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Biological Assessment of Atlantic salmon in the Restigouche River, 1988

by

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ABSTRACT

During 1988, returns of Atlantic salmon to the Restigouche River, as estimated from angling data, were about 13,500 1SW fish and 12,600 MSW fish. Returns of MSW salmon were about average, but returns of 1SW salmon were considerably above average. Angling catches of 1SW salmon in 1988 were the highest on record. The management plan initiated in 1984 was designed to increase the survival of MSW salmon in homewaters. An increase in the spawner to return ratio of 0.65 compared to a pre-plan average ratio of 0.25 was consistent with management objectives. Juvenile salmon densities at 15 electrofishing sites have been consistantly above average since the inception of the management plan, confirming that spawning levels have increased in recent years.

Assuming average returns of salmon in 1989, total returns could be about 11,400 1SW salmon and 12,300 MSW salmon. Spawning requirements for Restigouche River are 2,600 1SW salmon and 12,200 MSW salmon, and therefore the above returns indicate a potential surplus of 8,800 1SW salmon but no surplus of MSW salmon. Spawning indices for years that will produce salmon returns for 1989 were above average. Therefore the above forecast is probably conservative.

Several areas where further research is required are identified. The assessment of Atlantic salmon in the Restigouche River is largely dependent on the assumption that angling catches are a good index of salmon abundance. Annual variation in angling exploitation rates and factors that affect it need to be investigated; a research trap in the lower river would be useful for this purpose. Estimates of spawning escapement which are independent of angling catches (e.g. field surveys) require validation. Finally, an improved model for preseason forecasting of salmon returns, possibly incorporating data from the marine environment, is also needed.

RESUME

En 1988, les remontées de saumon de l'Atlantique dans la rivière Restigouche se sont établies à 13 500 saumons unibermarins et à 12 600 saumons redibermarins, d'après les données sur la pêche à la ligne. Dans le cas des seconds, le résultat correspond à peu près à la moyenne, mais pour les unibermarins, le chiffre est très supérieur à la moyenne. Les prises d'unibermarins à la ligne ont atteint un record. Le plan de gestion mis en oeuvre en 1984 visait à accroître la survie du saumon redibermarin dans ses eaux d'origine. La hausse de la proportion de reproducteurs par remontée--taux de 0,65 comparativement à un taux moyen de 0,25 avant l'entrée en vigueur du plan--est conforme à l'objectif visé. La densité des saumons juvéniles en 15 endroits où l'on pratique la pêche électronique s'est maintenue constamment au-dessus de la moyenne depuis la mise en oeuvre du plan, confirmant l'augmentation du nombre de géniteurs au cours des dernières années.

En tablant sur des remontées moyennes, on peut chiffrer respectivement à environ 11 400 unibermarins et 12 300 redibermarins les saumons qui reviendront dans la rivière en 1989. Or, on a besoin, pour la reproduction, de 2 600 unibermarins et de 12 200 redibermarins. Cela signifie qu'on pourrait avoir un surplus de 8 800 unibermarins, mais aucun de redibermarins. Les indices de frai au cours des années d'origine du saumon qui sera présent dans les remontées de 1989 étaient supérieurs à la moyenne. Les prévisions susmentionnées sont donc probablement prudentes.

On fait état de la nécessité d'effectuer de plus amples recherches dans plusieurs domaines. L'évaluation du saumon de l'Atlantique dans la rivière Restigouche est fondée en grande partie sur l'hypothèse selon laquelle les captures à la ligne sont un bon indice de l'abondance du saumon. Or, il convient d'examiner les variations annuelles des taux de pêche à la ligne et les facteurs qui les affectent; l'installation d'un parc en filet dans la partie inférieure de la rivière pourrait être utile à cette fin. Les estimations des échappées de reproducteurs, qui sont indépendantes des prises à la ligne, (étant obtenues, p. ex., dans le cadre d'études sur le terrain) ont besoin d'être soumises à une vérification de modèle. Enfin, on également besoin d'un modèle amélioré de prévision présaisonnière des remontées de saumon, qui intégrerait éventuellement des données provenant du milieu marin.

INTRODUCTION

The objective of this report was to provide a biological assessment of Atlantic salmon (Salmo salar) in Restigouche River for 1988. Nominal landings of salmon from the Native and angling fisheries were summarized, escapement in 1988 was estimated from angling data, juvenile densities and spawner counts, and a forecast for salmon returns in 1989 was provided.

The management plan in the Restigouche River in 1988 was the final year of a five-year conservation program initiated in 1984. Commercial fisheries in Baie des Chaleurs remained closed in both Quebec and New Brunswick. Anglers in New Brunswick were required to release all multi-sea-winter (MSW) salmon ($\geq$ 63 cm) and catches of 1SW salmon were restricted by season, possession, and daily bag limits of ten, six and two fish, respectively. Quebec anglers were allowed to land both 1SW and MSW salmon, with a total daily and seasonal limit of one and seven fish, respectively. Quebec anglers fishing in Quebec/New Brunswick boundary waters, however were required to release all MSW salmon. For both provinces, it was illegal to retain salmon caught by non-salmon commercial gear (by-catch).

Native fishermen at Restigouche, Quebec were allocated a salmon quota of 6,995 kg. Native fishermen at Eel River Bar, New Brunswick did not have a quota.

METHODS

1. Angling and Native catch-and-effort data

Angling data from Quebec portions of the Restigouche River in 1988 were provided by the Ministère du Loisir, de la Chasse et de la Pêche (MLCP). New Brunswick data were provided monthly by DFO fishery officers (mainly from camp logbooks), and Crown Reserve angling data were from the Department of Natural Resources and Energy (DNRE). Catches were identified as being 1SW or MSW salmon ($\geq$ 63 cm). Effort was given in rod-days where one rod-day was one fisherman fishing a river for any portion of one day.

Numbers of MSW salmon caught and released by anglers in New Brunswick from 1984 to 1988 were estimated using four methods: (i) correlation between catch and release of salmon at four angling camps and total Restigouche catch, 1970 to 1983 (Table 1); (ii) correlation between Quebec angling and New Brunswick angling catches, 1970 to 1983 (Table 1); (iii) reported catch-and-release data from DFO fishery officers, and (iv) estimated catch-and-release as calculated from a subsample of license stubs (DNRE Fishsys program) (Table 2).

Native fishery landings from Restigouche, Quebec, were provided by MLCP, and data for Eel River Bar, New Brunswick, were reported from the Band Council office to DFO on a weekly basis.

2. Research counting facilities

Counts of 1SW and MSW salmon in 1988 at a headwater barrier in the Upsalquitch River, operated since 1980, were provided by DNRE. Counts of salmon at two estuarial monitoring traps, monitored since 1985, were provided by MLCP.

Biological characteristics of Atlantic salmon entering Restigouche River in 1988 were obtained from preliminary samples collected at the Native fishery and/or the estuarial traps (Fig. 1). Salmon were measured (FL to nearest mm) and aged.

3. Recruitment

Densities of juvenile salmon (ages 0+, 1+ and 2+) were estimated by electrofishing at 15 sites in the Restigouche River in 1988. Densities (number per $100m^2$) were calculated using the removal method (Zippin 1956) and 95% confidence intervals were calculated after individual site counts were transformed (ln X+1). To identify long-term trends, mean densities at the same 15 sites were compared from 1972 to 1988.

4. Spawning escapement in 1988

Three methods were used to estimate salmon spawning escapement in 1988:

Method 1: Spawning escapement was calculated as angling catch divided by angling exploitation rate, minus angling and broodstock removals. In previous assessments, an exploitation rate of 0.20 was used (Chadwick and Randall 1983). However, this rate was judged to be too low for two reasons: 1) spawner counts as estimated from field surveys by DNRE and MLCP (see Method 3) suggest angling exploitation rate may be substantially higher than 0.2 (Table 4); exploitation rate of early-run salmon in the Miramichi River was estimated to average 0.30 (Randall pers. obs.). Therefore, three exploitation rates were used, 0.2, 0.3 and 0.4. Total returns were calculated as the sum of escapement, harvest and poaching and disease removals.

Method 2: A ratio of spawner to angled fish of 0.70 was used. This ratio was calculated in the 1987 assessment (Randall et al. 1988). Annual egg depositions were back-calculated from small parr (age 1+) densities assuming 10% survival (Elson 1957, 1974; Chadwick 1982), and a rearing area of 29,768,000 m^2. Spawners were calculated by dividing egg deposition by the average number of eggs per MSW spawner (Randall 1984). Escapement in 1988 was estimated as the product of the spawner to angled fish ratio and angling catch minus broodstock removals.

Method 3: Spawning escapement was estimated by field surveys in all major tributaries by DNRE and MLCP staff. Spawners were visually counted from canoes; over 80% of all habitat was surveyed. Variances or potential biases associated with field estimates have not yet been determined. However, tentative results of field surveys were considered in this assessment to provide an estimate of spawning escapement which was independent of angling catches. Spawner surveys have been conducted on the Restigouche River since 1982.

For all three methods, a poaching and disease mortality of 0.14 for 1SW and 0.16 for MSW salmon was used. These rates were estimated from NW Upsalquitch River data, where mortalities were monitored at a barrier protection pool, and poaching losses were estimated from spawner counts above the barrier (Table 5 and Randall et al. 1988). Note that poaching and disease mortality rates were applied to total river returns, before angling exploitation occurred.

Mortalities from stress of catch-and-release of MSW salmon were estimated from observations at five angling camps. Camp managers provided data on the number of MSW salmon caught and released in their stretch of water, and an estimate of the total mortalities they observed that may have resulted from catch-and-release stress (i.e., no physical indication of furunculosis lesions on the fish). Similar estimates have been made since 1985.

Egg deposition requirements for the total Restigouche River are 71,443,200 eggs (Randall 1984). About 12,200 MSW salmon are required to produce these eggs, and an additional 2,600 1SW salmon are required to ensure a 1:1 sex ratio at spawning.

5. Forecast

Returns of MSW salmon to the Restigouche River in 1989 were predicted using two methods: 1. from a correlation between 1SW salmon at Kedgwick Lodge (year i) and total MSW returns (year i+1). This method has been used in previous assessments (Chadwick et al. 1984; 1985; Randall et al. 1985; 1986; 1987; 1988). 2. from historic (1986-1988) averages. Returns of 1SW salmon were also predicted from previous three-year averages.

In addition to these two methods, another forecast model was tested, whereby MSW salmon returns were divided into individual sea ages (2SW, 3SW and previous spawners) and separate forecasts were tested for each age group. Various indices of spawning levels were used in the regression models, including juvenile salmon densities (age 0+ and 1+), angling catches of MSW salmon, and 1SW returns. No statistically significant regressions were found, and thus this model was rejected.

RESULTS

1. Landings

During 1988, the estimated harvest of MSW salmon by anglers in Quebec tributaries of the Restigouche River was 963 fish, an increase of 10% from 1987 (Table 6). Effort (rod-days) increased from 1987 to 1988 by 17%, and catch per unit of effort remained the same.

The number of MSW salmon caught and released in New Brunswick waters from 1984 to 1988 as estimated from the four index camps and from Quebec landings are compared in Table 1. In addition, estimates were available from DFO fishery officers and from the DNRE Fishsys program (1984 to 1987). All four methods showed similar trends among years (Table 2). For the 1984 to 1987 assessments, angling catch from the four index camps have been used to estimate the catch. However, these estimates have been consistently higher than estimates from the other three methods (Table 2). All estimates of the numbers of fish caught-and-released by anglers probably overestimate salmon abundance compared to actual landings because of possible recaptures and also the inclusion of released fish that may not have been landable. Estimated catches from the four index camps may have confounded this potential bias because they were consistently the highest estimates of any of the four methods (Table 2). For this reason, DFO estimates of the numbers of MSW salmon released by anglers for the period 1984 to 1988 were used in this assessment. As will be noted later, the change from index camp to DFO data resulted in a lower estimate of spawning escapement for the period 1984 to 1987 than used in previous assessments.

The DFO estimate of the numbers of MSW salmon caught and released in New Brunswick in 1988 was 4546 fish, a 42% increase from 1987 (Table 3). Angling effort in New Brunswick also increased in 1988 from 1987 by 9% (Table 6), and CPUE increased from 0.32 to 0.41 (28%), suggesting MSW salmon were more abundant in 1988 than in 1987. Total angling catch of MSW salmon (NB and Quebec) in 1988 was 35% higher than in 1987, and 36% higher than the long term average (Table 3).

Landings of 1SW salmon in Quebec increased in 1988 (692 fish) from 1987 (591 fish) by 17% (Table 6). CPUE for 1SW salmon, despite a 10% increase in effort, remained the same from 1987 to 1988. Landings of 1SW salmon in New Brunswick also increased from 1987 to 1988; catches increased from 4414 to 6084 fish, an increase of 38%. Effort and CPUE for 1SW salmon in New Brunswick increased by 9% and 25%, respectively. Total catch of 1SW salmon in 1988 (NB and Quebec) was 35% greater than in 1987, 178% greater than the long term average (Table 3), and was the highest catch to date. Angling catch and effort data therefore indicated increased returns of 1SW salmon in 1988 from 1987; 1988 returns were also apparently greater than the long term average.

Nominal landings of salmon from the Native fisheries at Eel River Bar decreased from 1987 to 1988, by 26% for 1SW salmon and by 44% for MSW salmon (Table 6). Effort was similar in both years. At the Restigouche Native fishery, a total of 924 salmon were reported caught (921 MSW and 3 1SW salmon). Sampling at Restigouche during the fishery indicated a mean weight of salmon of 6.5 kg (n=262). Therefore a total of 6006 kg of salmon were landed, which was 86% of the quota (6995 kg). The fishing season at Restigouche was from 6 June to 6 July, which was similar to 1987, but shorter than in years prior to 1986 (Appendix 6). Reported landings at Restigouche increased in 1988 from 1987; in 1987, only 57% of the quota was reported caught (Randall et al. 1988). For both the Restigouche and Eel River Bar fisheries, however, it was difficult to compare run strength among years because of the uncertainty of the landing data.

Total nominal salmon landings in the Restigouche River in 1988 are compared to historic catches (1951 to 1987) in Table 7.

2. Research counting facilities

Catches of MSW salmon at the lower estuarial trap operated by MLCP decreased by 57% from 1987 to 1988 (Table 8). Catches of 1SW salmon also decreased from 1987 to 1988, by 12%. Counts of salmon at the upper trap were also down substantially in 1988 from 1987, by 85% for MSW salmon and by 68% for 1SW salmon. Biologists monitoring the traps suspected weather conditions in 1987 (low river discharges;Fig. 2) increased the trap catches relative to other years.

Counts of MSW salmon at Upsalquitch barrier were similar in 1988 and 1987. Counts of 1SW salmon in 1988 were less by 26% than in 1987.

3. Biological characteristics

Preliminary samples from the lower estuarial trap indicated that 1SW were relatively more abundant in 1988 than 1987 (Table 9). Proportion of 3SW salmon in the MSW salmon component of the spawning run was lower than both the 1987 proportion and the historic (Dalhousie trap data) average. Mean sizes of 2SW, 3SW and previous spawners in 1988 were within the ranges reported in other years. Cumulative counts of salmon at the lower estuarial trap in 1988 are illustrated in Fig. 3.

4. Recruitment

Average densities of juvenile Atlantic salmon at 15 sites in the Restigouche River in 1988 are compared to historic data in Table 10 and Fig. 4. Mean densities of age 0+ salmon were the highest on record; 1988 densities were 2.8 times greater than the long term average. Densities of 1+ and 2+ parr were lower in 1988 than in 1987, but they were slightly above

long term averages (by 7% for age 1+ and by 24% for age 2+ parr). Age 1+ and 2+ parr densities were lower than expected from the densities of 0+ fry and 1+ parr the years before (Table 10).

5. Spawning escapement

For methods 1 and 2, spawning escapement in 1988 was estimated using angling catches of 6776 1SW salmon and 5509 MSW salmon (Table 3). MSW salmon catches included 963 salmon harvested in Quebec and 4546 salmon caught and released in New Brunswick. Mortality rate attributed to catch-and-release stress was estimated to be 4%:

	Catch-and-release	Mortalities	Proportion
Camp 1	238	2	0.01
2	118	15	0.13
3	196	12	0.06
4	423	20	0.05
5	229	5	0.02
TOTAL	1204	54	0.04

Spawning escapements as estimated using angling exploitation rates, the spawner to angled fish ratio, and field surveys, are summarized below:

MSW salmon Method	1			2	3
	Exploitation rate			Spawner/angled	Field spawning surveys
	0.2	0.3	0.4		
1. Total returns	34222	23292	17826	12579	13893
2. Harvest in estuary	1430	1430	1430	1430	1430
3. Harvest in river	963	963	963	963	963
4. Poaching & disease[1]	5247	3498	2624	1784	1784
5. Broodstock	18	18	18	18	18
6. C/R mortality[2]	182	182	182	182	182
7. Spawners	26382	17200	12610	8202	9516
8. Target spawners	12200	12200	12200	12200	12200
% target achieved	216	141	103	67	78

1SW salmon

	1			2	3
	0.2	0.3	0.4		Field Surveys
1. Total returns	39469	26337	19771	13468	12354
2. Harvest in estuary	73	73	73	73	73
3. Harvest in river	6776	6776	6776	6776	6776
4. Poaching & disease[1]	5516	3677	2758	1875	1719
5. Spawners	27104	15811	10164	4743	3786
6. Target spawners	2600	2600	2600	2600	2600
% target achieved	1042	608	390	182	146

1 0.16 and 0.14 of river returns of MSW and 1SW salmon, respectively.
2 0.04.

For MSW salmon the spawner/angled fish ratio (Method 2) indicated a spawning escapement of 8202 (67% of requirements). In terms of egg deposition, the spawner/angled fish ratio indicated a total deposition of 49.1 X 10^6 eggs (69% of requirements). Spawning escapement as estimated by Method 3 (field surveys) and Method 1 (angling exploitation) were more optimistic, indicating egg deposition levels of 80% and 106% (assuming an exploitation rate of 0.4), respectively.

The estimated numbers of 1SW salmon that spawned in 1988 were at least 1.5 times greater than the numbers required. The spawner to angled fish ratio indicated a spawning escapement of 4743 1SW fish, which was 182% of requirements.

Numbers of MSW salmon forecasted to return in 1988 were 19,046 (9,474 - 28,619) based on the Kedgwick Lodge forecast, and 12,900 based on the previous five-year mean.[1] Method 2 indicated total returns 12,579 MSW salmon, which was close to the previous five year average. Returns of 1SW salmon in 1988, assuming average returns, were expected to be about 8,500 fish. Actual returns, as estimated by Method 2, were estimated to be 13,468 fish (58% greater than the average).

6. Spawning escapement and egg deposition, 1970 to 1988

Spawning escapement (as estimated by Method 2) and total river returns are summarized for the period 1970 to 1988 in Tables 11 (MSW salmon) and 12

1 Note that 12,900 was the mean return (1983-1987) as estimated using MSW angling data which were estimated from the index camps. Average returns for this period as estimated using DFO angling catches would be lower (about 10,500).

(1SW salmon). Correlations between spawning escapement as estimated from angling data (Method 2) and from field surveys (Method 3) were highly significant for both MSW salmon (R^2=0.95) and 1SW salmon (R^2=0.77) (Fig. 5). The ratio of spawning escapement to total returns in 1988 was 0.65, which, as in all years since 1984, was significantly higher than in years prior to the initiation of the current management plan (Table 11).

Estimates of total egg depositions from 1971 to 1988, calculated as numbers of spawners times the average number of eggs per spawner (Randall 1984) are given in Table 13. Egg depositions were significantly correlated with resulting fry and parr densities (Table 13; Fig. 6). As noted earlier, numbers of MSW spawners from 1984 to 1987 were significantly less as calculated using DFO rather than index camp estimates of angling catches (see parentheses in Table 13). Correlations between egg depositions and juvenile salmon densities were equally significant for both sets of data. For reasons noted on page 6, the DFO estimates from logbooks were judged to be the most reasonable estimates of angling catches (and therefore spawners and egg depositions) for this period.

7. Forecast for 1989

The regression between 1SW salmon catch at Kedgwick Lodge (year i) and total MSW salmon returns (year i+1) was significant but weak (F=5.93, R^2=0.26, P<0.026; Table 14 and Fig. 7). Returns in 1989 as predicted from this regression, were 14,611 MSW salmon (7,659 - 27,867). Data were transformed (natural logarithms) for this regression because the untransformed model initially tested was not significant (F=4.0, R^2=0.19, P<0.06). Peterman (1982) found that logarithmic transformations provided a statistically superior model for preseason forecasting sockeye and coho salmon returns in British Columbia.

Assuming returns of salmon to the Restigouche River in 1989 are similar to average returns for the past three years (1986-1988), returns would be 12,272 MSW salmon and 11,397 1SW salmon (calculated from Table 11 and 12). Spawning levels in past years that will produce salmon returns in 1989 suggest that returns will be greater than average. For example, 1SW salmon in 1989 will be from the 1984 (age 3 smolt) and 1985 (age 2 smolts) spawning years. Spawning indices in these two years were compared to the previous five-year averages:

	Spawning indices			
	Egg deposition	0+	1+	1SW
1SW (1989)	+112%	+37%	+37%	NA
MSW (1989)	-32%	+94%	+83%	+60%

For both 1SW and MSW salmon, most indices indicated greater than average spawning levels. Therefore, the above average returns predicted for 1989 should be considered to be minimum estimates.

As mentioned previously, another (new) regression model was tested in an attempt to forecast MSW salmon returns to the Restigouche River. In the new model, total 1SW salmon returns were used (rather than 1SW catch at one index camp as above) and MSW salmon returns were tested for each sea age group separately (2SW and 3SW). No significant regressions were found. For most years between 1971 to 1988, returns of MSW salmon only ranged between 10,000 and 14,000 salmon (Fig. 8). Returns which were greater (1977) or less than the above range (1975, 1979 and 1984) (Fig. 8), could not be predicted from 1SW returns or from the various indices of spawning escapement used.

DISCUSSION

Angling catch and effort data indicated that 1SW salmon returns in 1988 were greater than both 1987 returns and long term historic averages. Total returns were estimated to be about 13,500 fish, compared to a forecast (based on a previous five-year mean) of 8,500 1SW salmon (Randall et al. 1988). Greater than average returns were difficult to explain given the low egg depositions in 1983 (Table 13) which produced the 1SW returns in 1988 assuming a predominant smolt age of 3 years. It is possible, however, that many of the 1SW salmon were from the 1984 spawning year, (i.e. smolt age 2) when egg depositions were greater. Samples to identify the age composition of the 1988 1SW fish will determine if this was the case.

Returns of MSW salmon in 1988 were estimated to be about average (12,600 salmon). As in previous years, the management plan in effect resulted in a high survival of MSW salmon in homewaters; about 65% of returns potentially survived to spawn, resulting in a potential egg deposition of 49.1 X 10^6 egg which was 69% of the target egg deposition. Spawning levels in 1988 confirm that the management plan has had a significant impact on Atlantic salmon in the Restigouche River. Average egg depositions since the plan was initiated (1984 to 1988) were 3 times the levels in the five years preceeding the plan (Table 13). Average fry densities have apparently increased as a result of this increased egg deposition by a factor of about 2.

Two areas of research are required to improve the Restigouche assessment: angling exploitation rates need to be validated and further investigations are needed to improve preseason forecasts of salmon abundance. Both Methods 1 and 2, which were used in this assessment to calculate salmon run strength and spawning escapement, assume that angling catch is a good index of salmon abundance (i.e., exploitation rate is known and it is constant among years). Two facts suggest that this assumption may be valid. First, spawning escapements for both 1SW and MSW salmon as estimated from angling data (Method 2) were significantly correlated with spawning escapements from field spawning surveys (Fig. 5). Secondly,

angling catches in Upsalquitch River were weakly correlated to counts of 1SW salmon at the headwater barrier (Table 15) (R^2=0.33, n=9, P=0.10). [The latter correlation assumes that the barrier counts were a good indicater of the numbers of fish available to anglers below the barrier]. Factors other than abundance may affect angling success, however, and if catch rate changes from one year to the next, interpretations of run strength from angling catches may be misleading. In Upsalquitch River, for example, catch rates (angling catch/barrier count) were also weakly correlated with discharge rates (Fig. 9) (R^2=0.34, n=9, P=0.10). Thus angling catches may be an imperfect index of salmon abundance in the Restigouche River.

An additional problem is the use of catch-and-release data for MSW salmon since the inception of the 1984 management plan. As mentioned earlier, catch-and-release estimates of angling catch may be biased positively compared to actual landing data because of multiple recaptures and the inclusion of releases that may not have been landable fish. Potential biases in angling data emphasize the need for a counting facility in the lower Restigouche River which could be used as an index of run strength independent of angling data.

Spawner counts from visual field surveys were used in this assessment as a tentative independent index of spawning success. These surveys have potential merit, but they need to be tested for accuracy and precision. Field spawner counts on the west coast of Canada were shown to be significantly negatively biased, although they did provide a reasonable and consistent index of abundance (Shardlow et al. 1987).

The second research requirement for the Restigouche River is the development of improved methods for forecasting salmon returns one year in advance. Much of the work completed to date has considered 'within river' data only. Atlantic salmon from Restigouche River are also intercepted in high seas fisheries at Greenland and Newfoundland, and forecast models may be improved if marine data (commercial landings and/or physical conditions) are incorporated.

Assuming average returns of 1SW and MSW salmon in 1989, total returns could be about 11,397 1SW salmon and 12,272 MSW salmon. Given that requirements are 2,600 1SW salmon and 12,200 MSW salmon, the above returns would provide a surplus of about 8,800 1SW salmon but no surplus of MSW salmon. Indices of spawning levels in years that will produce salmon returns in 1989, however, suggest returns could be above average and therefore the above forecasts are probably minimum estimates.

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Table 1. Estimated angling catches of MSW salmon in the Restigouche River, 1970 to 1988.

Year 1	Index camps 2	Total catch minus camps 3	Total catch 4	NB catch 5	Quebec catch 6
1970	277	1765	2042	1716	326
1971	194	822	1016	757	259
1972	601	4440	5041	3870	1171
1973	571	4321	4892	3746	1146
1974	959	4989	5948	4785	1163
1975	494	2407	2901	2160	741
1976	----	----	5510	4481	1029
1977	909	5798	6707	5128	1579
1978	615	4410	5025	3373	1652
1979	353	1470	1823	997	826
1980	905	5252	6157	4098	2059
1981	602	3638	4240	2832	1408
1982	453	2129	2582	1620	962
1983	409	1659	2068	1481	587
1984	490	[2836][1]	3326	2756 (1895)[2]	570
1985	859	[5203]	6062	5310 (2276)	752
1986	1233	[7603]	8836	7418 (3671)	1418
1987	696	[4157]	4853	3980 (2530)	873
1988	1171	[7206]	8377	7414 (2718)	963

[1] Total catch minus camps (column 3) from 1984 to 1988 estimated from a correlation between catch at the four index camps (X) and total catch (y) 1970 to 1983; $y = -308.7 + 6.4(X)$; $R^2 = 0.87$, $P<0.01$.

[2] New Brunswick catch 1984 to 1988 (in parenthesis, column 5) estimated from a correlation between catch in Quebec (X) and NB catch (y) 1970 to 1983; $y = 701.16 + 2.09\ (X)$; $R^2 = 0.52$, $P<0.01$.

Table 2. Estimated numbers of MSW salmon caught and released in New Brunswick from 1984 to 1988 as estimated from four index camps, DFO officers, DNRE (FISHSYS) and Quebec data.

Year	Index camps	Quebec landings	NB catch and release			
			camps	DFO	DNRE	Quebec
1	2	3	4	5	6	7
1984	490	570	2756	1672	1401	1895
1985	859	752	5310	3563	3214	2276
1986	1233	1418	7418	4763	4372	3671
1987	696	873	3980	3203	3458	2530
1988	1171	963	7414	4546	----	2718

Table 3. Estimated angling catches of salmon in the Restigouche River, 1970 to 1988.

Year	MSW			1SW			Proportion MSW
	PQ	NB	Total	PQ	NB	Total	
1970	326	1,716	2,042	166	1,340	1,506	0.58
1971	259	757	1,016	173	999	1,172	0.46
1972	1,171	3,870	5,041	111	978	1,089	0.82
1973	1,146	3,746	4,892	147	1,423	1,570	0.76
1974	1,163	4,785	5,948	129	1,038	1,167	0.84
1975	741	2,160	2,901	149	1,130	1,279	0.69
1976	1,029	4,481	5,510	377	2,345	2,722	0.67
1977	1,579	5,128	6,707	459	2,333	2,792	0.71
1978	1,652	3,373	5,025	282	1,322	1,604	0.76
1979	826	997	1,823	556	1,990	2,546	0.42
1980	2,059	4,098	6,157	409	2,833	3,242	0.66
1981	1,408	2,832	4,240	635	3,010	3,645	0.54
1982	962	1,620	2,582	402	2,449	2,851	0.48
1983	587	1,481	2,068	181	715	896	0.70
1984	570	[1,672][1]	[2,242]	348	1,474	1,822	0.55
1985	752	[3,563]	[4,315]	259	3,258	3,517	0.55
1986	1,418	[4,763]	[6,181]	498	4,915	5,413	0.53
1987	873	[3,203]	[4,076]	591	4,414	5,005	0.45
1988	963	[4,546]	[5,509]	692	6,084	6,776	0.45
Mean (70-87)	1,029	[3,014]	[4,043]	326	2,109	2,435	0.63[2]

1 Estimates in parenthesis [ ] include MSW salmon released in New Brunswick. New Brunswick catch-and-release data (1984 to 1988) were estimated from DFO fishery officers.

2 Mean proportion MSM calculated after arcsine transformation.

Table 4. Estimated angling exploitation rates (U) in Restigouche River, 1982 to 1988. Numbers of spawners were estimated from field spawning surveys and returns were estimated assuming a poaching and disease rate of 0.16 for MSW and 0.14 for 1SW salmon.

	1SW				MSW salmon				
Yr	Angling	Spawners	Returns	u	Angling	Landings	Spawners	Returns	u
1982	2,851	1,577	5,149	0.55	2,582	2,582	3,563	7,315	0.35
1983	896	986	2,188	0.41	2,068	2,068	2,397	5,315	0.39
1984	1,822	1,374	3,716	0.49	2,242	654	5,233	7,008	(0.09)
1985	3,517	2,111	6,544	0.54	4,315	1,037	7,898	10,637	(0.10)
1986	5,413	5,190	12,329	0.44	6,181	1,656	9,542	13,331	(0.12)
1987	5,005	3,930	10,390	0.48	4,076	1,033	8,535	11,390	(0.09)
1988	6,776	3,786	12,281	0.55	5,509	1,145	9,516	12,692	(0.09)

( ) catch-and-release of MSW salmon in New Brunswick.

Table 5. Counts of salmon at Upsalquitch barrier, 1982 to 1988, and estimated survival at spawning.

Year	Arrivals at barrier		Mortalities at barrier: Furunculosis		Mortalities at barrier: Other		Poaching mortalities above barrier		Spawners		Proportion lost: Furunculosis at barrier		Proportion lost: Poaching above the barrier		Proportion lost: Furunculosis & above barrier	
	1SW	MSW	1SW	MSW	1SW	MSW	1SW	MSW	1SW	MSW	1SW	MSW	1SW	MSW	1SW	MSW
1982	819	622	16	46	6	1	203	127	594	448	.02	.07	.25	.20	.27	.28
1983	430	301	18	18	2	1	0	0	410	282	.04	.06	.00	.00	.04	.06
1984	518	642	7	40	5	2	131	174	375	426	.01	.06	.25	.27	.27	.33
1985	748	517	5	2	4	1	105	83	634	431	.01	.00	.14	.16	.15	.16
1986	1,738	1,166	11	7	1	4	86	55	1,640	1,100	.01	.01	.05	.05	.06	.05
Mean (82-86)[1]	851	650	11	23	4	2	105	88	731	537	.02	.03	.11	.10	.14	.16
1987	1,557	1,000	18	48	2	0	0	0	1,524	940	.01	.05	.00	.00	.01	.05
1988	1,147	979	19	23	0	0	---	---	-----	-----	.02	.02	---	---	---	---

[1] Mean proportions calculated after arcsine transformation.

Table 6. Preliminary 1988 nominal landings and effort in Restigouche River from Native and angling fisheries. Landings for 1987 and 1986 (updated from Randall et al. 1988) given for comparison.

	1988			1987			1986		
Fishery	MSW	1SW	Effort	MSW	1SW	Effort	MSW	1SW	Effort
Native									
N.B.	509	70	------	916	95	------	431	26	------
P.Q.	921	3	------	986	5	------	1,145	4	------
Angling									
N.B.	---	6,084	11,076	---	4,414	10,131	-----	4,915	10,098
P.Q.	963	692	9,149	873	591	7,805	1,418	498	7,811
TOTAL	2,393	6,849		2,775	5,105		2,994	5,443	

Table 7. Commercial, angling and Native salmon landings from Baie des Chaleurs and Restigouche River, 1951 to 1988. Data sources given in Appendices 1 to 4.

	Commercial		Angling		Native		
Year	1SW	MSW	1SW	MSW	1SW	MSW	Total
1951		42,453					(46,149)[1]
1952		39,619					(45,758)
1953		31,893					(35,042)
1954		31,327					(34,683)
1955		18,356					(20,705)
1956		15,167					(17,829)
1957		19,916					(23,686)
1958		26,791					(36,496)
1959		32,035					(35,513)
1960		30,618	627	2,427			33,672
1961		21,970	125	3,135			25,230
1962		27,428	203	3,236			30,867
1963		24,097	1,621	5,793			31,511
1964		28,775	136	6,788			35,699
1965		39,547	4,071	3,526			47,144
1966		33,310	1,909	2,138			37,357
1967		34,728	1,341	3,020			39,089
1968		26,719	465	745			27,929
1969		18,356	1,489	1,512			21,357
1970		18,180	1,506	2,042			21,728
1971		8,967	1,172	1,016			11,155
1972	36	23	1,089	5,041			6,189
1973	1,272	295	1,570	4,892			8,029
1974	132	68	1,167	5,948			7,315
1975	163	1,026	1,279	2,901	3	132	5,504
1976	5,107	225	2,722	5,510	13	1,641	15,218
1977	1,134	168	2,792	6,707	19	2,950	13,770
1978	1,522	156	1,604	5,025	23	129	8,459
1979	83	671	2,546	1,823	169	896	6,188
1980	1,986	9	3,242	6,157	58	1,827	13,279
1981	3,045	3,534	3,645	4,240			14,464
1982	2,202	4,437	2,851	2,582	148	1,521	13,741
1983	1,552	4,569	896	2,068	32	1,476	10,593
1984	7,161	2,026	1,822	570	178	1,283	13,040
1985	0	0	3,517	752	35	1,217	5,521
1986	0	0	5,413	1,418	30	1,576	8,437
1987	0	0	5,005	873	100	1,902	7,880
1988	0	0	6,776	963	73	1,430	9,242

[1]Totals from 1951 to 1959 include angling landings for which the 1SW to MSW ratio was unknown.

Table 8. Counts of salmon at a fish barrier on NW Upsalquitch River, 1980 to 1988, and in two estuarial traps, 1985 to 1988.

Year	1SW	MSW	Total
Upsalquitch barrier			
1980	843	887	1,730
1981	789	481	1,270
1982	819	622	1,441
1983	430	301	731
1984	518	642	1,160
1985	748	517	1,265
1986	1,738	1,166	2,904
1987	1,557	1,000	2,557
1988	1,147	979	2,126
Mean (80-87)	930	702	1,632
Estuarial traps			
Lower			
1985	16	52	68
1986	64	109	173
1987	113	188	301
1988	100	80	180
Upper			
1985	34	34	68
1986	109	59	168
1987	468	254	722
1988	152	37	189

Table 9. Biological characteristics of salmon in Restigouche River. Data for 1985 to 1988 from salmon sampled at the Native fishery and/or estuarial traps (Fig. 1). For comparison, data for 1972 to 1980 (Dalhousie trap; Pepper 1983) are also given. Fork length and sea age data includes previous spawners. (PS = previous spawners; y-c = year class).

1. Fork length

	1SW			2SW			3SW			PS		
	n	$\bar{X}$	SD	n	$\bar{X}$	SD	n	$\bar{X}$	SD	n	$\bar{X}$	SD
1972-1980	1,488	53.2	2.7	699	76.5	4.8	291	92.0	4.2	46	95.0	11.1
1985	48	53.2	3.7	45	75.7	4.7	29	92.0	4.3	9	91.9	14.7
1986	170	56.3	3.1	136	77.2	4.2	14	91.4	4.2	13	98.5	10.5
1987	552	55.1	3.1	273	78.6	4.4	97	93.4	3.3	57	96.6	8.7
1988	18	57.5	4.1	161	77.9	3.6	29	93.4	3.7	54	98.7	8.7

2. Sea age, %

	1SW	2SW	3SW	PS
1972-1980	39	43 (70)[1]	15	3
1985	24	38 (50)[1]	30	8
1986	38	50 (81)[1]	7	5
1987	38	39 (63)[1]	16	7
1988	55	36 (80)[1]	5	4

[1] ( )% of MSW salmon which were 2SW.

Table 10. Juvenile salmon densities at 15 electrofishing sites (number per 100m^2) in the Restigouche River, 1972 to 1988. 95% confidence interval in parenthesis.

Year	Age 0+	Age 1+	Age 2+
1972	5.2 (3.0 - 8.8)	2.5 (1.6 - 3.8)	1.2 (0.9 - 1.6)
1973	22.0 (11.4 - 42.5)	2.8 (1.9 - 4.1)	0.7 (0.6 - 1.0)
1974	13.1 (5.9 - 29.3)	6.1 (4.2 - 9.0)	0.6 (0.5 - 0.8)
1975	28.6 (13.3 - 61.8)	4.8 (2.8 - 8.4)	1.5 (1.1 - 2.2)
1976	13.3 (7.1 - 25.0)	6.9 (3.9 - 12.1)	1.0 (0.7 - 1.2)
1977	14.7 (6.6 - 32.6)	3.9 (2.5 - 6.0)	1.4 (1.1 - 1.8)
1978	19.5 (10.9 - 34.9)	6.3 (3.8 - 10.6)	1.0 (0.7 - 1.4)
1979	6.1 (3.7 - 10.2)	5.9 (4.2 - 8.3)	1.4 (1.0 - 2.0)
1980	9.3 (5.1 - 17.0)	3.8 (2.4 - 6.2)	2.1 (1.3 - 3.3)
1981	18.9 (13.2 - 27.0)	2.4 (1.6 - 3.6)	0.4 (0.3 - 0.5)
1982	11.2 (6.2 - 20.2)	3.3 (2.0 - 5.5)	0.4 (0.3 - 0.5)
1983	25.4 (12.0 - 53.6)	7.8 (4.5 - 13.5)	3.1 (1.9 - 5.0)
1984	25.1 (9.2 - 68.2)	7.3 (4.1 - 12.9)	2.5 (1.5 - 4.0)
1985	25.2 (9.4 - 67.6)	10.4 (5.0 - 21.3)	1.6 (1.1 - 2.3)
1986	23.9 (10.5 - 54.3)	7.5 (3.8 - 14.8)	2.8 (1.7 - 4.6)
1987	42.0 (19.3 - 91.2)	9.4 (4.8 - 18.3)	4.7 (2.5 - 8.7)
1988	53.2 (22.9 - 123.6)	6.1 (3.5 - 10.5)	2.1 (1.5 - 3.1)
1972-87 mean	19.0	5.7	1.7

Table 11. Estimated spawners and total returns of MSW salmon in Restigouche River, 1970 - 1988. Spawners were estimated using a spawner/angled fish ratio of 0.7.

Year	Harvest		MSW Released plus P.Q.	PAD	Spawners (S)	Returns (R)	S/R
	Estuary	River					
1970	18,180	2,042	-----	661	1,429	22,313	0.06
1971	8,967	1,016	-----	329	711	11,023	0.06
1972	23	5,041	-----	1,633	3,529	10,225	0.35
1973	295	4,892	-----	1,584	3,424	10,196	0.34
1974	68	5,948	-----	1,926	4,164	12,106	0.34
1975	1,158	2,901	-----	939	2,031	7,029	0.29
1976	1,866	5,510	-----	1,784	3,857	13,017	0.30
1977	3,118	6,707	-----	2,172	4,695	16,692	0.28
1978	285	5,025	-----	1,627	3,517	10,455	0.34
1979	1,567	1,823	-----	590	1,276	5,256	0.24
1980	1,836	6,157	-----	1,994	4,310	14,297	0.30
1981	3,534	4,240	-----	1,373	2,968	12,115	0.24
1982	5,958	2,582	-----	836	1,807 (3,563)[1]	11,184	0.16
1983	6,045	2,068	-----	670	1,448 (2,397)	10,230	0.14
1984	3,309	688[2]	2,242	726	3,123 (5,233)	7,846	0.40
1985	1,217	1,074	4,315	1,397	6,262 (7,898)	9,950	0.63
1986	1,576	1,693	6,181	2,002	8,815 (9,542)	14,085	0.63
1987	1,902	1,073	4,076	1,320	5,856 (8,535)	10,151	0.58
1988	1,430	1,163	5,509	1,784	8,202 (9,516)	12,579	0.65

[1](Spawner counts from field surveys.)

[2]River harvests, 1984 to 1988, include catch and release mortalities of 84, 285, 238, 160 and 182 MSW salmon and broodstock removals of 34, 37, 37, 40, and 18. Estimates of catch and release from DFO fishery officers.

Table 12. Estimated spawners and total returns of 1SW salmon in Restigouche River, 1970 - 1988. Spawners were estimated using a spawner/angled fish ratio of 0.7.

Year	Harvest		PAD	Spawners (S)	Returns (R)	S/R
	Estuary	River				
1970	0	1,506	417	1,054	2,977	0.35
1971	0	1,172	324	820	2,317	0.35
1972	36	1,089	301	762	2,189	0.35
1973	1,272	1,570	435	1,099	4,376	0.25
1974	132	1,167	323	817	2,439	0.33
1975	166	1,279	354	895	2,694	0.33
1976	5,120	2,722	753	1,905	10,501	0.18
1977	1,153	2,792	773	1,954	6,672	0.29
1978	1,545	1,604	444	1,123	4,716	0.24
1979	252	2,546	705	1,782	5,285	0.34
1980	2,044	3,242	897	2,269	8,453	0.27
1981	3,045	3,645	1,009	2,551	10,250	0.25
1982	2,350	2,851	789	1,996 (1,577)[1]	7,986	0.25
1983	1,584	896	248	627 (986)	3,355	0.19
1984	7,339	1,822	504	1,275 (1,374)	10,941	0.12
1985	35	3,517	973	2,462 (2,111)	6,987	0.35
1986	30	5,413	1,498	3,789 (5,190)	10,730	0.35
1987	100	5,005	1,385	3,504 (3,930)	9,994	0.35
1988	73	6,776	1,875	4,743 (3,786)	13,468	0.35

[1] Field spawner counts.

Table 13. Estimates of total spawning escapement, egg deposition and resulting juvenile densities of Atlantic salmon in the Restigouche River, 1971 to 1988. MSW spawners from 1984 to 1988 were estimated from DFO angling data and index camp data (in parenthesis) (see text).

Year	Spawning escapement 1SW	Spawning escapement MSW	Egg deposition (millions)	Juvenile salmon densities 0+	Juvenile salmon densities 1+
1	2	3	4	5	6
1971	820	711	4.3	5.2	2.8
1972	762	3529	20.1	22.0	6.1
1973	1099	3424	21.7	13.1	4.8
1974	817	4164	25.3	28.6	6.9
1975	895	2031	13.4	13.3	3.9
1976	1905	3857	24.9	14.7	6.3
1977	1954	4695	25.6	19.5	5.9
1978	1123	3517	21.4	6.1	3.8
1979	1782	1276	8.1	9.3	2.4
1980	2269	4310	20.5	18.9	3.3
1981	2551	2968	17.8	11.2	7.8
1982	1996	1807	10.9	25.4	7.3
1983	627	1448	8.7	25.1	10.4
1984	1275	3123 (4912)	18.6 (29.2)	25.2	7.5
1985	2462	6262 (9091)	37.4 (54.1)	23.9	9.4
1986	3789	8815 (13195)	52.6 (78.6)	42.0	6.1
1987	3504	5856 (7138)	35.0 (42.6)	53.2	----
1988	4743	8202 (12963)	49.1 (77.3)	----	----

Correlations:

1. Spawners, 1984 - 1988, calculated from DFO data.

	n	r	P
4 with 5	16	0.71	0.0022
4 with 6	15	0.47	0.0757
ln 4 with ln 5	16	0.69	0.0028
ln 4 with ln 6	15	0.61	0.0150

2. Spawners, 1984 - 1988, calculated from index camps data (in parenthesis).

	n	r	P
4 with 5	16	0.69	0.0034
4 with 6	15	0.60	0.0182
ln 4 with ln 5	16	0.73	0.0014
ln 4 with ln 6	15	0.64	0.0103

Table 14. Total returns of MSW salmon to Restigouche River and catch of 1SW salmon at Kedgwick Lodge in the previous year (1969-88). Total returns are calculated in Table 11. Returns of MSW salmon predicted for 1989 are given in parenthesis.

Year (i)	Kedgwick Lodge 1SW salmon catch (year i)	Total returns of MSW salmon to Restigouche (year i+1)
1969	174	22,313
1970	124	11,023
1971	72	10,225
1972	36	10,196
1973	30	12,106
1974	27	7,029
1975	33	13,017
1976	71	16,692
1977	37	10,455
1978	25	5,256
1979	128	14,297
1980	26	12,115
1981	45	11,184
1982	69	10,230
1983	44	7,846
1984	83	9,950
1985	98	14,085
1986	199	10,151
1987	238	12,579
1988	223	(14,611)

MSW returns in 1989 (parenthesis) were estimated from the regression: ln MSW (yr i+1) = 8.41 + 0.22 ln (1SW, yr i). (R^2 = 0.26, df = 18, F = 5.93, P<0.026).

Table 15. Catch rate of 1SW salmon in the Upsalquitch River as estimated by comparing angling catches below the barrier to counts at the barrier. Discharge is average monthly discharges from June to August.

Year	Angling	Barrier	Catch rate	Discharge (m^3 sec^{-1})
1980	1178	843	1.40	40.2
1981	1234	789	1.56	39.4
1982	818	819	1.00	25.5
1983	203	430	0.47	33.6
1984	483	518	0.93	45.6
1985	1175	748	1.57	48.9
1986	1397	1738	0.80	25.6
1987	819	1557	0.53	10.2
1988	1296	1147	1.13	17.1

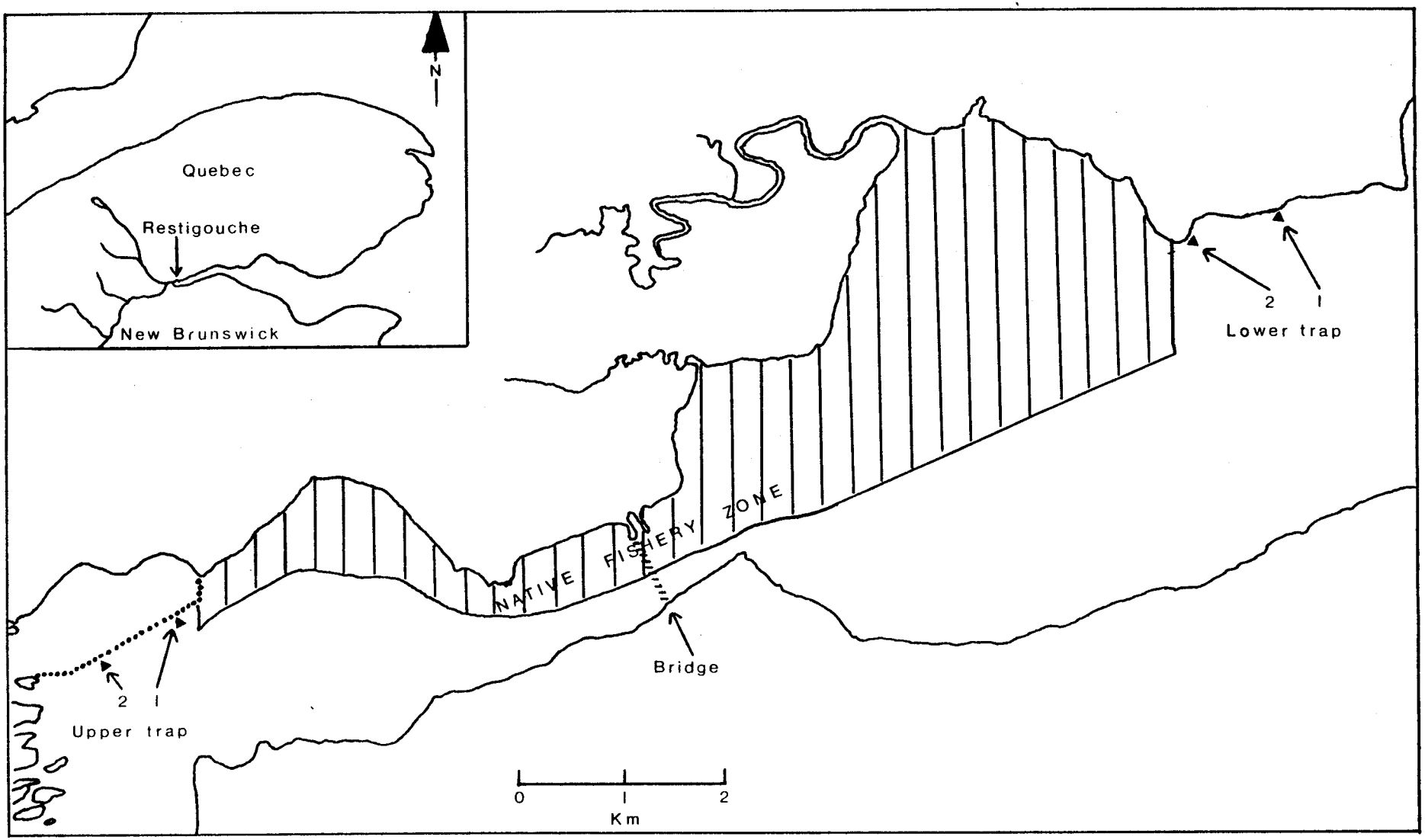


Figure 1. Map of the lower Restigouche River showing the location of the salmon traps (operated by Ministere du Loisir, de la Chasse et de la Peche) and the native fishery at Restigouche. (1 is 1985 location; 2 is the 1986 to 1988 locations)

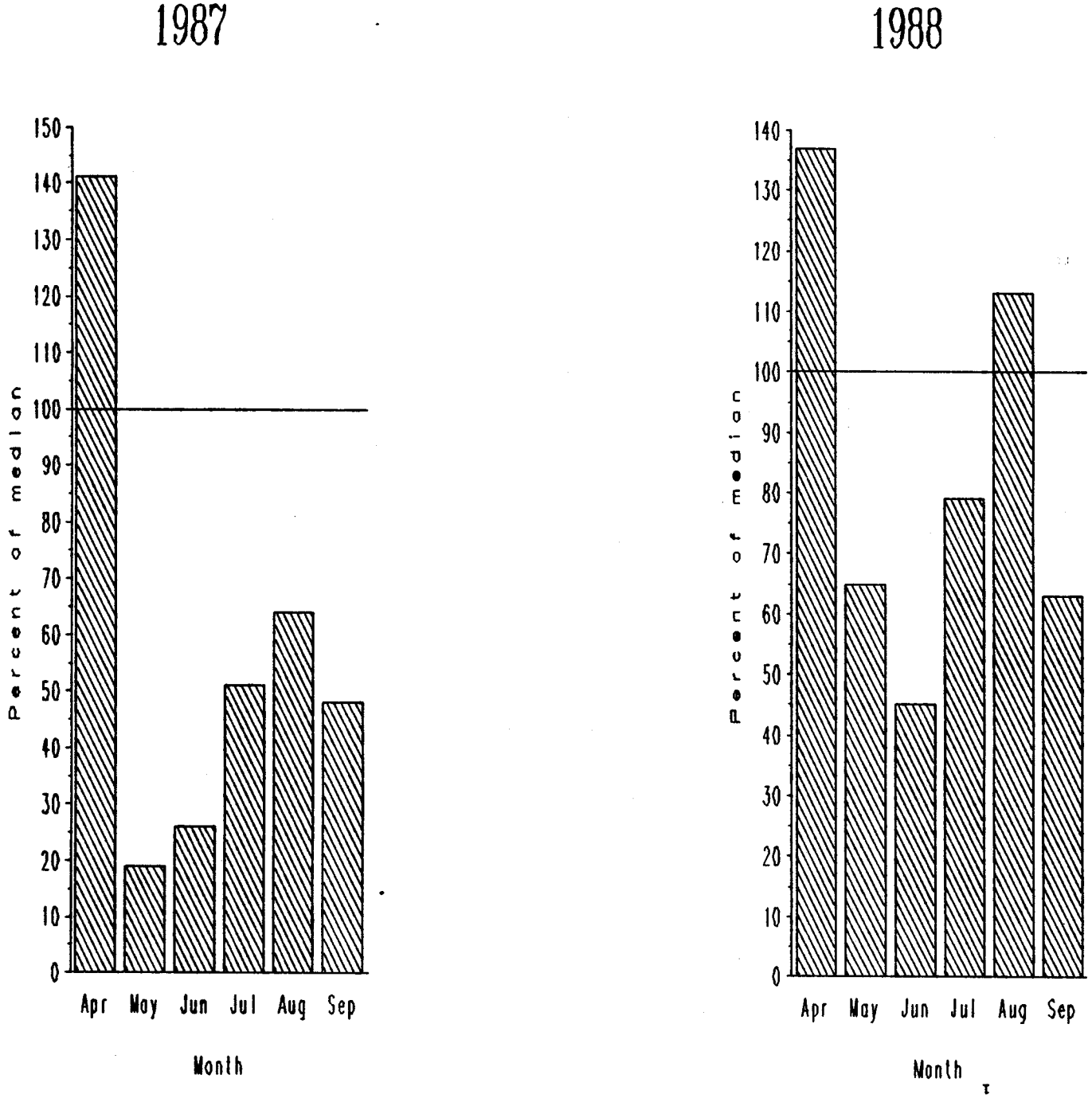


Figure 2. Mean monthly discharge of the Upsalquitch River in 1987 and 1988, expressed as a percent of the long term median.

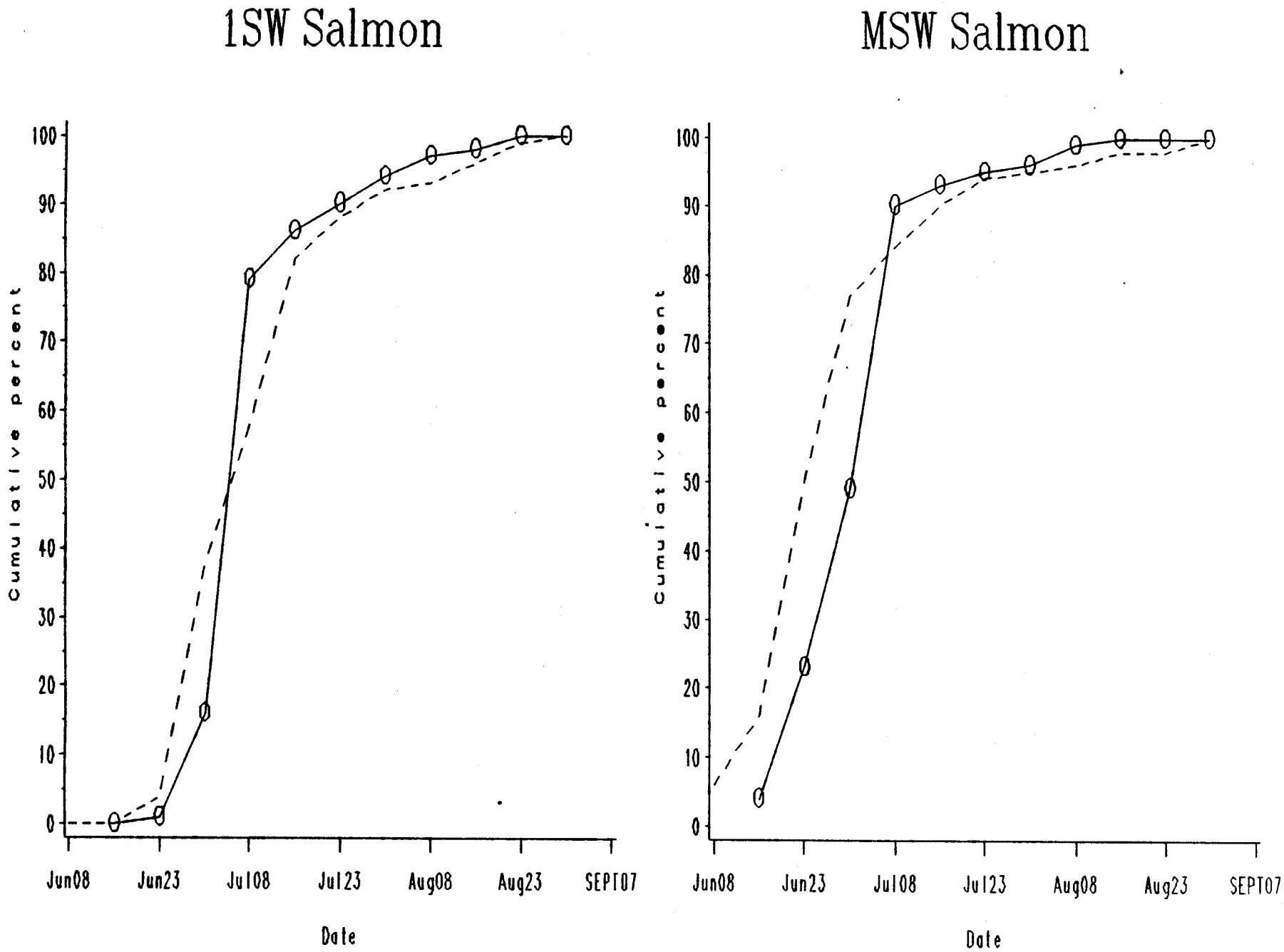


Figure 3. Cumulative catch (%) of 1SW and MSW salmon in the lower estuarial trap, Restigouche River, in 1987 (dashed line) and 1988 (solid line).

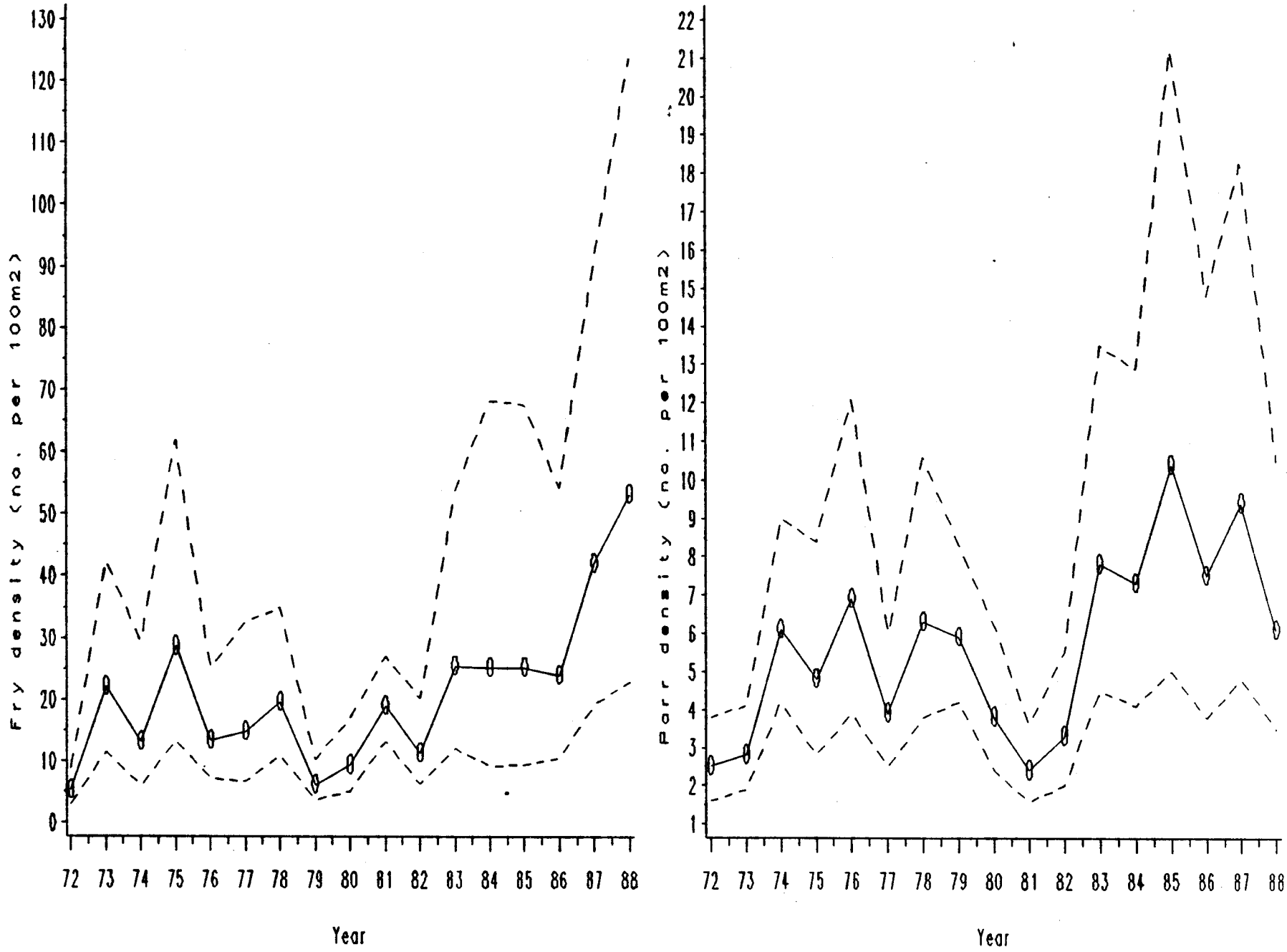


Figure 4. Mean densities (per 100m2) of age 0+ (1eft) and age 1+ (right) salmon at 15 sites in the Restigouche River, 1972 to 1988.

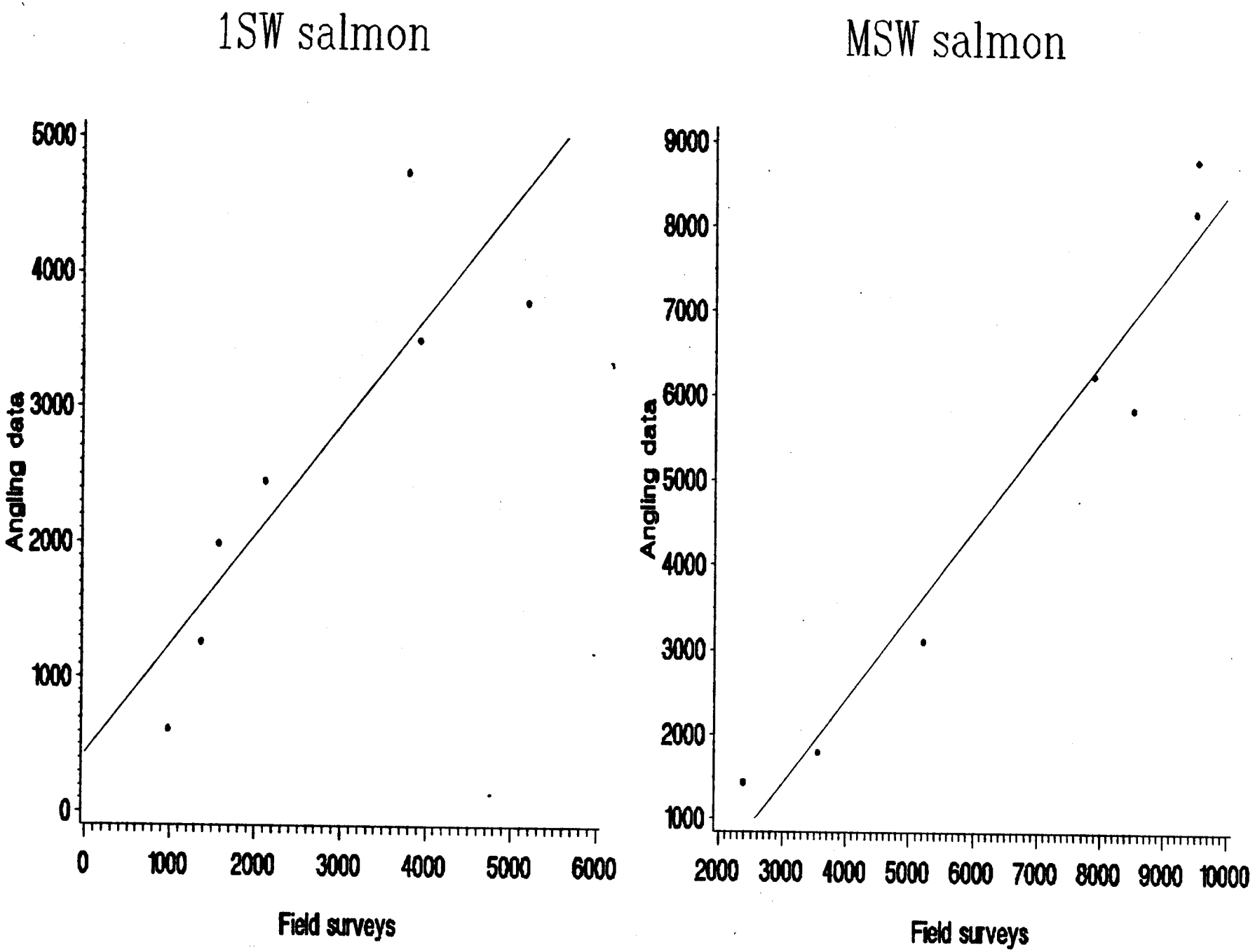
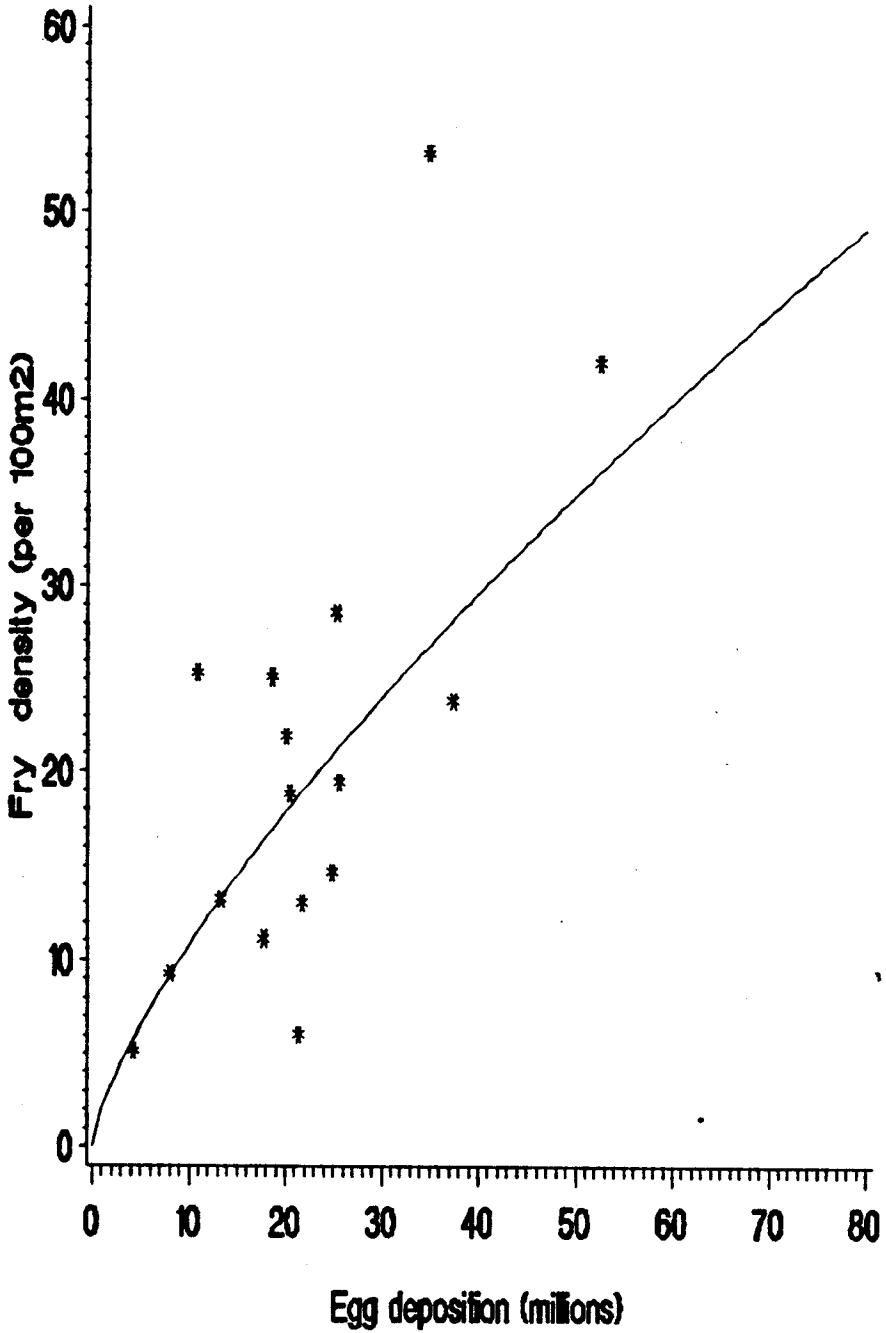


Figure 5. Correlation between spawning escapements as estimated from field spawner counts (canoe surveys) and from angling catch data. Correlations for both 1SW and MSW salmon were significant (P«0.05).



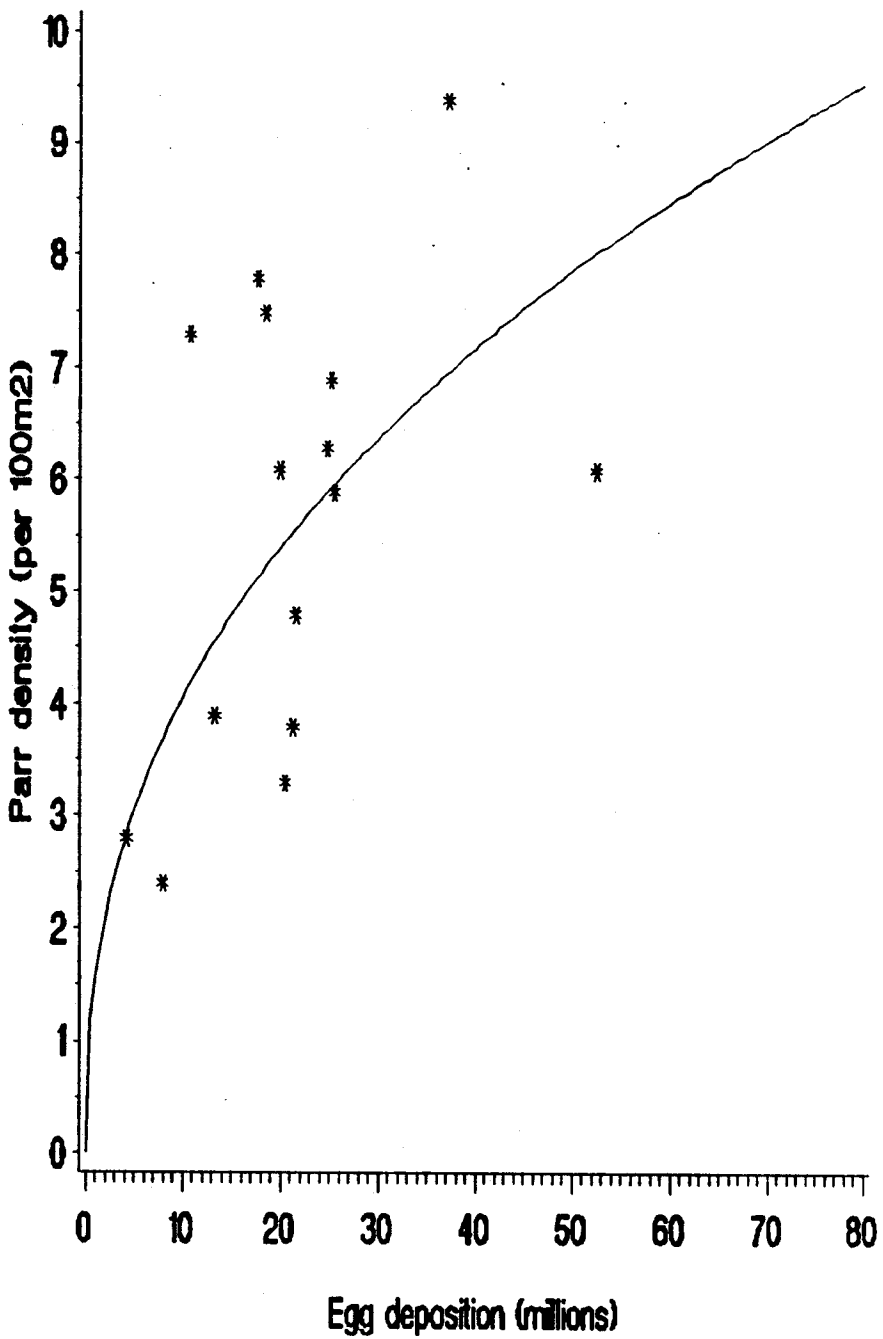


Figure 6. Relationships between estimated egg deposition and resulting age 0+ (left) and age 1+ parr densities in the Restigouche River, 1972 to 1988. (For age 0+ salmon, R2=0.38, P«0.015; for age 1+ salmon, R2=0.48, P«0.003).

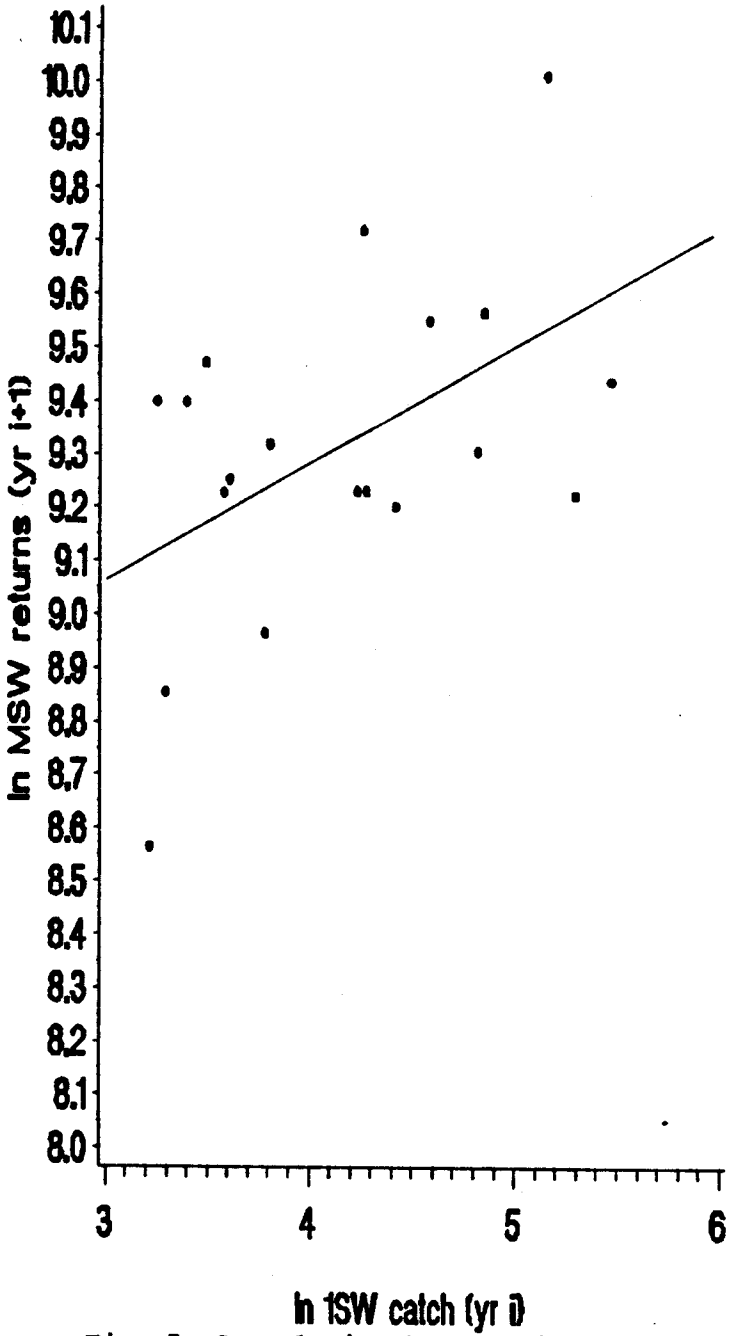


Fig. 7. Correlation between 1SW salmon catch at Kedgwick Lodge (year i) and MSW salmon returns to Restigouche River (year i+1) (regression equation given in Table 14.)

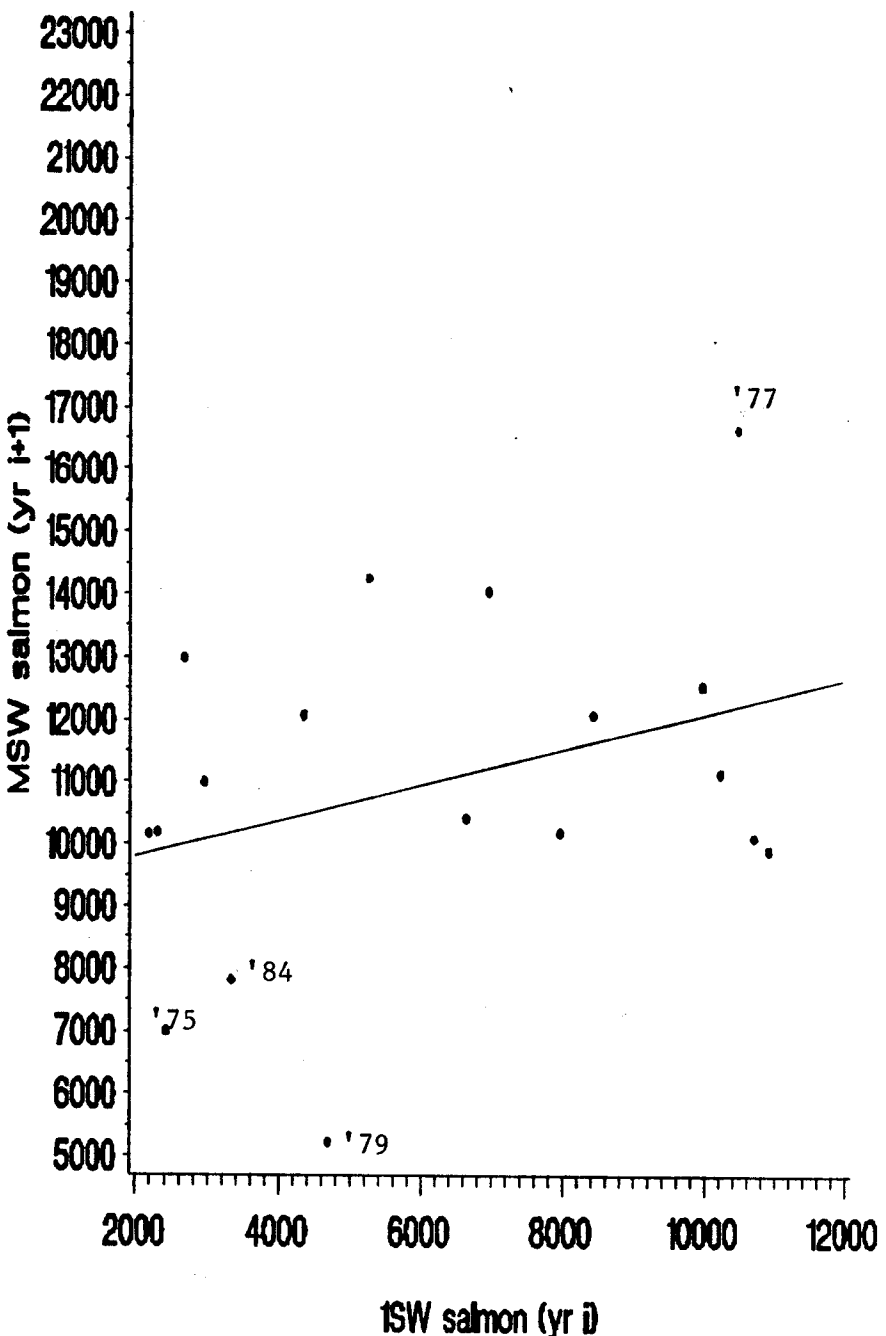


Fig. 8. Relationship between total estimated returns of 1SW salmon (year i) and MSW salmon returns (year i+1) to the Restigouche River. The relationship was not significant.

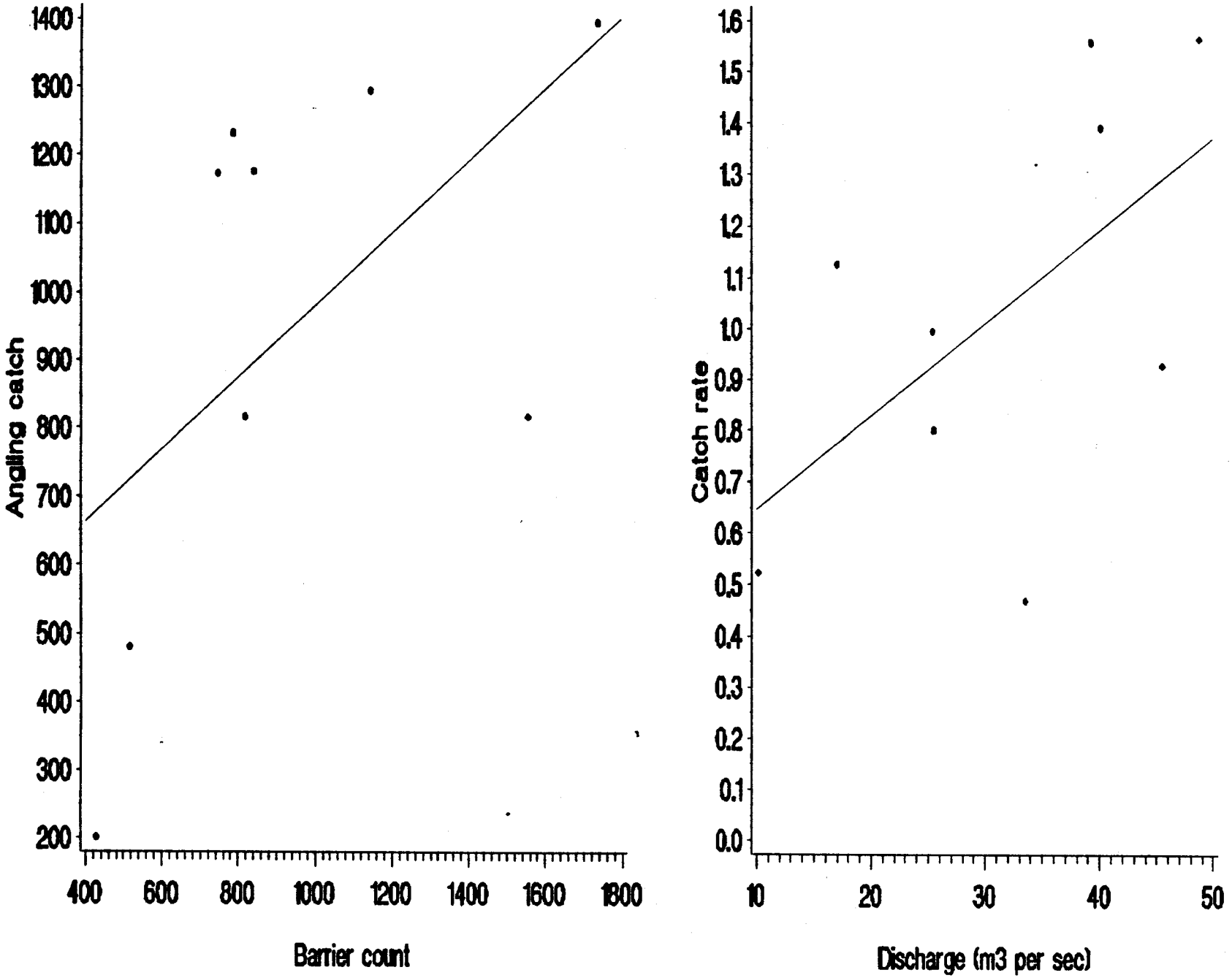


Figure 9. Left: Correlation between the count of 1SW salmon at the Upsalquitch barrier and angling catch below the barrier. Right: correlation between discharge rate and the angling catch rate (angling catch/barrier count) in the Upsalquitch River.

APPENDIX 1

Commercial salmon landings from Baie des Chaleurs and Restigouche River, 1951 to 1988. Data sources given in Appendix 4.

Year	New Brunswick			Québec			TOTAL
	1SW	MSW	TOTAL	1SW	MSW	TOTAL	
1951		17,718	17,718		24,735	24,735	42,453
1952		19,207	19,207		20,412	20,412	39,619
1953		16,868	16,868		15,025	15,025	31,893
1954		17,081	17,081		14,246	14,246	31,327
1955		8,221	8,221		10,135	10,135	18,356
1956		7,513	7,513		7,654	7,654	15,167
1957		9,639	9,639		10,277	10,277	19,916
1958		15,380	15,380		11,411	11,411	26,791
1959		16,159	16,159		15,876	15,876	32,035
1960		13,537	13,537		17,081	17,081	30,618
1961		12,119	12,119		9,851	9,851	21,970
1962		16,443	16,443		10,985	10,985	27,428
1963		13,820	13,820		10,277	10,277	24,097
1964		15,876	15,876		12,899	12,899	28,775
1965		22,750	22,750		16,797	16,797	39,547
1966		17,789	17,789		15,521	15,521	33,310
1967		21,404	21,404		13,324	13,324	34,728
1968		15,734	15,734		10,985	10,985	26,719
1969		10,206	10,206		8,150	8,150	18,356
1970		9,100	9,100		9,080	9,080	18,180
1971		3,949	3,949		5,018	5,018	8,967
1972	36	23	59	0	0	0	59
1973	723	168	891	549	127	676	1,567
1974	31	16	47	101	52	153	200
1975	144	906	1,050	19	120	139	1,189
1976	3,674	162	3,836	1,433	63	1,496	5,332
1977	1,134	168	1,302	0	0	0	1,302
1978	1,522	156	1,678	0	0	0	1,678
1979	83	671	754	0	0	0	754
1980	1,986	9	1,995	0	0	0	1,995
1981	3,045	3,534	6,579	0	0	0	6,579
1982	2,118	2,545	4,663	84	1,892	1,976	6,639
1983	1,467	2,227	3,694	85	2,342	2,427	6,121
1984	7,161	2,026	9,187	0	0	0	9,187
1985	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0

APPENDIX 2

Angling salmon landings from Restigouche River, 1951 to 1988. Data sources given in Appendix 4.

Year	New Brunswick			Québec			TOTAL
	1SW	MSW	TOTAL	1SW	MSW	TOTAL	
1951			3,511	25	160	185	3,696
1952			5,662	104	373	477	6,139
1953			2,963	75	111	186	3,149
1954			2,855	127	374	501	3,356
1955			2,018	99	232	331	2,349
1956			2,328	107	227	334	2,662
1957			3,387	124	259	383	3,770
1958			9,135	220	350	570	9,705
1959			3,161	108	209	317	3,478
1960	621	2,406	3,027	6	21	27	3,054
1961	117	3,103	3,220	8	32	40	3,260
1962	202	3,236	3,438	1	0	1	3,439
1963	1,617	5,788	7,405	4	5	9	7,414
1964	0	6,480	6,480	136	308	444	6,924
1965	3,860	3,050	6,910	211	476	687	7,597
1966	1,710	1,687	3,397	199	451	650	4,047
1967	1,084	2,440	3,524	257	580	837	4,361
1968	408	617	1,025	57	128	185	1,210
1969	1,352	1,200	2,552	137	312	449	3,001
1970	1,340	1,716	3,056	166	326	492	3,548
1971	999	757	1,756	173	259	432	2,188
1972	978	3,870	4,848	111	1,171	1,282	6,130
1973	1,423	3,746	5,169	147	1,146	1,293	6,462
1974	1,038	4,785	5,823	129	1,163	1,292	7,115
1975	1,130	2,160	3,290	149	741	890	4,180
1976	2,345	4,481	6,826	377	1,029	1,406	8,232
1977	2,333	5,128	7,461	459	1,579	2,038	9,499
1978	1,322	3,373	4,695	282	1,652	1,934	6,629
1979	1,990	997	2,987	556	826	1,382	4,369
1980	2,833	4,098	6,931	409	2,059	2,468	9,399
1981	3,010	2,832	5,842	635	1,408	2,043	7,885
1982	2,449	1,620	4,069	402	962	1,364	5,433
1983	715	1,481	2,196	181	587	768	2,964
1984	1,474	0	1,474	348	570	918	2,392
1985	3,258	0	3,258	259	752	1,011	4,269
1986	4,915	0	4,915	498	1,418	1,916	6,831
1987	4,414	0	4,414	591	873	1,464	5,878
1988	6,084	0	6,084	692	963	1,655	7,739

APPENDIX 3

Native salmon landings from Baie des Chaleurs and Restigouche River, 1975 to 1988. Data sources given in Appendix 4.

Year	New Brunswick			Québec			TOTAL
	1SW	MSW	TOTAL	1SW	MSW	TOTAL	
1975	3	132	135				135
1976	13	124	137	0	1,517	1,517	1,654
1977	19	212	231	0	2,738	2,738	2,969
1978	23	129	152				152
1979	84	148	232	85	748	833	1,065
1980	34	264	298	24	1,563	1,587	1,885
1981	20	211	231				231
1982	12	155	167	148	1,521	1,669	1,836
1983	0	260	260	32	1,216	1,248	1,508
1984	1	213	214	177	1,070	1,247	1,461
1985	0	241	241	35	976	1,011	1,252
1986	26	431	457	4	1,145	1,149	1,606
1987	95	916	1,011	5	986	991	2,002
1988	70	509	579	3	921	924	1,503

APPENDIX 4

Salmon landings for Baie des Chaleurs and Restigouche River given in Appendices 1 to 3 are from the following sources:

1. Commercial data

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

   New Brunswick and Québec commercial data for 1951 to 1969 from May and Lear (1971) and assume salmon average 6.4 kg.

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

   Québec commercial for 1970 to 1981 from Bureau de la Statistique du Québec (G. Ouellet and J.P. Lebel, pers. comm.), and assume average weight and MSW/1SW ratio same as calculated from Redbooks.

   Québec commercial for 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 angling data for 1951 to 1959 from Smith (1981); 1960 to 1969 from Swetnam and O'Neil (1985); 1970 to 1979 from O'Neil 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); and 1987 from O'Neil (pers. comm.).

   Québec angling from 1951 to 1969 from New Brunswick Department of Natural Resources and Energy files (A. Madden, pers. comm.). Angling data for 1970 to 1987 from Ministère du Loisir, de la Chasse et de la Pêche, Québec (G. Ouellet, J.P. Lebel and G. Landry, pers. comm.).

3. Native data

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

   Québec Native data for 1976 to 1984 from Gaudreault (1984); 1985 to 1987 from Ministère du Loisir, de la Chasse et de la Pêche, Québec (G. Landry, pers. comm.).

4. All 1988 data are preliminary as described in text.

APPENDIX 5

Angling salmon landings from Restigouche River System, 1970-1988. Data sources given in Appendix 4.

	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
1982	259	841	818	214	143	112	322	190	59[1]	50[1]	1250	1175
1983	154	456	203	218	27	103	68	224	14	0	430	1067
1984[2]	318	527	483	0	45	33	149	10	102	0	725	0
1985	208	708	1175	0	103	32	329	12	163	0	1539	0
1986	387	1293	1397	0	162	89	565	36	481	0	2421	0
1987	498	817	819	0	193	40	582	16	407	0	2506	0
1988	580	902	1296	0	188	29	807	32	524	0	3381	0

[1] Prior to 1982 Little Main landings included in Main Restigouche.

[2] Hook and release of MSW salmon began in New Brunswick.

APPENDIX 6

Operating dates of Native fisheries in Baie des Chaleurs and Restigouche River, 1979 to 1988. Data sources given in Appendix 4.

	New Brunswick		Québec
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
1986	May 19 - August 10	May 26 - July 20[1]	June 2 - June 26
1987	May 24 - July 27	May 24 - July 15[2]	June 1 - June 30
1988	May 16 - August 26	May 16 - August 14	June 6 - July 6

1 One trap net in 1986.
2 Two trap nets in 1987 and 1988.