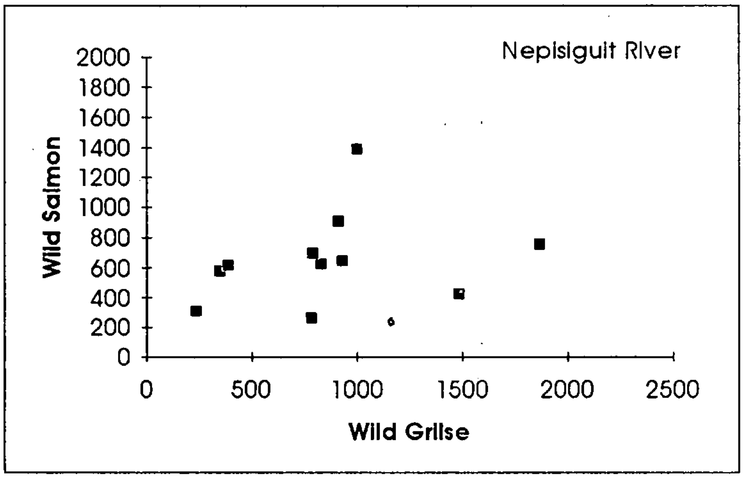
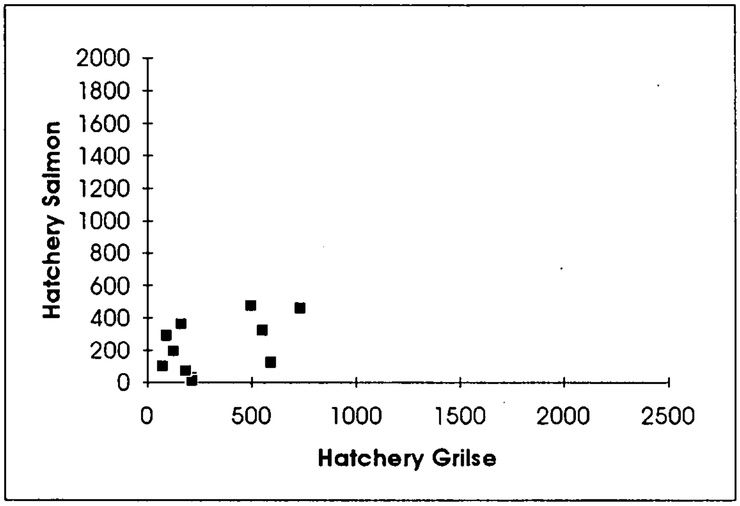


Fig. 10 . Ricker recruitment curves for wild total, salmon, and grilse returr Year shown is year of return.





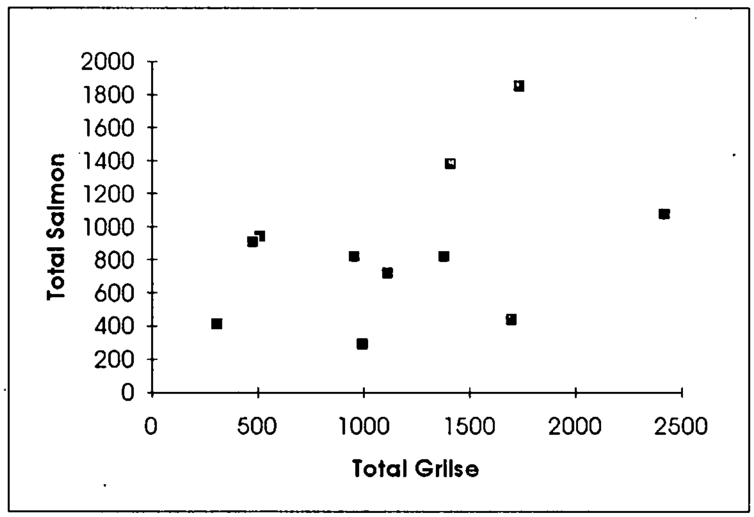
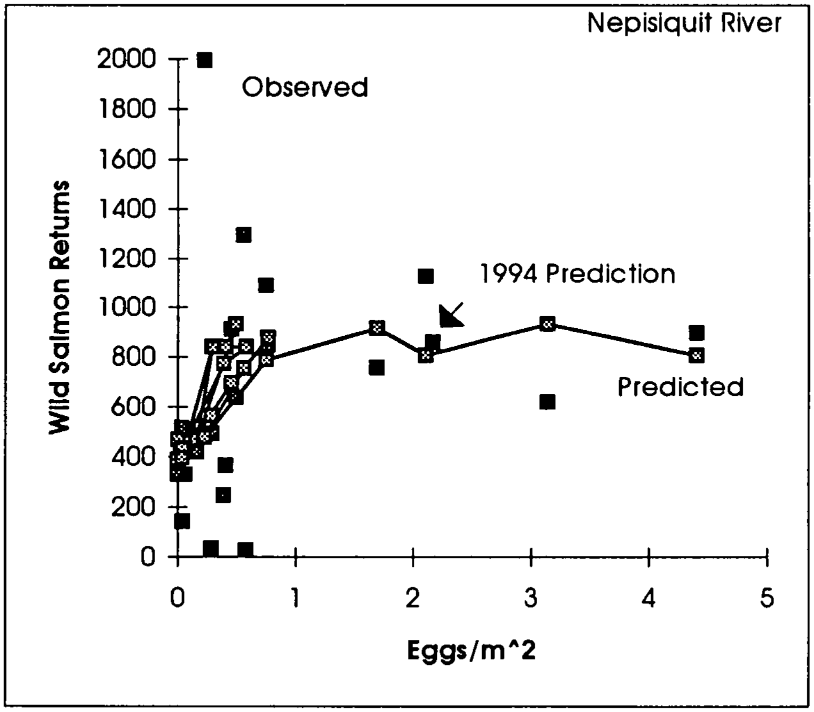


Fig. 11. Small salmon (grilse) returns in year i and large salmor returns year i+1. Year shown is year of salmon returns.



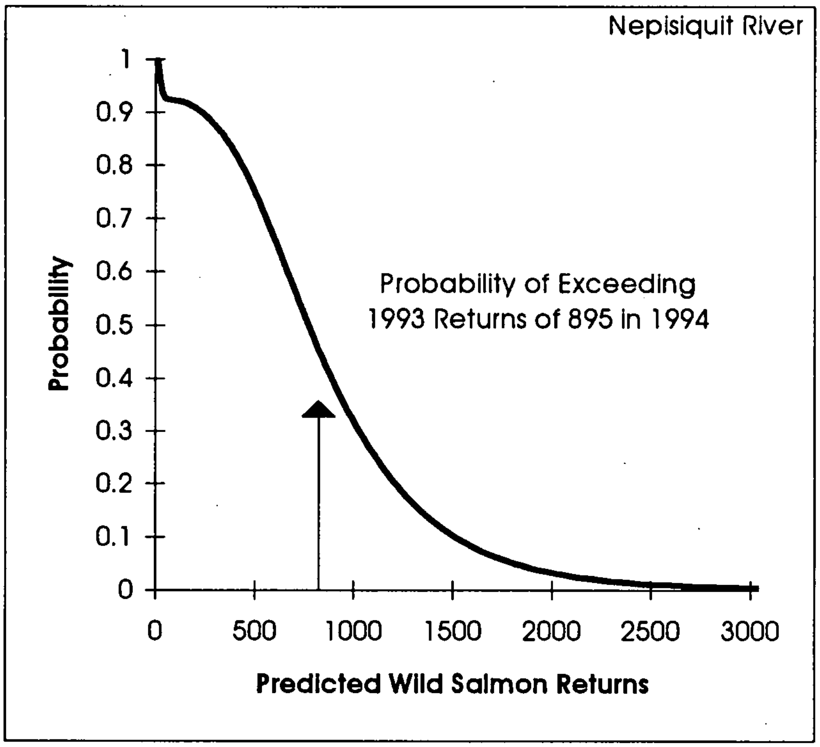
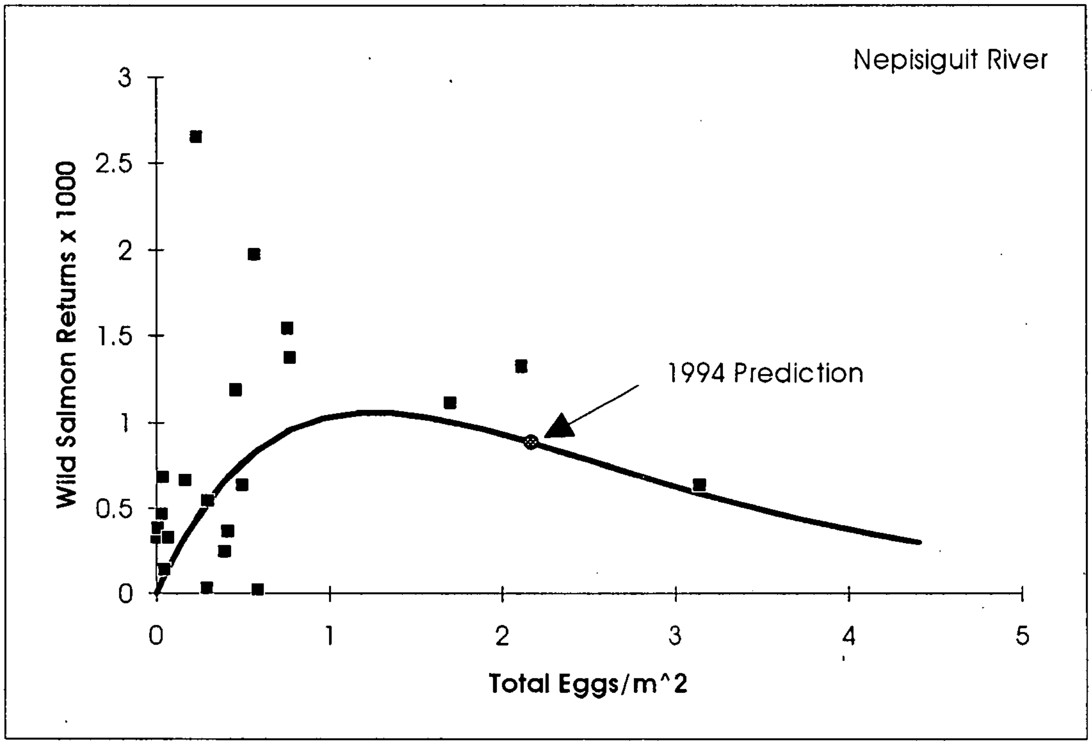


Fig. 12. Predicted versus observed pre-season forecasts and probability of exceeding 1993 returns in 1994.



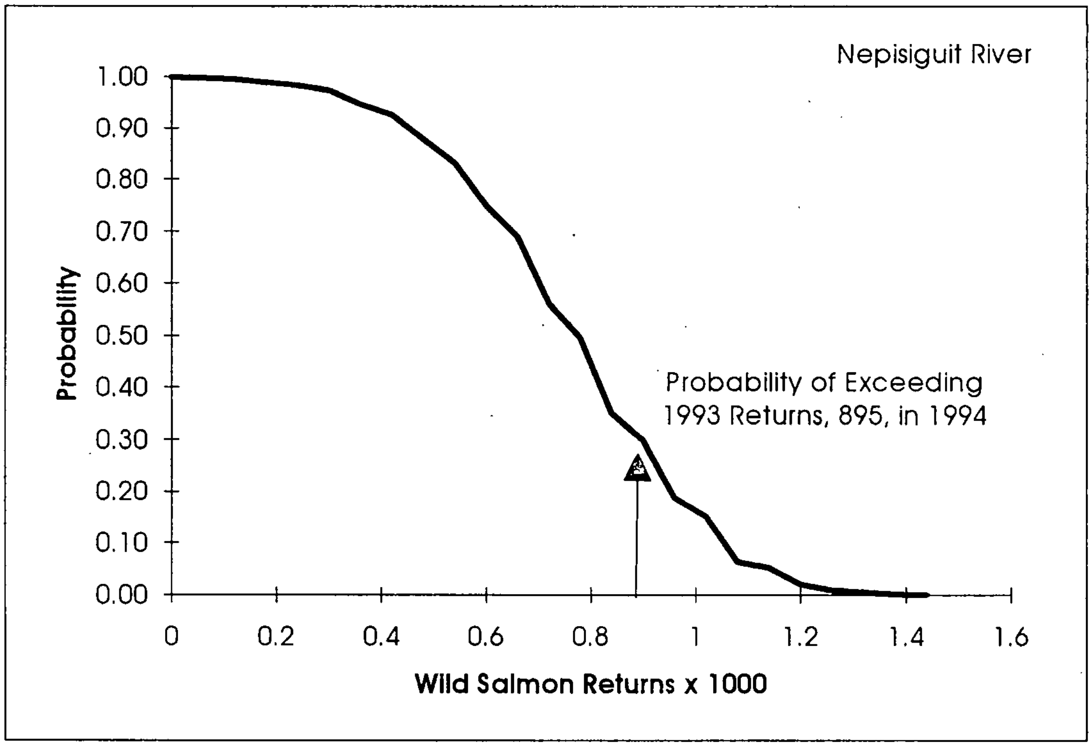
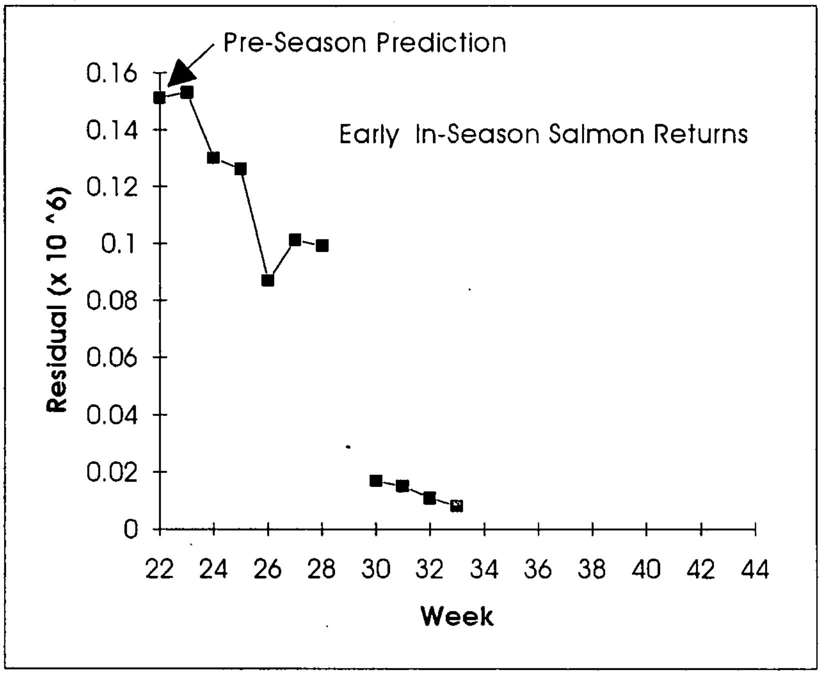


Fig. 13. Predicted versus observed pre-season forecasts based on Ricker recruitment function and probability of exceeding 1993 returns in 1994.



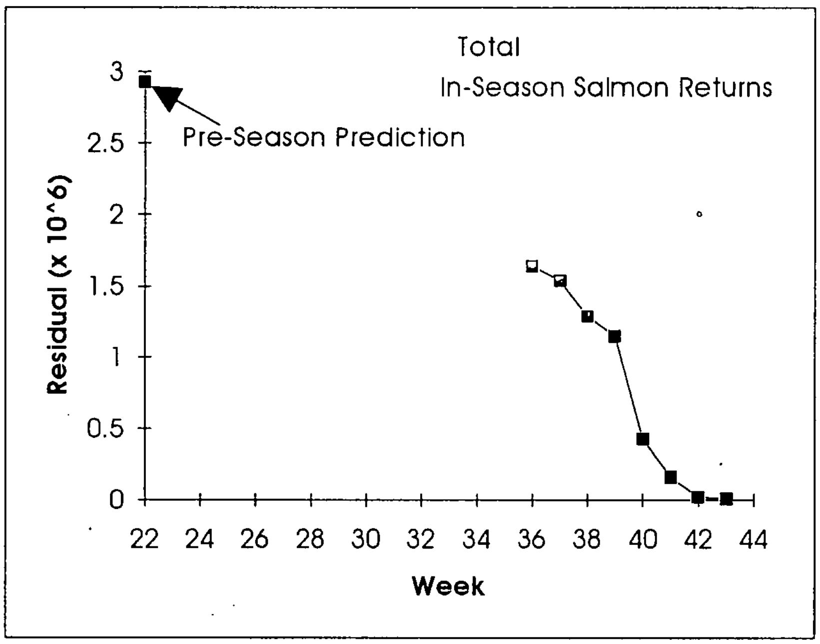


Fig. 14. Improvement in pre-season predictions using in-season model on early and total (early + late) run.

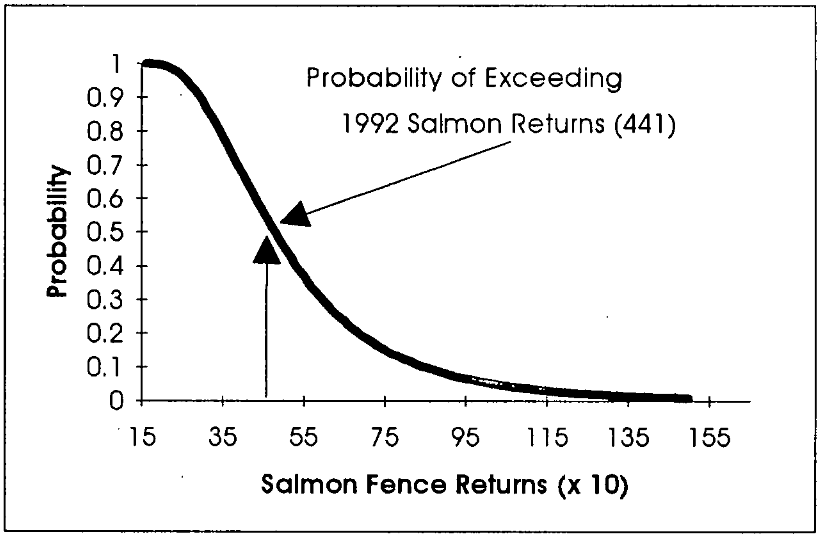


Fig. 15. Update of pre-season forecast using in-season data.

Appendix 1. Percent seeding requirement achieved in Nepisiguit River 1983-90 (Lutzac, T.G. 1991. A table showing percent seeding requirement achieved in Nepisiguit River, N.B., 1983-90. CAFSAC Working Paper 91/151. 1 p.). Assumptions: 3,973,000 m^2 spawning habitat below Grand Falls, spawning requirement 2.4 $eggs.m^{-2}$, fecundity is 1760 $eggs.kg^{-1}$.

Year	Spawners		Weights (kg)		% females		total #	%seeding	% from grilse
	Salmon	Grilse	Salmon	Grilse	Salmon	Grilse	eggs x10^6		
1983	444	653	4.3	1.5	71	16	2.662	28	10
1984	589	941	4.3	1.4	73	18	3.671	39	11
1985	932	366	4.0	1.3	70	17	4.735	50	3
1986	1079	1569	5.0	1.5	59	24	6.596	69	15
1987	2032	2166	6.2	1.1	76	14	17.439	183	3
1988	2355	2933	5.1	1.1	80	19	17.846	187	6
1989	1478	436	6.5	1.8	68	17	11.732	123	2
1990	1692	1766	6.0	1.4	71	17	13.295	139	5
Mean	---	---	5.2	1.4	71	17	----	---	--

Appendix 2. Summary of multiplicative model of analysis of variance for log-transformed abundance of 0+, 1+ and 2+ parr.

a) LOGGED DENSITY OF 0+ PARR

General Linear Models Procedure
Class Level Information

Class	Levels	Values
RIVER	3	GM NB PA
YEAR	11	1982 1983 1984 1986 1987 1988 1989 1990 1991 1992 1993

Number of observations in data set = 160

Dependent Variable: DENS

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	12	69.26948877	5.77245740	3.51	0.0001
Error	147	241.86639157	1.64534960		
Corrected Total	159	311.13588034			

R-Square	C.V.	Root MSE	DENS Mean
0.222634	354.2377	1.28271182	0.36210482

Source	DF	Type I SS	Mean Square	F Value	Pr > F
RIVER	2	9.71193273	4.85596636	2.95	0.0554
YEAR	10	59.55755604	5.95575560	3.62	0.0003

Source	DF	Type III SS	Mean Square	F Value	Pr > F
RIVER	2	13.19556301	6.59778151	4.01	0.0202
YEAR	10	59.55755604	5.95575560	3.62	0.0003

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		0.444578395 B	1.50	0.1346	0.29550533
RIVER	GM	0.522316479 B	1.43	0.1560	0.36629518
	NB	0.612242565 B	2.79	0.0059	0.21918930
	PA	0.000000000 B	.	.	.
YEAR	1982	-0.163665388 B	-0.34	0.7358	0.48422370
	1983	-0.465414295 B	-1.12	0.2653	0.41620946
	1984	-1.738365965 B	-4.18	0.0001	0.41620946
	1986	-0.574119232 B	-1.40	0.1622	0.40867771
	1987	-1.346387450 B	-3.23	0.0015	0.41620946
	1988	-0.594217358 B	-1.34	0.1815	0.44260214
	1989	-0.336447052 B	-0.76	0.4510	0.44514103
	1990	0.020897546 B	0.05	0.9636	0.45771816
	1991	0.337614481 B	0.74	0.4590	0.45470719
	1992	0.162741852 B	0.35	0.7290	0.46878227
	1993	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.

Appendix 2 (con't)

b) LOGGED DENSITY OF 1+ PARR

General Linear Models Procedure
Class Level Information

Class	Levels	Values
RIVER	3	GM NB PA
YEAR	11	1982 1983 1984 1986 1987 1988 1989 1990 1991 1992 1993

Number of observations in data set = 160

NOTE: Due to missing values, only 157 observations can be used in this analysis.

General Linear Models Procedure

Dependent Variable: DENS

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	12	75.71903736	6.30991978	3.07	0.0007
Error	144	296.20525000	2.05698090		
Corrected Total	156	371.92428735			

R-Square	C.V.	Root MSE	DENS Mean
0.203587	-455.2172	1.43421787	-0.3150623

Source	DF	Type I SS	Mean Square	F Value	Pr > F
RIVER	2	13.17848474	6.58924237	3.20	0.0435
YEAR	10	62.54055261	6.25405526	3.04	0.0016

Source	DF	Type III SS	Mean Square	F Value	Pr > F
RIVER	2	14.30410406	7.15205203	3.48	0.0335
YEAR	10	62.54055261	6.25405526	3.04	0.0016

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		0.522032138 B	1.58	0.1172	0.33124953
RIVER	GM	0.632339617 B	1.54	0.1261	0.41102158
	NB	-0.358161859 B	-1.44	0.1508	0.24796757
	PA	0.000000000 B	.	.	.
YEAR	1982	-0.490497569 B	-0.91	0.3665	0.54142274
	1983	-0.667816712 B	-1.44	0.1535	0.46537668
	1984	-1.606717482 B	-3.45	0.0007	0.46537668
	1986	-0.616483320 B	-1.35	0.1794	0.45695778
	1987	-0.622371553 B	-1.34	0.1832	0.46537668
	1988	-2.174381941 B	-4.39	0.0001	0.49488232
	1989	-0.733910976 B	-1.47	0.1425	0.49772794
	1990	-0.306531075 B	-0.60	0.5502	0.51179719
	1991	-0.803404680 B	-1.58	0.1163	0.50842131
	1992	0.220651970 B	0.38	0.7078	0.58760879
	1993	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.

Appendix 2 (con't)

c) LOGGED DENSITY OF 2+ PARR

General Linear Models Procedure
Class Level Information

Class	Levels	Values
RIVER	3	GM NB PA
YEAR	11	1982 1983 1984 1986 1987 1988 1989 1990 1991 1992 1993

Number of observations in data set = 160

NOTE: Due to missing values, only 157 observations can be used in this analysis.

Dependent Variable: DENS

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	12	93.99028329	7.83252361	4.28	0.0001
Error	144	263.65686108	1.83095042		
Corrected Total	156	357.64714437			

R-Square	C.V.	Root MSE	DENS Mean
0.262802	-73.11236	1.35312617	-1.85074874

Source	DF	Type I SS	Mean Square	F Value	Pr > F
RIVER	2	16.57679548	8.28839774	4.53	0.0124
YEAR	10	77.41348781	7.74134878	4.23	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
RIVER	2	20.82133766	10.41066883	5.69	0.0042
YEAR	10	77.41348781	7.74134878	4.23	0.0001

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		-0.360178195 B	-1.15	0.2510	0.31252045
RIVER	GM	-0.071647706 B	-0.18	0.8537	0.38778213
	NB	-0.750491623 B	-3.21	0.0016	0.23394730
	PA	0.000000000 B	.	.	.
YEAR	1982	-1.454090849 B	-2.85	0.0051	0.51081031
	1983	-0.520721629 B	-1.19	0.2376	0.43906395
	1984	-1.249872937 B	-2.85	0.0051	0.43906395
	1986	-1.386066667 B	-3.22	0.0016	0.43112106
	1987	-0.900896811 B	-2.05	0.0420	0.43906395
	1988	-2.064875022 B	-4.42	0.0001	0.46690132
	1989	-2.282418332 B	-4.86	0.0001	0.46958604
	1990	-1.653119094 B	-3.42	0.0008	0.48285981
	1991	-0.380434879 B	-0.79	0.4290	0.47967480
	1992	-0.914507433 B	-1.65	0.1012	0.55438496
	1993	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.

Appendix 3. Historical angling catches in the Nepisiguit River, by month. Data from D.F.O. C&P.

(a) Bright salmon angling catches.

Year	Month	Grilse	Salmon	Effort	CPUE
1960	July	57	0	260	0.219
	Aug.	0	46	200	0.230
	Sept.	0	90	300	0.300
	Total	57	136	760	0.254
1961	July	0	38	160	0.238
	Aug.	0	110	500	0.220
	Sept.	0	165	600	0.275
	Total	0	313	1260	0.248
1962	July	0	51	160	0.319
	Aug.	0	190	600	0.317
	Sept.	0	205	600	0.342
	Total	0	446	1360	0.328
1963	June	0	3	90	0.033
	July	0	92	240	0.383
	Aug.	0	153	240	0.638
	Sept.	86	0	84	1.024
	Total	86	248	654	0.511

Year	Month	Grilse	Salmon	Effort	CPUE
1964	June	0	2	6	0.333
	July	0	96	100	0.960
	Aug.	0	82	132	0.621
	Sept.	0	52	44	1.182
	Total	0	232	282	0.823
1965	June	4	2	16	0.375
	July	84	3	35	2.486
	Aug.	151	6	88	1.784
	Sept.	244	9	100	2.530
	Total	483	20	239	2.105
1966	June	0	3	6	0.500
	July	103	9	64	1.750
	Aug.	101	11	132	0.848
	Sept.	203	15	192	1.135
	Total	407	38	394	1.129
1967	June	0	0	9	0.000
	July	52	12	100	0.640
	Aug.	101	12	80	1.413
	Sept.	257	22	286	0.976
	Total	410	46	475	0.960
1968	June	2	0	20	0.100
	July	52	0	60	0.867
	Aug.	37	2	176	0.222
	Sept.	98	3	120	0.842
	Total	189	5	376	0.516

Year	Month	Grilse	Salmon	Effort	CPUE
1969	June	0	1	24	0.042
	July	7	1	140	0.057
	Aug.	13	1	60	0.233
	Sept.	18	2	108	0.185
	Total	38	5	332	0.130
1970	May	0	0	60	0.000
	June	0	0	12	0.000
	July	2	0	20	0.100
	Aug.	-	-	-	-----
	Sept.	0	0	5	0.000
	Total	2	0	97	0.021
1971	May	0	0	30	0.000
	June	0	0	10	0.000
	July	0	0	30	0.000
	Aug.	6	0	72	0.083
	Sept.	10	1	50	0.220
	Total	16	1	192	0.089
1972	April	0	0	10	0.000
	May	-	-	-	-
	June	-	-	-	-
	July	7	0	80	0.088
	Aug.	5	4	25	0.360
	Sept.	4	6	50	0.200
	Total	16	10	165	0.158

Year	Month	Grilse	Salmon	Effort	CPUE
1973	July	0	60	400	0.150
	Aug.	0	20	300	0.067
	Sept.	0	15	300	0.050
	Total	0	95	1000	0.095
1974	June	0	12	270	0.044
	July	11	4	300	0.050
	Aug.	10	20	300	0.100
	Sept.	7	104	180	0.617
	Total	28	140	1050	0.160
1975	June	10	35	400	0.113
	July	22	42	450	0.142
	Aug.	12	8	250	0.080
	Sept.	33	10	150	0.287
	Total	77	95	1250	0.138
1976	June	0	4	60	0.067
	July	98	23	150	0.807
	Aug.	119	31	180	0.833
	Sept.	118	42	176	0.909
	Total	335	100	566	0.769
1977	May	0	0	12	0.000
	June	0	4	125	0.032
	July	9	5	186	0.075
	Aug.	11	18	220	0.132
	Sept.	8	11	135	0.141
	Total	28	38	678	0.097

Year	Month	Grilse	Salmon	Effort	CPUE
1978	May	0	0	70	0.000
	June	0	10	300	0.033
	July	5	14	330	0.058
	Aug.	15	5	280	0.071
	Sept.	20	40	235	0.255
	Total	40	69	1215	0.090
1979	May	0	0	70	0.000
	June	10	4	130	0.108
	July	7	2	135	0.067
	Aug.	11	0	112	0.098
	Sept.	16	0	125	0.128
	Total	44	6	572	0.087
1980	April	0	0	45	0.000
	May	0	0	120	0.000
	June	20	15	200	0.175
	July	40	25	400	0.163
	Aug.	37	21	350	0.166
	Sept.	38	42	400	0.200
	Total	135	103	1515	0.157
1981	June	11	48	250	0.236
	July	52	44	360	0.267
	Aug.	46	52	480	0.204
	Sept.	21	35	300	0.187
	Total	130	179	1390	0.222

Year	Month	Grilse	Salmon	Effort	CPUE
1982	June	20	62	480	0.171
	July	30	41	300	0.237
	Aug.	36	48	360	0.233
	Sept.	44	36	320	0.250
	Total	130	187	1460	0.217
1983	June	20	66	380	0.226
	July	20	43	378	0.167
	Aug.	25	24	360	0.136
	Sept.	52	43	225	0.422
	Total	117	176	1343	0.218
1984	June	30		302	0.099
	July	210		904	0.232
	Aug.	120		603	0.199
	Sept.	240		1206	0.199
	Total	600		3015	0.199
1985	June	40		300	0.133
	July	70		700	0.100
	Aug.	29		373	0.078
	Sept.	66		241	0.274
	Oct.	24		120	0.200
	Total	229		1734	0.132

Year	Month	Grilse	Salmon	Effort	CPUE
1986	June	40		400	0.100
	July	160		800	0.200
	Aug.	250		1000	0.250
	Sept.	300		1200	0.250
	Oct.	50		200	0.250
	Total	800		3600	0.222
1987	June	70		500	0.140
	July	50		250	0.200
	Aug.	100		800	0.125
	Sept.	505		2200	0.230
	Oct.	75		500	0.150
	Total	800		4250	0.188
1988	June	40		500	0.080
	July	70		600	0.117
	Aug.	50		400	0.125
	Sept.	665		2700	0.246
	Oct.	175		800	0.219
	Total	1000		5000	0.200

(b) Kelt angling catches in Nepisiguit River.

1960	April	0	10	25	0.400
	May	0	40	120	0.333
	Total	0	50	145	0.345

Year	Month	Grilse	Salmon	Effort	CPUE
1961	May	0	25	100	0.250
1962	April	0	20	60	0.333
	May	0	50	150	0.333
	Total	0	70	210	0.333
1963	May	0	10	224	0.045
1964	April	0	18	80	0.225
	May	0	195	195	1.000
	Total	0	213	275	0.775
1965	April	80	2	90	0.911
	May	30	4	42	0.810
	Total	110	6	132	0.879
1966	April	0	151	160	0.944
	May	0	203	264	0.769
	Total	0	354	424	0.835
1967	April	0	12	39	0.308
	May	0	30	90	0.333
	Total	0	42	129	0.326
1968	April	8	0	54	0.148
	May	47	0	121	0.388
	Total	55	0	175	0.314

Year	Month	Grilse	Salmon	Effort	CPUE
1969	April	11	0	40	0.275
	May	21	0	108	0.194
	Total	32	0	148	0.216
1974	April	0	2	27	0.074
	May	0	5	150	0.033
	Total	0	7	177	0.040
1975	April	3	5	80	0.100
	May	5	9	127	0.110
	Total	8	14	207	0.106
1976	May	3	0	10	0.300
1979	April	0	15	42	0.357
	May	0	0	70	0.000
	Total	0	15	112	0.134
1981	April	21	28	175	0.280
	May	25	34	165	0.358
	Total	46	62	340	0.318
1982	April	5	6	100	0.110
	May	20	24	220	0.200
	Total	25	30	320	0.172

Appendix 4

Minutes of Peer Review
Anadromous Stocks Gulf Region

February 21, 1994

Review Committee:

M. Chadwick (Chair)
J. Allard
S. Bates
A. Chiasson
R. Cunjak
J.-G. Godin

General Comments

1. The error associated with extrapolating information from one watershed to another should be estimated using the prorating techniques in hydrological studies. This type of error could be estimated from smaller watershed within rivers where the populations are well estimated.
2. In order to account for possible longterm trends, comparisons should be made with means over long time periods in addition to 5-year means.
3. A logbook program similar to the program in Nova Scotia should be considered for New Brunswick and PEI.
4. The mark-recapture experiments should be encouraged, but other independent estimates of stock abundance such as sport catch data and electrofishing should also be continued.
5. An introductory document summarizing terminology, the basics of mark-recapture experiments, and methods used in electrofishing, creel surveys, and fish fences should accompany next year's assessments. The stock assessment documents should have the same format.
6. Summary sheets should be pictoral, perhaps maps with pie graphs by watershed of catches, spawning requirements, and spawning escapements.
7. A description of multi-species factors such as the abundance and dynamics of other stocks should be included in the assessments.
8. With some minor changes all the assessments were suitable to be published as research documents; however future assessments should be put into a standardized format.
9. Estimate tag-loss function using brood-stock experiments at

hatcheries for Miramichi, Restigouche, and Nepisiguit rivers. The tag loss rate contributes significantly to the error in population estimates.

10. More time is required for reviews in the future and reviewers should focus on 1 or 2 assessments for critical evaluation.
11. Techniques to summarize results from several estimators should be explored.
12. The decision of whether or not a value is a constant or a variable needs to be standardized. Variables are re-evaluated every year, where as constants can be aggregated over years to reduce the confidence interval.

Nepisiguit River

1. First Nation catches need to be documented.
2. A fish trap should be operated in the estuary to estimate size of the early run and to estimate the number of fish that spawn below the fence.
3. The hatchery program lacks careful evaluation. In future, all releases should be marked uniquely by life history stage, or life history stages should not be mixed with other stages and stockings should be done in blocks of three or more years.
4. Parr densities should be used to verify the stock-recruitment relationship.
5. The stock-recruitment relationship should be corrected for unmarked hatchery releases, if possible.
6. Assess reliability of redd counts. The spatial distribution of redds should be documented and examined in relation to stock abundance.
7. Evaluate the electrofishing program. The main-river densities of juvenile salmon are greater than those found in the tributaries. This trend is in contrast to Miramichi & Margaree data.
8. Some attention should be given to habitat quality, which may be limiting productivity of the system.

Participants:

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Author's Note:

Computerized counting fence records need to be verified with original logs of daily fence counts and scale samples.