Status of Atlantic salmon in the Restigouche River, 1986

by

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ABSTRACT

Catches at two estuarial traps and the Native fishery at Restigouche indicate salmon returned earlier to the Restigouche River in 1986 than in 1985. Angling catches of MSW salmon (in Québec) and 1SW salmon (Québec and New Brunswick) exceeded average catches of previous years, suggesting returns in 1986 were relatively high, particularly for 1SW salmon. Counts of MSW and 1SW salmon at Upsalquitch barrier were also greater than average (about 2X). Total returns were estimated to be 19,900 MSW and 11,000 1SW salmon, and spawning requirements were apparently met in 1986. The 1986 management plan, which restricted harvest of MSW spawners in homewaters, resulted in 75% of MSW salmon returns potentially surviving to spawn. Large average size for 1SW salmon in 1986 suggests growth conditions at sea were favourable, and high marine survival might explain the increased abundance of salmon in 1986. Returns in 1987 are forecasted to be 21,900 MSW salmon and 9,100 1SW salmon.

RESUME

Les relevés des prises réalisées dans deux parcs estuariens et par la pêche pratiquée par les autochtones à Restigouche indiquent que les saumons sont revenus dans la rivière Restigouche plus tôt en 1986 qu'en 1985. Les résultats de la pêche à la ligne du saumon PHM (au Québec) et du saumon 1HM (Québec et Nouveau-Brunswick) ont dépassé les prises moyennes des années antérieures, ce qui indiquerait que les retours ont été relativement élevés en 1986, surtout dans le cas du saumon 1HM. Les dénombrements de saumons PHM et 1HM à la barrière d'Upsalquitch ont également été plus élevés que les valeurs moyennes (environ le double). On a estimé que les retours totaux étaient de 19 900 dans le cas du saumon PHM et 11 000 dans le cas du saumon 1HM; les besoins en matière de frai auraient été atteints en 1986. Le plan de gestion de 1986, qui limitait la récolte des géniteurs PHM dans les eaux territoriales, a eu pour effet que 75 % des saumons PHM ont pu survivre pour frayer. Les tailles moyennes élevées dans le cas des saumons 1HM en 1986 indiqueraient que les conditions de croissance en mer étaient favorables et le taux de survie élevé en mer pourrait expliquer l'abondance accrue du saumon en 1986. On prévoit que les retours en 1987 seront de 21 900 saumons PHM et de 9 100 saumons 1HM.

INTRODUCTION

The management plan for Atlantic salmon in the Restigouche River in 1986 was a continuation of a five-year conservation program introduced in 1984-85. Commercial fisheries in Baie des Chaleurs remained closed in both Québec and New Brunswick. Anglers in New Brunswick were required to release all multi-sea-winter (MSW) salmon (≥ 63 cm) and landings of one-sea-winter (1SW) salmon were restricted by season, possession and daily bag limits of ten, six and two fish, respectively. Québec anglers were allowed to land both 1SW and MSW salmon, with a daily and seasonal limit of one and seven fish, respectively. However, Québec anglers fishing in Québec/New Brunswick boundary waters were also 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, Québec, were allowed a 6,995 kg quota, as in 1984 and 1985. Native fishermen at Eel River Bar, New Brunswick, were not controlled by quota.

The purpose of this assessment was to summarize salmon landings in 1986, to estimate spawning escapement, and to evaluate the impact of the 1986 management plan on Atlantic salmon in the Restigouche River.

METHODS

1. Angling and Native catch-and-effort data

Angling catch-and-effort data from Québec portions of the Restigouche River 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 (≥ 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 were estimated using three 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 Québec angling and New Brunswick angling catches, 1970 to 1983 (Table 2); and (iii) reported catch-and-release data from DFO fishery officers.

Native fishery landings from Restigouche, Québec, 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. Counts of salmon at the Upsalquitch fish barrier, monitored since 1980, were provided by DNRE. Counts of salmon at two estuarial monitoring traps (1985 and 1986) were provided by MLCP.

Biological characteristics of Atlantic salmon entering Restigouche River in 1986 were from samples collected at the Native fishery and/or the estuarial traps (Fig. 1). Salmon were measured (FL to nearest cm) and aged.

2. Recruitment

Densities of salmon fry (age 0+) and parr (1+) were estimated by electrofishing at 30 sites in the Restigouche River in 1986. Densities (number$\cdot 100m^{-2}$) were calculated using the removal method (Zippin 1956; Randall and Chadwick 1986).

3. Spawning escapement in 1986

Two methods were used to estimate spawning escapement in 1986:

Method 1: An angling exploitation rate of 0.20 (Chadwick and Randall [1983]) was used. Spawning escapement was calculated as angling catch/0.20, minus angling and poaching removals. Total returns were calculated as the sum of escapement, harvest and poaching removals.

Method 2: A ratio of spawner to angled fish of 0.87 was used (Table 3). This ratio was updated from the 1985 assessment (Randall et al. 1986) by including 1986 parr densities. Annual egg depositions were back-calculated from small parr 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 1986 was estimated as the product of the spawner to angled fish ratio and angling catch in 1986.

For the past few years, spawning surveys have been conducted on all major tributaries of the Restigouche River each autumn by DNRE and MLCP personnel. Surveys are conducted in September (Québec) and October (New Brunswick) each year. Fishery wardens canoe sections of river and make visual counts of all salmon observed. Results of these surveys for 1982 to 1985 are used in this assessment for comparison with spawners as estimated with Methods 1 and 2.

Mortalities due to poaching and disease were assumed to be 2,000 MSW salmon and 1,000 1SW salmon, as in previous assessments. Mortalities from stress of catch and release of MSW salmon were estimated from observations at five angling camps, and from a catch-and-release study on Upsalquitch River. Camp managers provided data on the total number of MSW salmon caught and released in their stretch of water, and observations on mortalities that may have resulted from catch-and-release stress (i.e. no physical indication of furunculosis on fish). On Upsalquitch River, portions of salmon hooked and released by anglers in a Crown Reserve angling area were tagged and pools were subsequently monitored for mortalities.

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.

4. Forecast

Returns of MSW salmon to the Restigouche River in 1987 were predicted from a significant 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). Returns of 1SW salmon were predicted from previous five-year averages.

RESULTS

1. Landings

Landings of MSW salmon in Québec portions of the Restigouche watershed increased to 1,247 fish in 1986 from 752 fish in 1985, an increase of 66% (Table 4). Effort (rod-days) also increased from 5,759 to 7,486 (30%) and may have partially contributed to increased catches of MSW salmon. Québec catches in 1986 were 23% above long-term average (Table 2).

Estimates of numbers of MSW salmon caught and released in New Brunswick in 1986 are given below:

Method	R^2	NB catch	Total catch minus camps	Total catch
1. Camps versus total angling	0.87	7,589	7,603	8,836
2. PQ vs NB angling	0.52	3,313	---	4,560
3. Reported by DFO officers	---	4,763	---	6,010

Method 1, which uses data from four angling camps to predict total numbers of MSW salmon caught and released in New Brunswick, was judged to be the best estimate, as in the previous two assessments (Randall et al. 1985; 1986). New Brunswick catch-and-release data from Method 1 indicated catches in 1986 increased by 43% from 1985 (7,589 from 5,310; Table 2). Angling effort was similar in both years (Table 4). MSW salmon catches in New Brunswick in 1986 were the highest catches recorded in the data series (1970 to 1986); however, recent catch-and-release data (1984 to 1986) are probably not comparable to historic landing data because of the possibility of recaptures.

Landings of 1SW salmon in Québec increased in 1986 (428 fish) from 1985 (259 fish) by 65% (Table 2), but as with MSW salmon, part of this increase may have resulted from increased effort. Landings in New Brunswick also increased from 3,258 fish (1985) to 4,915 fish (1986), an increase of 51%. Landings of 1SW salmon in both provinces were above long-term averages (Table 2). Returns of both 1SW and MSW salmon in 1986, judging from angling data, were above average.

Reported landings from Native fisheries at Eel River Bar and Restigouche were similar in 1985 and 1986 (Table 4). Native fishermen at Restigouche reported landing 5,900 kg, or 84% of the designated quota (6,995 kg). The quota in 1986, however, was achieved by the end of June, much earlier than in previous years (Fig. 2).

Total salmon landings in the Restigouche River in 1986 are compared to historic landings in Table 5.

Returns of both 1SW and MSW salmon to the Upsalquitch barrier in 1986 were the highest recorded for the 1980 to 1986 data series (Table 6). Counts of both 1SW and MSW were over twice the 1980 to 1985 average. Catches at two estuarial traps also increased from 1985 to 1986 (Table 6); however, trap locations were changed between years (Fig. 1), and this may account for some of the changes in catches.

Anglers reported that salmon returned to the Restigouche River earlier in 1986 than in 1985. Catches at the lower estuarial trap confirmed this (Fig. 3) and indicated it was true for both 1SW and MSW fish. Early returns were also reflected in the Native fishery at Restigouche where the quota was caught early (Fig. 2). Biological characteristics of salmon sampled from the Native fishery and/or estuarial sampling traps indicated 1SW salmon were larger than usual (Table 7). Most (76%) of 1SW salmon were from the 1982 year-class (1981 spawners) while 2SW salmon were mainly (78%) from the 1981 year-class (1980 spawners).

2. Recruitment

Although densities of age 0+ salmon were above average (Table 8), they were not as high as expected from the estimate of spawning escapement in 1985 (Randall et al. 1986). Densities of age 1+ parr were slightly above average (Table 8). Age 1+ parr (year i+2) were roughly correlated (R^2 = 0.51, $P < 0.05$) with angling catches (year i), but only if the 1983 value was omitted (Fig. 4).

3. Spawning escapement

A total angling catch of 8,800 MSW salmon (Québec landings and estimates of catch and release in New Brunswick, page 5) was used for estimating spawning escapement. Mortality rate attributed to catch-and-release stress was estimated to be 5%:

	Catch and release	Mortalities	Proportion
Camp 1	330	6	0.02
Camp 2	133	22	0.17
Camp 3	197	18	0.09
Camp 4	374	12	0.03
Camp 5	293	12	0.04
Total	1,327	70	0.05

The above estimate of catch-and-release mortality is probably an overestimate for two reasons: (1) a proportion of mortalities reported by camp managers probably died from furunculosis even though symptoms were undetectable; (2) extensive surveillance of the Upsalquitch River in 1986 indicated mortalities attributable to the catch-and-release program were low. Of 33 fish tagged before release, none were subsequently observed dead in pools despite close observations. Within the whole Upsalquitch tributary, 48 MSW salmon mortalities were observed, which is 8% of the number of MSW salmon released by anglers (Table 9). This is the maximum rate that could be attributed to angling stress. However, most of these deaths probably resulted from furunculosis. Twenty-two of 23 mortalities observed within Upsalquitch barrier had symptoms of furunculosis, and all salmon sent to Halifax for autopsy (6) were confirmed to have died from this disease (A. Eaton, DFO, Halifax). Assuming 50% of MSW salmon deaths outside of the barrier resulted from angling stress would indicate a mortality rate of 3%. These observations suggest catch-and-release mortalities were low and a rate of 5% is probably an overestimate. It was interesting to note that of the 33 salmon tagged and released in Upsalquitch River, none were subsequently caught a second time.

Spawning escapement as estimated using two methods is given below:

	Method 1		Method 2	
	MSW	1SW	MSW	1SW
1. Total returns	45,378	26,733	19,871	11,009
2. Harvest	2,625	5,361	2,625	5,361
3. Poaching and disease	2,000	1,000	2,000	1,000
4. Broodstock	37	0	37	0
5. Catch-and-release mortality	379	---	379	---
6. Spawning escapement	40,337	20,372	14,830	4,648
7. Target spawners	12,200	2,600	12,200	2,600
% target achieved	331%	784%	122%	179%

As in past years, there was a large discrepancy between spawners as estimated by the two methods. Without data for support, we have assumed in previous assessments that Method 2 was relatively more accurate (Randall et al. 1985; 1986). Spawner counts from field surveys seem to support this assumption, as field counts are more comparable to spawners as estimated by Method 2 than Method 1 (Table 10). Method 2 (above) indicates spawning requirements were met in 1986 for both MSW and 1SW salmon. Total returns were estimated to be 19,871 MSW salmon and 11,009 1SW salmon.

4. Forecast

MSW salmon returns in 1987 are predicted to be 21,883 fish, as estimated from the equation (Table 11; Fig. 5):

$$y = 8{,}873.51 + 65.4\ x$$

where y = MSW salmon returns (year i+1)
x = 1SW salmon catch, Kedgwick Lodge (year i)
$R^2 = 0.52$, $n = 17$, $P < 0.01$

y (1987) = 21,883 (14,145 - 29,622).

Total 1SW returns in 1987 could be 9,060 fish, assuming returns will be average (1982 to 1986; Table 13).

DISCUSSION

Returns of both 1SW and MSW salmon in 1986 were higher than predicted last year. An estimated 19,900 MSW salmon returned, which was 34% greater than predicted in the 1985 assessment (14,800 ± 5,900) (Table 14). 1SW salmon returns were 25% greater than predicted (11,000 versus 8,800 salmon). As in the previous two years, the 1986 management plan had a significant impact on the proportion of MSW salmon returns that potentially survived to spawn. An estimated 75% of MSW salmon survived to spawn in 1986, compared to < 30% in most years before the 1984-86 management plan was introduced (Table 12). Spawning requirements were apparently met in 1986 in the Restigouche River.

Reasons for greater salmon returns than forecasted in 1986 may have resulted in part from favourable conditions in the marine environment, at least for 1SW salmon. Grilse were larger than usual in 1986, indicating good growth conditions at sea, which may also have affected survival. The marine environment may have favoured MSW salmon survival also, although their average size was apparently not affected. Judging from captures of salmon in the two estuarial monitoring traps and the Native fishery, returns of both 1SW and MSW salmon were early in 1986, and this may have affected relative exploitation rates in high seas fisheries as well. It is difficult to attribute increased returns in 1986 to spawning escapement in previous years, since MSW salmon spawners were judged to be relatively low in all years contributing to salmon returns in 1986 (i.e. the 1979 to 1981 spawning years).

The large discrepancy in estimates of spawning escapement between Methods 1 and 2 observed in previous assessments (Randall et al. 1985; 1986) was evident again in 1986. As mentioned previously, agreement between estimated spawners as indicated by Method 2 and field surveys may suggest parr densities are a better indication of escapement than angling catches (assuming an exploitation rate of 20%). If we assume escapement as estimated by either parr densities or field spawner counts are relatively more accurate, they indicate a significantly higher angling exploitation rate for the Restigouche than what has been used previously (Table 15). Using an exploitation rate of 0.43 (Table 15) would make spawning escapement as estimated by Method 1 more comparable to estimates from Method 2 and field surveys.

The forecast of MSW salmon returns in 1987 was 21,900 fish, indicating a potential surplus to spawning requirements of 9,700 MSW salmon. Assuming average returns of 1SW salmon would indicate returns of 9,100 fish, or a potential surplus of 6,500 1SW salmon.

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Table 1. Catches of MSW salmon at four index angling camps (Chadwick et al. 1984) and total catch in the Restigouche River.

Year	MSW salmon angling catch	
	Angling camps	Total catch minus camps
1970	277	1,765
1971	194	822
1972	601	4,440
1973	571	4,321
1974	959	4,989
1975	494	2,407
1976		
1977	909	5,798
1978	615	4,410
1979	353	1,470
1980	905	5,252
1981	602	3,638
1982	453	2,129
1983	409	1,659
1984	490	(2,836)[1]
1985	859	(5,203)[1]
1986	1,233	(7,603)[1]

[1] Total catches in 1984, 1985 and 1986 were estimated from the correlation between catch at the angling camps (x) and total catch (y) 1970 to 1983; $y = -308.7 + 6.4(x)$; $R^2 = 0.87$, $P < 0.01$.

Table 2. Angling catches in the Restigouche River, 1970 to 1986.

Year	MSW PQ	MSW NB	MSW Total	1SW PQ	1SW NB	1SW Total	Proportion MSW
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	[2,756][1]	[3,326]	348	1,474	1,822	0.65
1985	752	[5,310]	[6,062]	259	3,258	3,517	0.63
Mean	1,014	3,069	4,084	299	1,790	2,089	0.65
1986	1,247	[7,589]	[8,836]	428	4,915	5,343	0.62

[1] Estimates in parenthesis [ ] include MSW salmon released in New Brunswick. New Brunswick catch-and-release data (1984 to 1986) were estimated from a correlation between four angling camps and total angling catch (Table 1).

Table 3. Ratios of spawner per angled fish in the Restigouche River, 1970 to 1984.

Year (i)	Parr/m^2 (i+2)	Eggs/MSW salmon	Proportion MSW	Spawners		Ratio of spawner per angled fish
				MSW	1SW	
1970	0.021	5,933	0.58	1,054	763	0.52
1971	0.025	5,933	0.46	1,254	1,472	1.23
1972	0.068	5,661	0.82	3,576	785	0.71
1973	0.099	6,282	0.76	4,691	1,481	0.96
1974	0.085	6,056	0.84	4,178	796	0.70
1975	0.043	6,565	0.69	1,950	876	0.67
1976	0.081	6,441	0.67	3,744	1,844	0.68
1977	0.071	5,445	0.71	3,882	1,585	0.58
1978	0.039	6,094	0.76	1,905	602	0.38
1979	0.035	6,155	0.42	1,693	2,338	0.93
1980	0.041	4,700	0.66	2,597	1,338	0.42
1981	0.068	5,933	0.54	3,412	2,906	0.80
1982	0.050	5,933	0.48	2,509	2,718	0.97
1983	0.100	5,933	0.70	5,017	2,150	2.43
1984	0.066	5,933	0.65	3,311	1,783	1.00
Mean						0.87
S.D.						0.49

Table 4. Preliminary 1986 nominal landings and effort in Restigouche River from Native and angling fisheries. Landings for 1985 and 1984 (updated from Randall et al. 1986) given for comparison.

	1986			1985			1984		
Fishery	MSW	1SW	Effort	MSW	1SW	Effort	MSW	1SW	Effort
Commercial									
NB	---	---	0	---	---	0	1,958	6,716	220
PQ	---	---	0	---	---	0	---	---	0
Native									
Cross Point	1,145	4		976	35		1,070	177	
Eel River	233	14		241	0		213	1	
Angling									
NB	---	4,915	10,098	---	3,258	10,499	---	1,474	7,298
PQ	1,247	428	7,486	752	259	5,759	570	348	5,639
TOTAL	2,625	5,361		1,969	3,552		3,811	8,716	

Table 5. Commercial, angling and Native salmon landings from Baie des Chaleurs and Restigouche River, 1951 to 1986. Data are numbers x 10^3. Data sources given in Appendix 1.

	Commercial			Angling			Native			
Year	1SW	MSW	Total	1SW	MSW	Total	1SW	MSW	Total	Grand Total
1951		42.4	42.4			3.7				46.1
1952		39.6	39.6			6.2				45.8
1953		31.9	31.9			3.2				35.1
1954		31.3	31.3			3.4				34.7
1955		18.3	18.3			2.3				20.6
1956		15.2	15.2			2.6				17.8
1957		19.9	19.9			3.8				23.7
1958		26.8	26.8			9.7				36.5
1959		32.1	32.1			3.5				35.6
1960		30.6	30.6			3.0				33.6
1961		22.0	22.0			3.2				25.2
1962		27.4	27.4			3.4				30.8
1963		24.1	24.1			7.4				31.5
1964		28.8	28.8			6.9				35.7
1965		39.6	39.6			7.6				47.2
1966		33.3	33.3			4.1				37.4
1967		34.7	34.7			4.3				39.0
1968		26.7	26.7			1.2				27.9
1969		18.4	18.4			3.0				21.4
1970		18.2	18.2	1.6	2.0	3.6				21.8
1971		8.9	8.9	1.2	1.0	2.2				11.1
1972	0.1	0.0	0.1	1.1	5.0	6.1				6.2
1973	1.3	0.3	1.6	1.6	4.9	6.5				8.1
1974	0.1	0.1	0.2	1.1	6.0	7.1				7.3
1975	0.2	1.0	1.2	1.3	2.9	4.2	0.0	0.1	0.1	5.5
1976	5.1	0.2	5.3	2.7	5.5	8.2	0.0	1.6	1.6	15.1
1977	1.1	0.2	1.3	2.8	6.7	9.5	0.0	2.9	2.9	13.7
1978	1.5	0.2	1.7	1.6	5.0	6.6	0.0	0.2	0.2	8.5
1979	0.1	0.7	0.8	2.6	1.8	4.4	0.2	0.8	1.0	6.2
1980	2.0	0.0	2.0	3.2	6.2	9.4	0.0	1.9	1.9	13.3
1981	3.1	3.5	6.6	3.6	4.2	7.8				14.4
1982	2.2	4.5	6.7	2.9	2.6	5.5	0.2	1.5	1.7	13.9
1983	1.6	4.5	6.1	0.9	2.1	3.0	0.0	1.5	1.5	10.6
1984	7.2	2.0	9.2	1.8	0.6	2.4	0.2	1.2	1.4	13.0
1985	0.0	0.0	0.0	3.5	0.7	4.2	0.0	1.2	1.2	5.4
1986	0.0	0.0	0.0	5.3	1.3	6.6	0.0	1.3	1.3	7.9

Table 6. Counts of salmon at a fish barrier on NW Upsalquitch River, 1980 to 1986, and in two estuarial traps, 1985 and 1986.

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
Mean (80-85)	691	575	1,266
1986	1,738	1,166	2,904
Estuarial traps			
Lower			
1985	16	52	68
1986	64	109	173
Upper			
1985	34	34	68
1986	109	59	168

Table 7. Biological characteristics of salmon in Restigouche River. Data for 1985 and 1986 from salmon sampled at the Native fishery and/or estuarial traps (Fig. 1). For comparison, data for 1972 to 1980 (Dalhousie trap; Peppar 1983) are also given. Fork length and smolt age data are for virgin salmon; sea age composition includes previous spawners.

1. Fork length

	1SW			2SW			3SW		
	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
1985	48	53.2	3.7	45	75.7	4.7	29	92.0	4.3
1986	170	56.3	3.1	136	77.2	4.2	14	91.4	4.2

2. Smolt age, 1986

	1SW			2SW			3SW		
	n	%	y-c	n	%	y-c	n	%	y-c
2	32	19	1983	47	17	1982	7	19	1981
3	126	76	1982	219	78	1981	29	76	1980
4	9	5	1981	13	5	1980	2	5	1979

3. Sea age, %

	1SW	2SW	3SW and older
1972-1980	39	45 (70)[1]	16
1985	37	34 (54)[1]	29
1986	51	41 (83)[1]	8

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

Table 8. Juvenile Atlantic salmon densities (number .100 m^{-2}) in the Restigouche River, 1972 to 1986. (n = number of sites; 95% confidence interval in parenthesis).

Year	n	Mean density/100 m^2 Age 0+	Age 1+
1972	21	4.8 (3.1- 7.7)	2.1 (1.5- 2.9)
1973	25	18.0 (11.3-28.6)	2.5 (1.9- 3.3)
1974	26	12.9 (7.5-22.0)	6.8 (5.0- 9.3)
1975	31	32.6 (20.1-53.0)	9.9 (6.6-14.8)
1976	29	14.7 (9.5-22.8)	8.5 (5.7-12.6)
1977	34	17.2 (11.2-26.3)	4.3 (3.2- 5.6)
1978	38	23.8 (16.9-33.3)	8.1 (6.1-10.9)
1979	40	10.4 (7.5-14.6)	7.1 (5.6- 9.0)
1980	42	10.5 (7.6-14.5)	3.9 (3.0- 5.1)
1981	45	16.3 (12.5-21.3)	3.5 (2.8- 4.4)
1982	47	8.4 (6.0-11.8)	4.1 (3.1- 5.6)
1983	51	23.9 (15.1-37.6)	6.8 (5.1- 9.0)
1984	51	25.1 (15.7-40.1)	5.0 (3.8- 6.5)
1985	45	23.0 (13.3-40.0)	10.0 (7.1-14.1)
1972-85 mean		17.3	5.9
1986	30	24.2 (13.2-44.7)	6.6 (4.4- 9.8)

Table 9. Observed mortalities of MSW salmon in Upsalquitch River, 1986.

Area	Mortalities	Furunculosis	Catch and release
Angling camps	11	Unknown	279
Crown reserve	27	Unknown	351
Upsalquitch barrier	10	10	---
TOTAL	48		630

Table 10. Comparison of estimates of spawning escapement in Restigouche River as estimated using a 20% angling exploitation rate (Method 1), parr densities (Method 2) (data for both methods given in Tables 12 and 13) and field surveys.

	Method 1		Method 2		Field surveys	
Year	1SW	MSW	1SW	MSW	1SW	MSW
1982	10,600	8,400	2,800	2,500	1,600	3,600
1983	2,600	6,400	2,200	5,100	1,000	2,400
1984	6,200	13,900	1,800	6,000	1,400	5,200
1985	13,000	27,400	3,100	10,200	2,100	7,900
1986	20,200	40,300	4,600	14,800	5,200	9,500

Table 11. Total returns of MSW salmon to Restigouche River and catch of 1SW salmon at Kedgwick Lodge in the previous year (1969-86). Total returns are calculated in Table 12. Returns of MSW salmon predicted for 1987 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	23,200
1970	124	13,100
1971	72	10,600
1972	36	11,900
1973	30	12,300
1974	27	7,900
1975	33	13,000
1976	71	15,700
1977	37	9,300
1978	25	7,000
1979	128	12,700
1980	26	13,100
1981	45	13,100
1982	69	15,200
1983	44	11,800
1984	83	14,500
1985	98	19,800
1986	199	(21,900)

Table 12. Returns of MSW salmon (numbers x10^3) to the Restigouche River, 1970 to 1986. Spawners (1970 to 1983) were estimated as total angling X spawner/angled salmon ratio (Table 3). Spawners in 1984 to 1986 were calculated from a catch (PQ) and catch-and-release (NB) angling harvest of 3,300, 6,100 and 8,800 MSW salmon, respectively.

	Angling		Commercial						
Year	NB	PQ	NB	PQ	Native	Poaching and disease	Spawners (S)	Total returns (R)	S/R
1970	1.7	0.3	9.1	9.1	-	2.0	1.0	23.2	0.04
1971	0.8	0.2	3.9	5.0	-	2.0	1.2	13.1	0.09
1972	3.8	1.2	0.0	0.0	-	2.0	3.6	10.6	0.34
1973	3.8	1.1	0.2	0.1	-	2.0	4.7	11.9	0.39
1974	4.8	1.2	0.0	0.1	-	2.0	4.2	12.3	0.34
1975	2.2	0.7	0.9	0.1	0.1	2.0	1.9	7.9	0.24
1976	4.5	1.0	0.1	0.1	1.6	2.0	3.7	13.0	0.28
1977	5.1	1.6	0.2	0.0	2.9	2.0	3.9	15.7	0.25
1978	3.4	1.6	0.2	0.0	0.2	2.0	1.9	9.3	0.20
1979	1.0	0.8	0.7	0.0	0.8	2.0	1.7	7.0	0.24
1980	4.1	2.1	0.0	0.0	1.9	2.0	2.6	12.7	0.20
1981	2.8	1.4	3.5	0.0	-	2.0	3.4	13.1	0.26
1982	1.6	1.0	2.6	1.9	1.5	2.0	2.5	13.1	0.19
1983	1.5	0.6	2.2	2.3	1.5	2.0	5.1	15.2	0.34
1984	0.0	0.6	2.0	0.0	1.2	2.0	6.0	11.8	0.51
1985	0.4	0.7	0.0	0.0	1.2	2.0	10.2	14.5	0.70
1986	0.4	1.3	0.0	0.0	1.3	2.0	14.8	19.8[1]	0.75

[1] Because of rounding off, this estimate of returns differs slightly from the estimate on Page 7.

Table 13. Returns of 1SW salmon (numbers x10^3) to the Restigouche River, 1970 to 1986. Spawners (1970 to 1986) were estimated as total angling X spawner/angled salmon ratio (Table 3).

	Angling		Commercial			Poaching and		Total returns	
Year	NB	PQ	NB	PQ	Native	disease	Spawners (S)	(R)	S/R
1970	1.4	0.2	-	-	-	1.0	0.8	3.4	0.24
1971	1.0	0.2	-	-	-	1.0	1.5	3.7	0.41
1972	1.0	0.1	0.1	0.0	-	1.0	0.8	3.0	0.27
1973	1.4	0.2	0.7	0.6	-	1.0	1.5	5.4	0.28
1974	1.0	0.1	0.0	0.1	-	1.0	0.8	3.0	0.27
1975	1.1	0.2	0.2	0.0	0.0	1.0	0.9	3.4	0.26
1976	2.3	0.4	3.7	1.4	0.0	1.0	1.8	10.6	0.17
1977	2.4	0.4	1.1	0.0	0.0	1.0	1.6	6.5	0.25
1978	1.3	0.3	1.5	0.0	0.0	1.0	0.6	4.7	0.13
1979	2.0	0.6	0.1	0.0	0.2	1.0	2.4	6.3	0.38
1980	2.8	0.4	2.0	0.0	0.0	1.0	1.3	7.5	0.17
1981	3.0	0.6	3.1	0.0	-	1.0	2.9	10.6	0.27
1982	2.5	0.4	2.1	0.1	0.2	1.0	2.8	9.1	0.31
1983	0.7	0.2	1.5	0.1	0.0	1.0	2.2	5.7	0.39
1984	1.5	0.3	7.2	0.0	0.2	1.0	1.8	12.0	0.15
1985	3.2	0.3	0.0	0.0	0.0	1.0	3.1	7.6	0.41
1986	4.9	0.4	0.0	0.0	0.0	1.0	4.6	10.9[1]	0.42

[1] Because of rounding off, this estimate of returns differs slightly from the estimate on Page 7.

Table 14. Comparison of predicted and actual returns of MSW and 1SW salmon to Restigouche River, 1985 and 1986. MSW salmon returns were predicted from 1SW salmon catches the year before at Kedgwick Lodge (see text). 1SW salmon returns were predicted from previous five-year means.

Year	Predicted	(95% C.L.)	Actual
MSW salmon			
1985	12,219	(6,195-18,243)	14,600
1986	14,811	(8,862-20,759)	19,871
1987	21,883	(14,145-29,622)	
1SW salmon			
1985	9,000		7,032
1986	8,840		11,009
1987	9,060		

Table 15. Estimates of angling exploitation rates for Restigouche River. Upper: returns to river are calculated from Tables 12 and 13 (total returns minus Native and commercial); Lower: returns are estimated from field spawner counts.

	Returns to river		Angling		Exploitation rate	
Year	1SW	MSW	1SW	MSW	1SW	MSW
1970	3.4	5.0	1.6	2.0	0.47	0.40
1971	3.7	4.2	1.2	1.0	0.32	0.24
1972	2.9	10.6	1.1	5.0	0.38	0.47
1973	4.1	11.6	1.6	4.9	0.39	0.42
1974	2.9	12.2	1.1	6.0	0.38	0.49
1975	3.2	6.8	1.3	2.9	0.41	0.43
1976	5.5	11.2	2.7	5.5	0.49	0.49
1977	5.4	12.6	2.8	6.7	0.52	0.53
1978	3.2	8.9	1.6	5.0	0.50	0.56
1979	6.0	5.5	2.6	1.8	0.43	0.33
1980	5.5	10.8	3.2	6.2	0.58	0.57
1981	7.5	9.6	3.6	4.2	0.48	0.44
1982	6.7	7.1	2.9	2.6	0.43	0.37
1983	4.1	9.2	0.9	2.1	0.22	0.23
1984	4.6	8.6	1.8	0.6	0.39	(0.07)[1]
1985	7.6	13.3	3.5	1.1	0.46	(0.08)
1986	10.9	18.5	5.3	1.7	0.49	(0.09)
Mean					0.43	0.43
1982	5.5	8.1	2.9	2.6	0.53	0.32
1983	2.9	6.5	0.9	2.1	0.31	0.32
1984	4.2	7.8	1.8	0.6	0.43	(0.08)[1]
1985	6.6	11.0	3.5	1.1	0.53	(0.10)
1986	11.5	13.2	5.3	1.7	0.46	(0.13)
Mean					0.45	0.32

[1] Exploitation rates in parenthesis indicate years when catch-and-release regulations were in effect. These rates were not included in the overall mean.

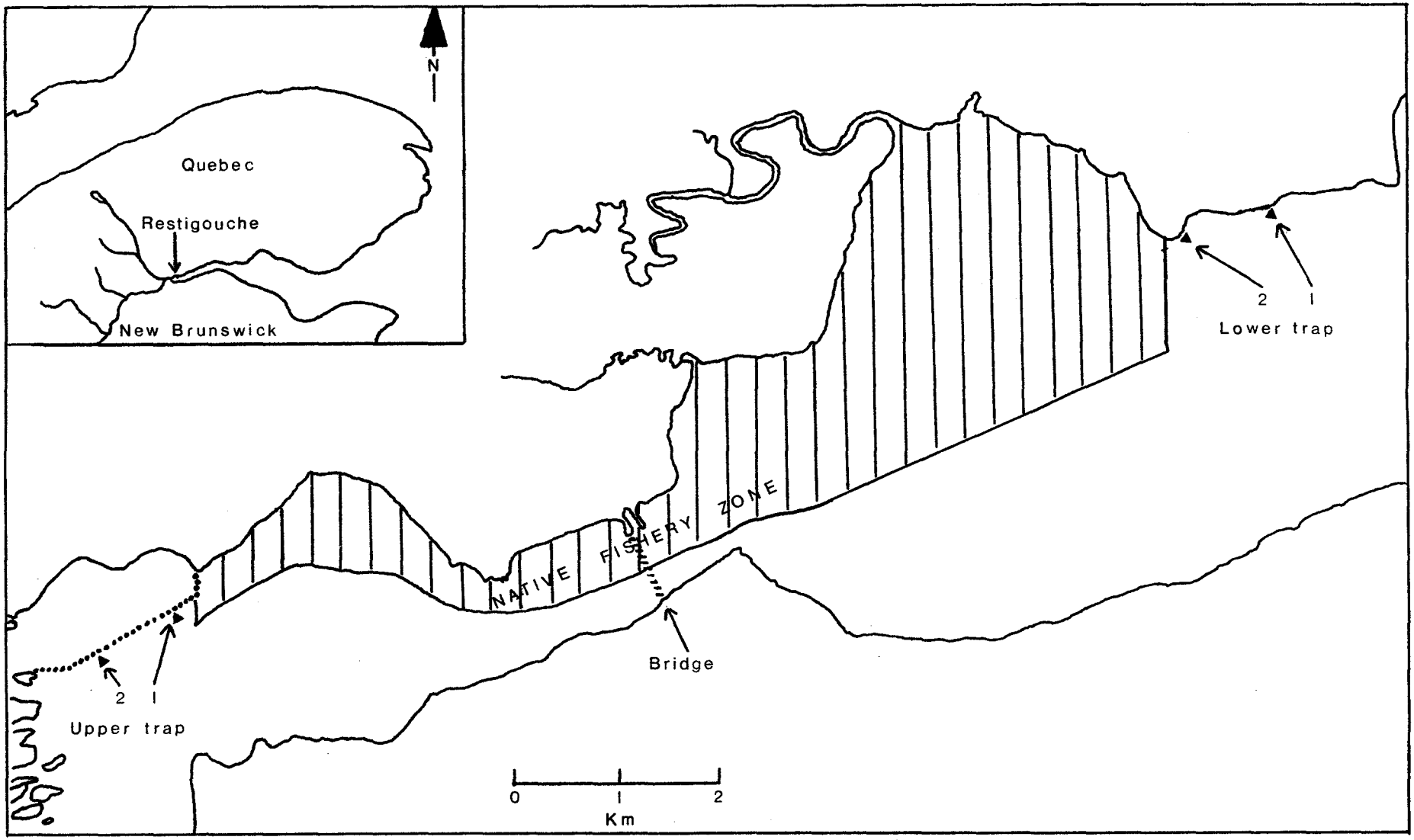

Fig. 1. General location of two trap nets in the estuary of the Restigouche River, operated by ministère du Loisir, de la Chasse et de la Pêche in 1985 and 1986.

1 1985 locations.
2 1986 locations.

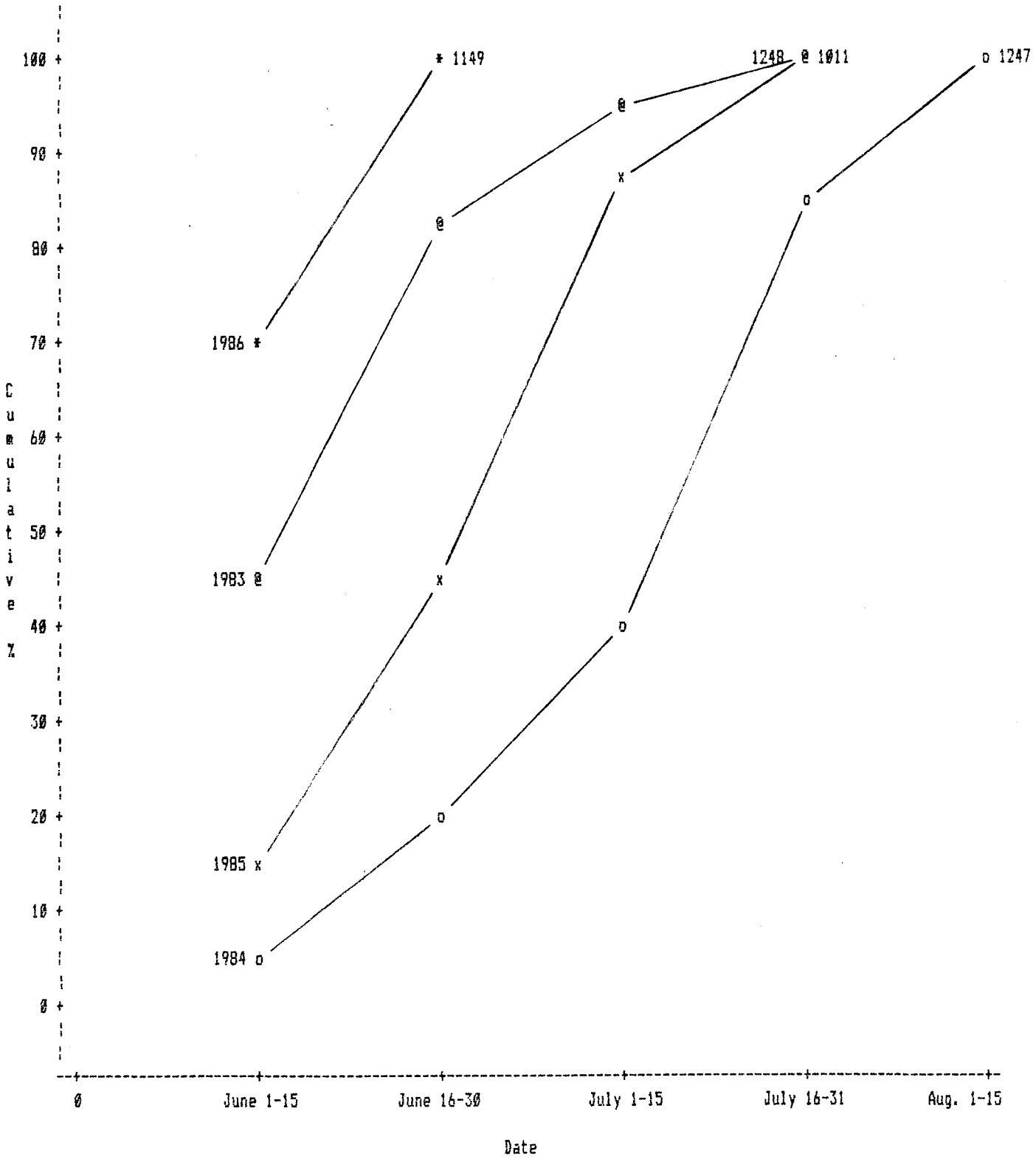

Fig. 2. Semi-monthly cumulative catch (%) of 1SW and MSW salmon in the Native fishery at Cross Point, Quebec, 1983 to 1986. Total catch each year is indicated.

Legend: @ 1983 o 1984 x 1985 * 1986

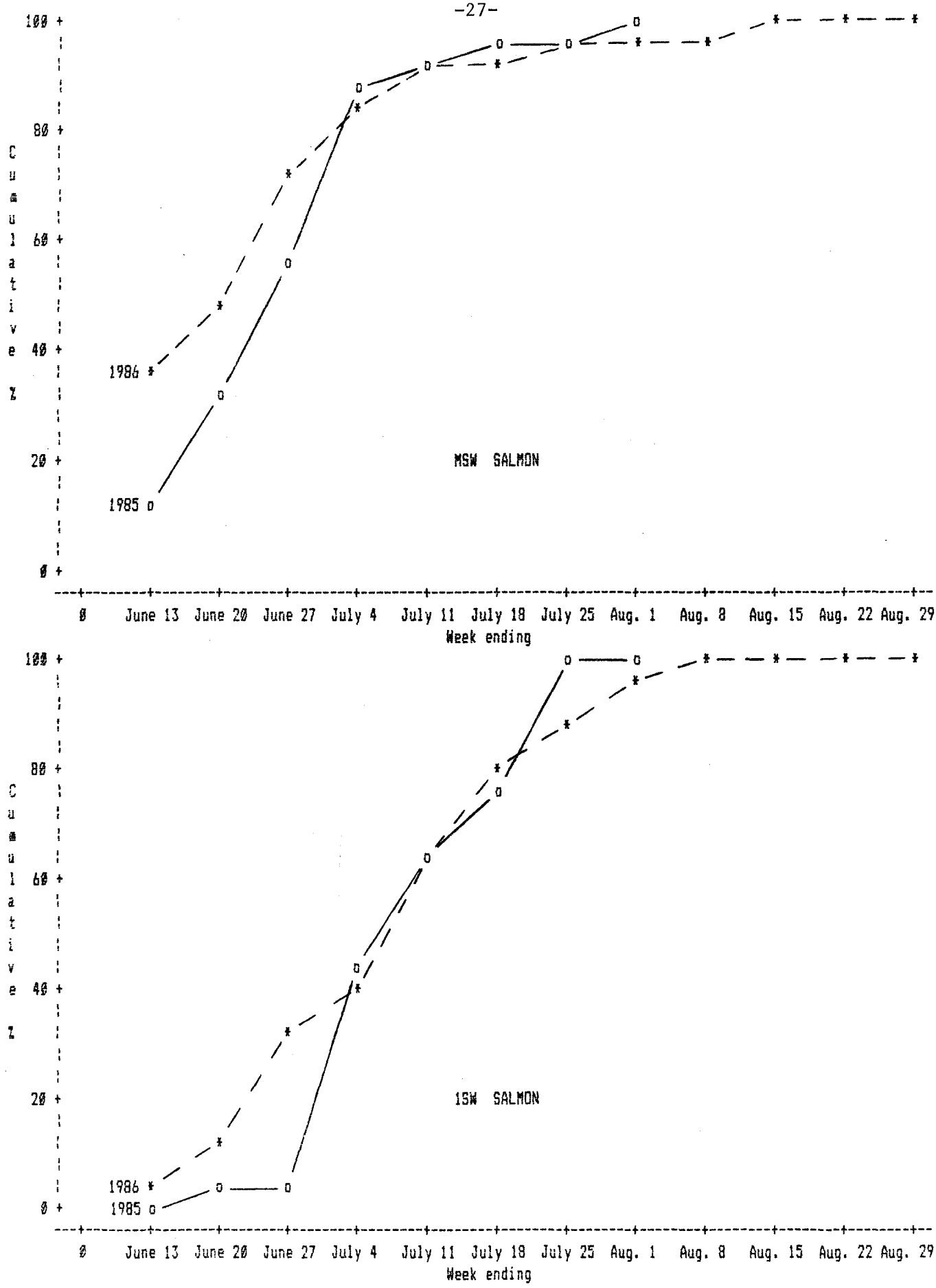

Fig. 3. Cumulative catch (%) of 1SW and MSW salmon in the lower estuarial trap, Restigouche River, 1985 (o) and 1986 (*)

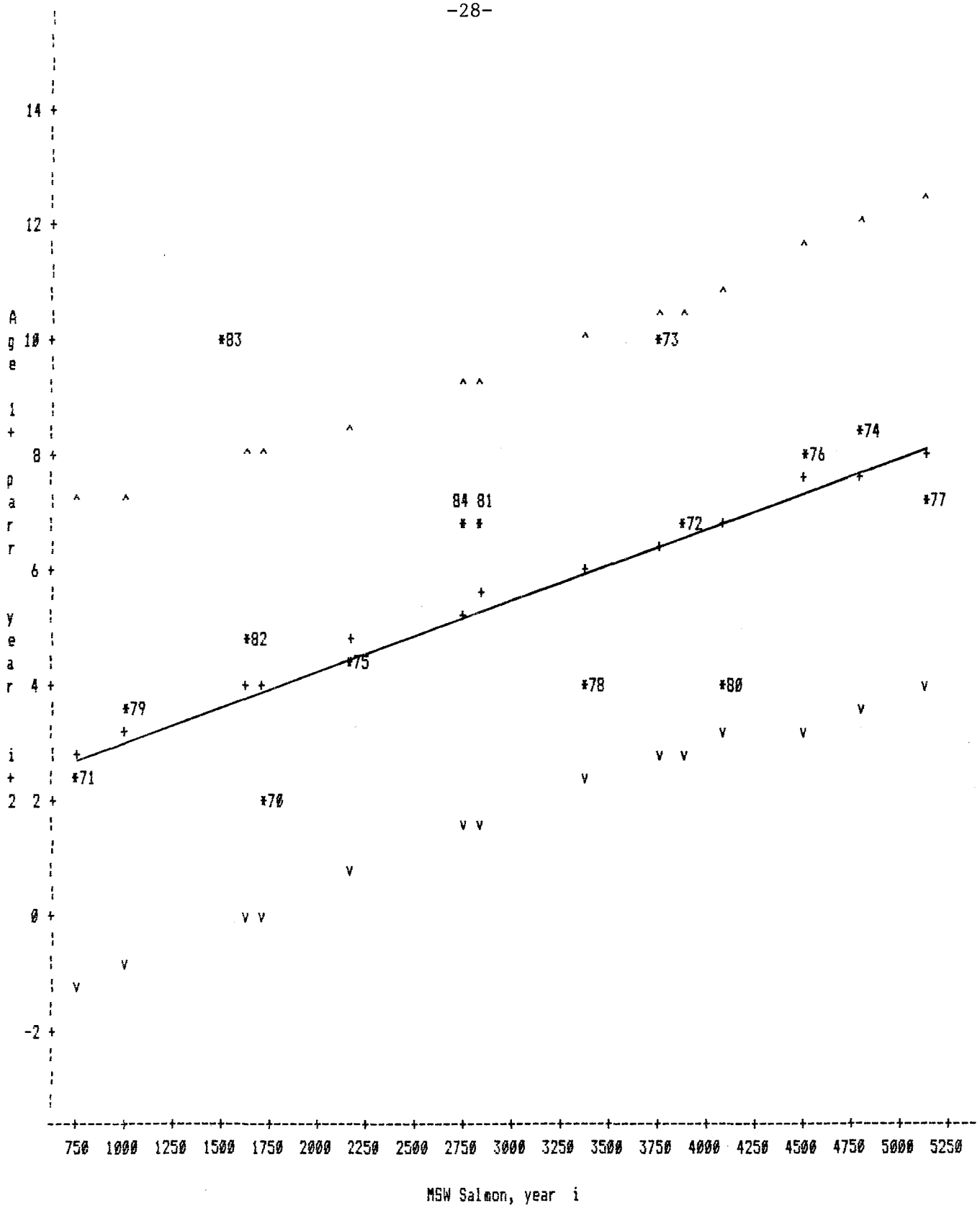

Fig. 4. Relationship between MSW salmon angling catch (year i) and age 1+ parr density (year i+2) in Restigouche River

Legend: * observed values + calculated regression (omitting 1983)
^ upper, v lower bounds of 95% CI for predictions

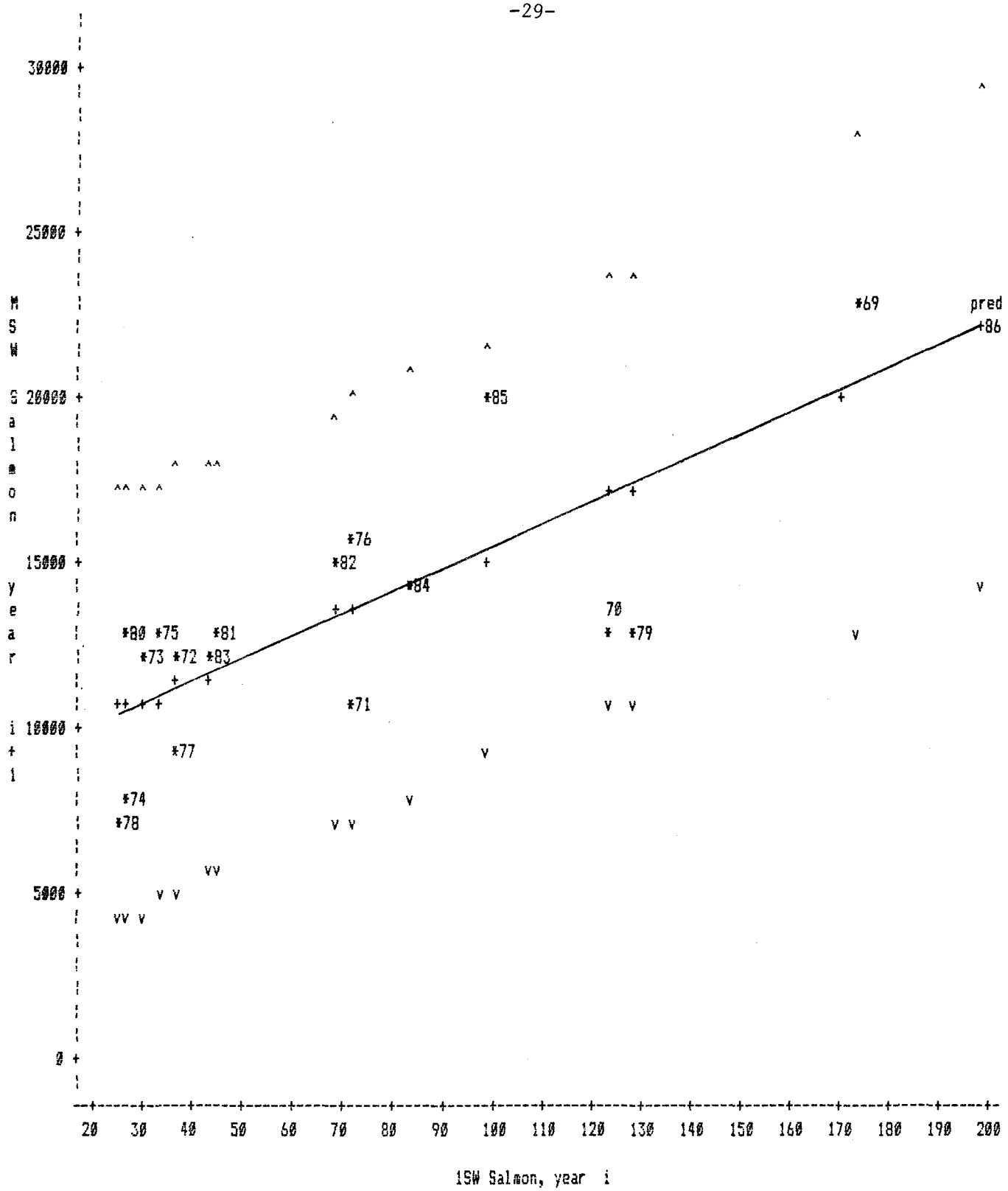

Fig. 5. Relationship between 1SW salmon angling catch at Kedgwick Lodge (year i) and total MSW salmon returns to Restigouche River (year i+1)

Legend: * observed values + calculated regression
^ upper, v lower bounds of 95% CI for predictions

APPENDIX 1

Salmon landings for Baie des Chaleurs and Restigouche River given in Table 5 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 and Swetnam (1984); 1980 to 1983 from Swetnam and O'Neil (1984); 1984 from O'Neil et al. (1985); and 1985 from O'Neil et al. (1986).

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 1985 from Ministère du Loisir, de la Chasse et de la Pêche, Québec (G. Ouellet and J.P. Lebel, 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 1985 from Department of Fisheries and Oceans, Resource Allocation and Development Branch, (K. Atwin, pers. comm.).

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

4. All 1986 data are preliminary as described in text.