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Status of Atlantic salmon in the Miramichi River, 1987

by

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ABSTRACT

During the 1987 season, a Petersen mark-recapture estimate indicated 13,453 MSW salmon and 97,130 1SW salmon returned to the Miramichi River. Returns of MSW salmon were significantly lower than forecasted in the 1986 assessment (about 54,000 salmon). The discrepancy between forecasted returns and actual returns resulted either from an underestimation of MSW salmon returns in 1987, or from an exceptionally high mortality rate of MSW salmon at sea (natural or fishing mortality), or from a combination of both factors. Evidence is presented that support either possibility: counts of salmon at headwater barriers suggested greater salmon abundance within the river than the mark-recapture data, and poor returns of MSW salmon to other major salmon rivers suggested a low sea survival for many Atlantic salmon stocks. Mark-recapture data, including recaptures from anglers, are presently being analysed in more detail in an attempt to improve the forecast model used for the Miramichi assessment. The salmon management plan in effect in 1987 resulted in a high proportion of salmon returns potentially surviving to spawn (84%). The combined escapement of both MSW salmon and 1SW salmon resulted in spawning requirements being met in 1987 (egg deposition was estimated to be at least 156.4 million eggs compared to a target of 132 million). For 1988, about 36,400 MSW salmon are forecasted to return, which would provide a potential surplus to spawning of 12,800 fish. Assuming average returns of 1SW salmon in 1988, total returns could be 61,900 fish, which is 39,300 more than required for spawning escapement.

RESUME

Durant la saison de 1987, d'après une estimation de la recapture de saumons porteurs de la marque Petersen, 13 453 saumons pluribermarins et 97 130 saumons unibermarins sont retournés à la rivière Miramichi. Les remontes de saumons pluribermarins sont de beaucoup inférieures aux prévisions établies en 1986 (environ 54 000 poissons). Cette différence entre les prévisions et la réalité est due soit à une sous-estimation des remontes de saumons pluribermarins en 1987 soit à un taux de mortalité exceptionnellement élevé de ces poissons en mer (mortalité naturelle ou mortalité par la pêche) ou à une combinaison de ces deux facteurs. Il y a des indices en faveur de chacune de ces deux possibilités : d'une part, d'après les dénombrements de saumons effectués près des barrières se trouvant dans les eaux d'amont, il y aurait une plus grande quantité de poissons de cette espèce à l'intérieur de la rivière que ne le laissaient croire les données sur la recapture des poissons marqués; d'autre part, les effectifs limités des saumons pluribermarins qui sont remontés dans d'autres importantes rivières à saumon font croire que beaucoup de stocks de saumons de l'Atlantique ont connu un faible taux de survie en mer. Les données sur la recapture de poissons marqués, y compris ceux recapturés par les pêcheurs sportifs, sont en train d'être analysées plus en détail dans le but d'améliorer le modèle de prévisions utilisé pour l'évaluation de la rivière Miramichi. Grâce à un plan de gestion du saumon, mis en place en 1987, un grand nombre de poissons de cette espèce ont pu remonter la rivière, survivre et frayer (84 %). L'échappée combinée à la fois des saumons pluribermarins et unibermarins a permis de répondre aux besoins de la ponte. (On estime que le nombre des oeufs déposés a atteint 156,4 millions comparé à une cible de 132 millions). Pour 1988, on prévoit une remonte de 36 400 saumons pluribermarins, ce qui donnerait un surplus éventuel de 12 800 poissons pour la ponte. En supposant une remonte moyenne de saumons unibermarins, en 1988, les remontes totales pourraient comprendre des effectifs de 61 900 poissons, soit 39 300 de plus que le nombre requis pour l'échappée en vue de la ponte.

INTRODUCTION

The objective of this report is to present a biological assessment of Atlantic salmon in the Miramichi River for 1987. Current catch and effort data from the angling and Native fisheries are summarized, salmon returns and spawners are estimated from a mark-recapture experiment, and a forecast of MSW salmon returns in 1988 is provided.

The management plan for Atlantic salmon in the Miramichi River in 1987 was a continuation of a five-year plan to conserve stocks which was initiated in 1984. The plan prohibited commercial fishing in Miramichi Bay and estuary. Anglers were allowed to keep only 1SW (< 63 cm); all MSW salmon were released. Season, possession and daily bag limits for anglers remained at 10, 6 and 2 fish respectively. Daily and seasonal bag limits did not include hooked-and-released salmon, but anglers were obliged to stop fishing after retaining the daily limit or after releasing a maximum number of fish equal to twice the daily limit. Catch-and-release regulations also applied to the kelt fishery (15 April to 15 May).

Native food fisheries at Burnt Church, Eel Ground and Red Bank were not restricted by quota as in previous years. Possession or sale of Atlantic salmon caught in non-salmon gear (by-catch) was illegal in all areas of New Brunswick.

METHODS

1. Landings and trap counts

Angling catches of 1SW salmon in the Miramichi River were provided monthly by DFO fishery officers. Angling data from the upper Southwest Miramichi River (York and Carleton counties) were not available; landings from this area were estimated from the average proportion of catches from these two counties from 1974 to 1983. As in previous assessments, DFO landings were adjusted by correlation with historic landings (1969 to 1985) as estimated by Department of Natural Resources and Energy (DNRE), which are considered more accurate (Randall and Chadwick 1983). Numbers of MSW salmon caught and released by anglers were estimated by correlation between Millbank trap catch and angling catch, 1969 to 1983 (Table 1). Angling effort was recorded in rod-days, where one rod-day was one angler fishing for any portion of one day. Angling seasons in 1987 were generally similar to 1986 for most Miramichi tributaries (Appendix I).

Landings of MSW and 1SW salmon from Native fisheries at Burnt Church, Red Bank and Eel Ground were reported from Band Council offices periodically during the season.

Returns of MSW and 1SW salmon entering the Miramichi River in 1987 were monitored daily at the Millbank trap (operated since 1954), at two recapture traps just above the confluence of the Northwest and Southwest Miramichi tributaries (operated since 1985) and at two headwater fish barriers on the Dungarvon and SW Miramichi tributaries (operated since 1981 by DNRE).

Millbank trap has been the principal monitoring trap for the Miramichi River for many years. Although the duration of the trap operation varied somewhat over the years, the starting and ending dates were standardized to 15 May to 15 October beginning with the 1987 season. Catches of salmon before and after these dates were usually <1% of the total run (Appendix II).

Biological characteristics of salmon were determined from samples collected at Millbank. About 350 salmon were examined and the following information was recorded: fork length to nearest cm; weight to nearest 0.1 kg; sex; and scales for aging.

2. Recruitment

During July and August of 1987, 15 sites in headwater tributaries of the Miramichi River were surveyed by electrofishing to determine densities of juvenile salmon. Densities of age 0+ and 1+ salmon were estimated by the removal method (Zippin 1956). To identify long-term trends in juvenile densities, mean densities from the same 15 sites were examined for the period 1971 to 1987. Densities of age 1+ parr at the 15 sites were also used to estimate spawning escapements from 1971 to 1987 (see Method 2 in section 3).

3. Spawning escapement in 1987

As in the 1986 assessment (Randall and Schofield 1987), two methods were used to estimate spawning escapement in 1987:

Method 1: Numbers of MSW and 1SW salmon returning to Millbank were estimated by a mark-recapture experiment in 1987. About 95% of MSW and 87% of 1SW salmon captured at Millbank were marked (Carline tags and/or adipose clipped). Recapture traps in the Northwest and Southwest tributaries (Fig. 1) were monitored continuously throughout the salmon run, and all tagged/fin clipped salmon were carefully enumerated. Returns of salmon to Millbank were estimated by the adjusted Petersen method (Ricker 1975), where:

$$N = \frac{(M + 1)\,(C + 1)}{R + 1}$$

where M = number of salmon marked
C = catch at recapture traps
R = recaptures
N = population estimate at time of marking (Millbank)

Confidence intervals (95%) were calculated assuming R approximated a binomial distribution (Ricker 1975). Tagging mortality was assumed to be 0.20, as in the 1986 assessment (Randall and Schofield 1987). Spawning escapement was estimated as salmon returns to Millbank minus known removals in the river (angling and native harvests, poaching and diseased fish, broodstock removals and trap mortalities).

Method 2: Ratios of spawner per MSW and 1SW salmon counted at Millbank were calculated for the period 1971 to 1985. Spawners were back-calculated from densities of age 1+ parr by assuming 10% survival from eggs to 1+ parr (Elson 1957; 1974; Chadwick 1982) and a total rearing area of 55 x 106 m^2 (Amiro 1983). Mean number of eggs per spawner in the Miramichi River was calculated by Randall (1985). The average ratio of spawner to salmon counted at Millbank was 7.90 (Table 2). This ratio was calculated using the 15 standard sites rather than all sites as in 1986; the ratios were similar whether all sites or the 15 sites were used (Table 2). Spawning escapement was calculated as the product of this ratio and counts of MSW and 1SW salmon at Millbank in 1987.

As in the 1986 assessment (Randall and Schofield 1987), two adjustments were made before the ratio of spawner to Millbank count (Method 2) was used to estimate spawning escapement in 1987. First, to account for the change in the Millbank trap efficiency since 1973 (discussed later), adjusted counts of MSW salmon (570) and 1SW salmon (5,381) were used. Second, estimated angling catches of MSW salmon (minus catch-and-release mortalities) were added to the estimated spawners. The latter adjustment was necessary because MSW salmon were released in 1987, while in other years when the spawner/Millbank count ratio was calculated, MSW salmon were landed.

For both Methods 1 and 2, salmon mortalities from disease and poaching were assumed to be 1,000 MSW salmon and 4,000 1SW salmon. Mortality caused by the stress of catch and release of MSW salmon by anglers was estimated to be 3% (Currie 1985; Randall et al. 1986).

Total egg deposition requirements for the Miramichi River was estimated to be 132 x 10^6 eggs (Randall 1985). Based on average fecundities of Miramichi salmon, Randall (1985) estimated 23,600 MSW salmon and 22,600 1SW salmon are required to produce the required egg deposition. The average fecundity of 1SW and MSW salmon in 1987 was estimated from a length-fecundity relationship calculated for Miramichi salmon (Randall 1985) and average lengths and sex ratios of salmon in 1987 as determined from Millbank samples. Total egg deposition in 1987 was calculated as average fecundity times spawning escapement (numbers of fish).

4. Predicting salmon returns in 1988

Returns of MSW salmon to the Miramichi River in 1988 were predicted from a significant multiple regression between the number and proportion female 1SW salmon returns (year i) and MSW salmon returns in year (i+1). For both 1SW and MSW salmon, total returns from 1971 to 1987 were estimated as returns to Millbank plus commercial landings in Miramichi Bay and estuary for years when a commercial fishery operated. Returns to Millbank were estimated using two methods: 1. by assuming a constant trap efficiency of 0.043 for MSW salmon and 0.055 for 1SW salmon for the period 1971 to 1984 (Turner 1983; assuming a tag loss rate of 0.20). 2. by using adjusted lower catch efficiencies for the period 1981 to 1984. The lower catch efficiencies were estimated by correlation between Millbank counts and DNRE

angling catches for the period 1969 to 1980. Lower catch efficiencies during this period may have resulted from dredging activities in the estuary downstream and upstream of Millbank trap. Returns to Millbank from 1985 to 1987 were estimated from mark-recapture data.

Returns of 1SW salmon in 1988 were predicted from historic averages, 1983 to 1987.

RESULTS

1. Landings in 1987

Despite a reduction in effort from 1986 to 1987 (about 9%), catches of 1SW kelts increased in 1987 by 100% (Table 3). This increase reflected the abundance of 1SW returns in 1986, as indicated by DNRE angling harvests of 1SW salmon (Table 1) and the mark-recapture estimate of 1SW returns in 1986 (110,700 fish).

Catches of bright 1SW salmon however decreased dramatically in 1987 (11,363) from 1986 (28,299) (Table 3). This decrease may have resulted in part from decreased effort (down by 34% from 1986) and from extremely low water conditions in 1987 (Fig. 2). Because of low and warm water conditions, several tributaries of the Miramichi were closed to angling for the last two weeks of July. Reported catches of 1SW salmon from DFO officers were adjusted by correlation with DNRE data (1969-1986) which gave an adjusted catch of 16,590 1SW salmon; this estimate was slightly below the long term average (Table 1).

Numbers of MSW salmon caught and released by anglers were estimated from a correlation between Millbank catch and DNRE catch, 1969-1983 (Table 1). An estimated 4234 MSW salmon were released, which was substantially less than the 1986 catch (14,266 salmon) and was below the long term average (Table 1).

Native fishermen at Burnt Church, Eel Ground and Red Bank reported catching 898 MSW salmon and 1274 1SW salmon in 1987 (Table 4). The reported catch from Red Bank (1500 fish) was not divided into 1SW and MSW salmon; our estimate was based on the 1SW : MSW ratio reported by Eel Ground. Effort in the Native fisheries was increased in 1987 because some nets were set in Northwest Miramichi River proper (Big Hole Tract), whereas historically fishing was restricted to tidal waters. Because of suspected overfishing, DFO wardens erected a barrier on the Northwest Miramichi just below Big Hole for 10 days in July to prevent overfishing. It is difficult to interpret relative run strength of salmon based on Native landings beacause of the obvious change in effort in 1987.

Total reported landings of 1SW and MSW salmon in 1987 are compared to 1985 and 1986 landings in Table 5. Long term landings for the Miramichi River (1951 to 1987) are given in Table 6.

Counts of both 1SW and MSW salmon at Millbank trap in 1987 decreased from 1986 (Table 1). Catches of MSW salmon decreased by 38% (from 469 to 291) and catches of 1SW salmon decreased by 28% (from 1763 to 1272). Both catches were below the previous five year (1981-1986) mean (328 MSW salmon and 1556 1SW salmon). In contrast, counts of MSW salmon at two headwater barriers increased in 1987 from 1986, and both were above 1981 to 1986 means (Table 7). Counts of 1SW salmon at one of the barriers was up from 1986 (Dungarvon barrier, 744 fish in 1987 versus 501 fish in 1986), but 1SW counts were down at the other barrier (SW Miramichi, 1175 fish in 1987 vs 2072 fish in 1986). It is possible however that water conditions in 1987 affected barrier counts: salmon may have preferred the cooler headwaters to warmer waters downstream. Also, the late run was reduced in 1987 compared to 1986, (Fig. 3) and this may have affected Millbank counts but not barrier counts.

Salmon returned to the Miramichi River later in 1987 than in 1986, and as mentioned above the proportions of salmon returning during the late run (after Aug.) was lower (Fig. 3). Biological characteristics of salmon sampled at Millbank are given in Table 8. Both 1SW salmon and 2SW salmon were from two year-classes: 1SW salmon were from the 1983 (58%) and 1984 (41%) year classes while 2SW salmon were from the 1982 (53%) and 1983 (47%) year-classes.

2. Recruitment

Average densities of age 0+ and 1+ salmon at 15 sites in 1987 are compared to densities at the same sites from 1971 to 1986 in Table 9 and Fig. 4. Densities in 1987 were the highest recorded at these sites for both 0+ and 1+ parr. Annual trends in parr densities were similar whether all sites (n varying form 32 to 90) or the standard (n = 15) sites were used.

3. Spawning escapement in 1987

Mark-recapture information for 1SW and MSW salmon marked at Millbank and recaptured in upstream traps in 1987 is summarized in Table 10. Results of the Petersen estimate of salmon returns to Millbank (assuming a tag loss rate of 0.20) are given below:

	N	95% confidence interval
1SW	97,130	(58,361-172,129)
MSW	13,453	(6,987- 28,323)

Catch efficiency of the Millbank trap decreased for 1SW salmon but increased for MSW salmon from 1986 to 1987 (Table 10). Catch efficiencies in 1973 were 1.96 times higher for MSW salmon and 4.23 times higher for 1SW salmon than efficiencies in 1987.

Numbers of MSW salmon released by anglers were estimated to be 4,234 fish (Table 1). Assuming a catch-and-release mortality rate of 0.03 (Randall et al. 1986), total angling mortalities were estimated to be 127 MSW salmon.

Numbers of MSW and 1SW spawners in 1987, as estimated by Methods 1 and 2, are given below:

	Method 1	Method 2
MSW salmon		
1. Total returns	13,453	
2. Harvest	1,025	
3. Poaching and disease	1,000	
4. Brood stock	84	
5. Trap mortalities	25	
6. Estimated spawners	11,319	8,610
7. Required spawners	23,600	23,600
% of target achieved	48%	36%
1SW salmon		
1. Total returns	97,130	
2. Harvest	17,864	
3. Poaching and disease	4,000	
4. Spawning escapement	75,266	42,510
5. Target spawners	22,600	22,600
% of target achieved	333%	188%

In 1987, average fecundity for 1SW and MSW salmon was 1,061 and 6,697 eggs per fish, respectively. Thus, Method 1 above indicates an egg deposition of 155.7 x 10^6 eggs (118% of requirements), while Method 2 indicates a deposition of 102.8 x 10^6 eggs (78% of requirements).

4. Spawning escapement and returns of salmon, 1971 to 1987

Returns and spawning escapement of 1SW and MSW salmon to Miramichi River, 1971 to 1987, are estimated in Tables 11 and 12. Returns to Millbank trap were estimated using both unadjusted and adjusted catch efficiencies for the period 1981 to 1984. Adjusted efficiencies were calculated using significant regressions with DNRE catch data (Table 13); average catch rates for the period 1981 to 1984 were 0.022 for MSW salmon and 0.034 for 1SW salmon. Spawners and returns as estimated using the adjusted efficiencies were judged to be the most reasonable because of the relatively high parr densities and returns of salmon that resulted from 1981 to 1984 spawning period. MSW salmon spawners as estimated with the lower Millbank catch

rates were significantly correlated with other indices of spawning levels in the Miramichi River, 1970 to 1987 (Table 14).

5. Forecast of 1988 MSW salmon returns

MSW salmon returns in 1988 were predicted from a multiple regression between 1SW returns to the Miramichi River (year i, variable X1), proportion female 1SW salmon (year i, variable X2) and MSW returns one year later (year i+1, y) for the years 1971 to 1987 (Table 15). Returns of MSW salmon in 1987, as estimated from recapture data, were significantly less than predicted from historic data prior to 1987: estimated returns were 13,453 salmon (6,987-28,323) compared to predicted returns of 54,170 (31,019-77,320). Thus, the regression was not significant when 1987 MSW salmon returns were included (Table 16).

Possible reasons for the discrepancy between the forecast and the actual returns of MSW salmon will be discussed later. Because of the uncertainties of the 1987 data, however, MSW salmon returns in 1988 were forecasted by omitting the MSW salmon value for 1987, and the 1SW salmon returns for 1986. Predicted returns in 1988 using these adjusted data were 36,378 salmon (16,950-55,805) (Table 16). Average returns of MSW salmon, 1983 to 1987, were 22,284 fish; given the above average returns of 1SW salmon in 1987, returns of MSW salmon should be above average in 1988 as well, suggesting the above forecast is reasonable. Returns of 36,378 salmon would potentially produce 12,778 fish surplus to spawning requirements in 1988 (0-32,205).

Average returns of 1SW salmon in the past five years were 61,877 fish. Assuming average returns of 1SW salmon, about 39,300 1SW salmon could be surplus to spawning requirements in 1988.

DISCUSSION

Returns of MSW salmon to the Miramichi River in 1987 as estimated from mark-recapture data were significantly lower than forecasted in the 1986 assessment: estimated returns were 13,453 salmon, only 25% of the forecasted 54,170 salmon. Reasons for this discrepancy are difficult to identify, but there are three possibilities: 1. returns of 1SW salmon in 1986 were significantly overestimated, resulting in an overestimated forecast for MSW salmon returns in 1987; 2. MSW salmon returns in 1987, as estimated with mark-recapture data, were significantly underestimated; and 3. estimated returns to the Miramichi River were correct, but unusually high proportions of Miramichi MSW salmon died at sea during the 1986/87 season because of natural or fishing mortality.

The first possibility was tested and rejected by comparing river harvests of 1SW salmon in 1986 (using DNRE angling data and Native landings) with the estimated returns of 1SW salmon to Millbank. A significant correlation between 1SW salmon returns and subsequent river harvests confirmed that 1SW salmon were abundant in 1986 (Fig. 5). Thus the basis of the forecast for MSW salmon returns in the 1986 assessment was apparently valid.

Returns of MSW in 1987 may have been under estimated. Headwater barrier counts of MSW salmon in 1987 were as high or higher than in 1986, suggesting returns of these fish were as abundant as in 1986 (about 30,000 fish). However, as mentioned previously, these barrier counts may not have been representative of the entire river because 1. barrier counts reflect early-run salmon returns only, 2. warm water conditions during summer of 1987 may have increased movements of salmon into cooler headwater areas, and 3. salmon that return to barriers have been protected for about one generation and thus production may be enhanced. Counts of MSW salmon at Millbank trap and at the two recapture traps were significantly lower in 1987 than in 1986, and thus agreed with the mark-recapture estimate. Because DNRE estimates of numbers of MSW salmon that were caught and released in 1987 were not available, there was no independent index of MSW salmon returns to compare to the mark-recpature data.[1]

The mark-recapture data used to estimate salmon abundance in 1987 were weak. The numbers of salmon marked at Millbank were few in relation to the population size, and recaptures were also few (total of 20 fish). As a result, confidence limits around the population estimate were wide (plus or minus 50% for MSW salmon). In order to reduce the confidence interval (to say plus or minus 25%), significantly larger numbers of salmon would have to be tagged, and the numbers of salmon examined for tags would have to be increased by 3 to 4 times. Ricker (1975) noted that there is no inherent bias in a population estimate if recaptures exceed four (or if M X C exceeds N by at least 4). Although the Miramichi data meet these criteria, a significant bias could still exist if Millbank or the recapture traps do not sample the Miramichi population randomly. Mark-recapture data from all years (1973 and 1985-87) need to be examined in more detail to see if this was the case. Also, recapture data from anglers may be potentially useful and these data are presently being analysed. Until more information is available, the estimate of salmon escapement in 1987 will remain tentative, and judging from barrier information at least, it may be negatively biased.

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[1]While this assessment was in final preparation, DNRE estimates of angling catches for 1987 became available. Estimates were that 20,765 1SW salmon were landed and 11,932 MSW salmon were caught and released during the 1987 season. While our preliminary estimate of 1SW salmon landings was comparable to this DNRE estimate (16,590; Table 1), we significantly underestimated MSW salmon catches by almost 3 times (4,234 fish). The updated DNRE data seem to confirm that MSW salmon escapement was underestimated in this assessment. Catch and release data must be interpreted with caution, however, because anglers may include 'releases' in their reports that might not have been catchable fish (i.e., release data may tend to overestimate salmon abundance).

The final possible reason for the discrepancy between forecasted and actual MSW salmon returns in 1987 was higher than usual mortalities of large salmon at sea. It is important to note that returns of MSW salmon to other major salmon rivers in eastern North America (Restigouche and Saint John Rivers, N.B., and Penobscot River, Maine; Anon. 1988) were significantly lower than forecasted. These observations suggest that mortality rate at sea was possibly high for many Atlantic salmon populations. For the Miramichi system, a combination of underestimating returns to the river and higher than average sea mortality probably resulted in the discrepancy observed between forecasted and estimated returns of MSW salmon in 1987.

The 1987 management plan resulted in a high proportion of MSW salmon that potentially survived to spawning, as has been observed since the management plan came into effect in 1984. Of the 13,453 MSW salmon that returned in 1987, an estimated 11,319 survived to spawn (84%). Age 1SW returns in 1987 were significantly higher than average. Of the 97,000 1SW fish that returned, about 75,000 potentially survived to spawn (77%). Total egg deposition from both MSW and 1SW salmon was 155.7×10^6 eggs, indicating the target egg deposition level (132×10^6 eggs) was achieved in 1987. If MSW salmon escapement was underestimated as discussed above, this estimate of egg deposition would be a minimum.

The forecast for returns for 1988 is about 36,400 MSW salmon and 61,900 1SW salmon. After subtracting the numbers of salmon required for spawning, these returns would indicate potential surpluses of 12,800 MSW salmon and 39,300 1SW salmon in 1988.

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Table 1. Angling statistics for MSW and 1SW salmon in the Miramichi River as estimated by DNRE and DFO, and salmon catches at Millbank 1969 to 1987.

	MSW salmon			1SW salmon		
Year	DFO	DNRE	Millbank	DFO	DNRE	Millbank
1969	2,827	3,804	667	26,715	24,284	4,350
1970	2,057	3,268	245	19,662	19,610	2,484
1971	1,247	1,792	399	8,464	13,727	1,962
1972	5,456	8,933	1,151	15,472	19,101	2,543
1973	4,881	5,977	1,132	9,033	13,857	2,450
1974	5,895	7,184	1,791	17,957	18,232	4,038
1975	3,756	6,288	1,208	9,730	15,598	3,548
1976	5,319	7,374	943	14,749	27,182	4,939
1977	14,344	11,617	1,934	8,244	13,590	1,505
1978	4,196	4,893	693	5,353	8,265	1,268
1979	2,422	2,656	318	7,625	14,508	2,500
1980	5,422	6,546	1,093	7,533	11,997	2,139
1981	1,602	3,238	199	7,031	22,716	2,174
1982	2,642	4,608	408	9,217	21,402	2,665
1983	1,646	2,240	245	3,897	8,390	810
1984	---	[5,299]	333	9,892	11,230	1,010
1985	---	[9,622]	311	11,926	18,439	912
1986	---	[14,266]	469	28,299	[26,163]	1,763
Mean	4,247	6,089	752	12,267	17,127	2,392
1987	---	[4,234][1]	291	11,363	[16,590][2]	1,272

[ ] Catch and release of MSW salmon.

1 MSW angling catch and release in 1986 was estimated from a correlation between Millbank salmon (x) and DNRE salmon (y) from 1969 to 1983; $y = 1{,}746.56 + 4.36\ (x)$, $R^2 = 0.79$, y (1987) = 4,234. Catch of MSW salmon at Millbank in 1987 was adjusted upwards (from 291 to 570) to account for the change in catch efficiency of Millbank trap (0.022 in 1987 versus 0.043 in 1973).

2 Angling catch of 1SW salmon in 1987 was estimated from a correlation between DFO salmon (x) and DNRE salmon (y) from 1969 to 1986; $y = 9{,}838.0 + 0.59\ (x)$; $R^2 = 0.52$; y (1987) = 16,590.

Table 2. Ratios of spawners to Millbank count, 1971 to 1985. Spawners were calculated from 1+ parr, assuming 10% survived from eggs to smolts, and a rearing area of 55 X 10^6 m^2. Mean densities of parr were from all sites (column 2) and from 15 sites (3).

1	2	3	4	5	6	7	8	9	10
	Parr m^{-2} (year i + 2)					Spawner		Spawner/Millbank	
Year (i)	All Sites	15 Sites	Eggs MSW salmon	Millbank	Proportion MSW	2	3	7	8
1971	0.016	0.030	1,206	399	0.17	1,233	2,312	3.09	5.79
1972	0.097	0.110	1,911	1,151	0.31	8,699	9,864	7.56	8.57
1973	0.112	0.128	2,125	1,132	0.32	9,161	10,470	8.09	9.25
1974	0.099	0.117	2,444	1,791	0.31	6,845	8,090	3.82	4.52
1975	0.096	0.084	2,149	1,208	0.25	6,241	5,460	5.17	4.52
1976	0.100	0.107	1,541	943	0.16	5,722	6,123	6.07	6.49
1977	0.074	0.090	3,761	1,934	0.56	6,086	7,402	3.15	3.83
1978	0.063	0.083	2,846	693	0.35	4,303	5,668	6.21	8.18
1979	0.091	0.070	1,370	318	0.11	4,123	3,171	12.96	9.97
1980	0.094	0.098	2,492	1,093	0.34	7,016	7,315	6.42	6.69
1981	0.104	0.067	956	199	0.08	5,018	3,232	25.21	16.24
1982	0.068	0.065	1,450	408	0.13	3,425	3,273	8.39	8.02
1983	0.097	0.089	1,832	245	0.23	6,763	6,205	27.60	25.33
1984	0.145	0.122	2,006	333	0.25	9,858	8,294	29.60	24.91
1985	0.131	0.131	2,006	311	0.25	9,134	9,134	29.37	29.37
Sum				12,158		93,627	96,013		
Mean ratio								7.70	7.90

Table 3. Angling catch-and-effort data for 1SW salmon in the Miramichi River in 1987 as estimated by DFO fishery officers. Data for 1986 given for comparison.

	1987			1986		
	Kelts	Brights	Rod-days	Kelts	Brights	Rod-days
April	2,244		2,577	850		2,651
May	652		3,163	597		3,622
TOTAL	2,896		5,740	1,447		6,273
Mean weight (kg)	1.21			1.33		
June		1,189	4,878		1,388	4,909
July		3,441	11,658		7,950	11,231
August		2,770	9,109		5,301	11,522
September		3,605	8,246		13,260	23,416
October		358	1,438		400	2,100
TOTAL		11,363	35,329		28,299	53,178
Mean weight (kg)		1.71			1.78	

Table 4. Native fishery landings in Miramichi River and Bay, 1985 to 1987.

	1987		1986		1985	
	1SW	MSW	1SW	MSW	1SW	MSW
Red Bank	885	615	1,064	336	216	127
Eel Ground	373	262	908	287	330	195
Burnt Church	16	21	16	18	0	5
TOTAL	1,274	898	1,988	641	546	327

Table 5. Preliminary 1987 salmon landings in the Miramichi River and Bay. Landings for 1985 and 1986 are given for comparison.

	1987		1986		1985	
	1SW	MSW	1SW	MSW	1SW	MSW
Native	1,274	898	1,988	641	546	327
Angling[1]	16,590	(127)[2]	26,163	(428)[2]	18,439	(289)[2]
TOTAL	17,864	1,025	28,151	1,069	18,985	616

[1] Angling landings from DNRE (Table 1).

2 Assuming a catch-and-release mortality rate of 0.03.

Table 6. Recorded catches of salmon in all fisheries, Miramichi River and Bay, 1951-87 (includes commercial, by-catch, recreational and Native). Kelts angled in year i are added to landings in year i-1. 1987 data are preliminary. All data are numbers x 10^3.

	COMMERCIAL			ANGLING							NATIVE			
				Kelts (yr i+1)			Bright (yr i)							GRAND
Year	1SW	MSW	Total	1SW	MSW	Total	1SW	MSW	Total	Total	1SW	MSW	Total	TOTAL
1951		27.6	27.6			12.0			9.6	21.6				49.2
1952		27.3	27.3			11.3			15.9	27.2				54.5
1953		24.4	24.4			10.1			18.2	28.3				52.7
1954		50.6	50.6			11.2			23.5	34.7				85.3
1955		15.3	15.3			8.9			14.7	23.6				38.9
1956		24.7	24.7			9.3			28.9	38.2				62.9
1957		29.9	29.9			8.4			19.5	27.9				57.8
1958		25.2	25.2			10.2			36.7	46.9				72.1
1959		37.3	37.3			9.5			10.3	19.8				57.1
1960		30.8	30.8			5.6			4.5	10.1				40.9
1961		30.0	30.0			9.5			11.0	20.5				50.5
1962		41.6	41.6			7.3			10.3	17.6				59.2
1963		40.7	40.7			5.2			50.9	56.1				96.8
1964		69.8	69.8			9.0			35.1	44.1				113.9
1965		69.5	69.5			16.0	38.7	3.9	42.6	58.6				128.1
1966		72.9	72.9			20.0	51.7	5.9	57.6	77.6				150.5
1967		102.2	102.2			14.1	41.8	4.1	45.9	60.0				162.2
1968		48.5	48.5			6.9	7.0	1.5	8.5	15.4				63.9
1969		41.3	41.3	3.7	1.6	5.3	24.3	3.8	28.1	33.4				74.7
1970		39.7	39.7	2.4	1.4	3.8	19.6	3.3	22.9	26.7				66.4
1971		18.3	18.3	1.5	0.5	2.0	13.7	1.8	15.5	17.5				35.8
1972		2.5	2.5	1.5	3.0	4.5	19.1	8.9	28.0	32.5				35.0
1973		0.9	0.9	1.5	3.0	4.5	13.9	6.0	19.9	24.4				25.3
1974		1.0	1.0	1.8	3.1	4.9	18.2	7.2	25.4	30.3				31.3
1975	0.4	0.7	1.1	2.3	1.4	3.7	15.6	6.3	21.9	25.6	0.4	0.2	0.6	27.3
1976	1.8	0.9	2.7	2.4	2.2	4.6	27.2	7.4	34.6	39.2	0.2	0.2	0.4	42.3
1977	0.4	6.9	7.3	1.4	2.1	3.5	13.6	11.6	25.2	28.7	0.5	0.4	0.9	36.9
1978	1.2	8.4	9.6	1.5	1.7	3.2	8.3	4.9	13.2	16.4	0.4	0.4	0.8	26.8
1979	5.5	1.7	7.2	2.2	1.5	3.7	14.5	2.7	17.2	20.9	0.1	0.2	0.3	28.4
1980	2.7	10.9	13.6	1.7	2.1	3.8	12.0	6.5	18.5	22.3	-	-	-	35.9
1981	1.6	7.8	9.4	2.7	1.4	4.1	22.7	3.2	25.9	30.0	1.0	0.5	1.5	40.9
1982	2.3	12.5	14.8	2.1	1.0	3.1	21.4	4.6	26.0	29.1	0.7	0.4	1.1	45.0
1983	1.6	17.1	18.7	1.6	0.7	2.3	8.4	2.2	10.6	12.9	0.4	0.2	0.6	32.2
1984	0.0	0.0	0.0	2.4	0.0	2.4	11.2	0.0	11.2	13.6	0.4	0.3	0.7	14.3
1985	0.0	0.0	0.0	2.5	0.0	2.5	18.4	0.0	18.4	20.9	0.5	0.3	0.8	21.7
1986	0.0	0.0	0.0	---	0.0	---	26.2	0.0	26.2	26.2	2.0	0.6	2.6	28.8
1987	0.0	0.0	0.0	---	---	---	16.6	0.0	16.6	16.6	1.3	0.9	2.2	18.8

Table 7. Numbers of MSW and 1SW salmon counted at barriers in two tributaries of the Miramichi River, 1981 to 1987.

Tributary	Year	MSW	1SW	Total
North Branch of SW Miramichi	1981	54	671	725
	1982	282	621	903
	1983	219	290	509
	1984	297	230	527
	1985	604	492	1,096
	1986	1,138	2,072	3,210
	Mean	432	729	1,162
	1987	1,266	1,175	2,441
Dungarvon River	1981	112	550	662
	1982	120	489	609
	1983	126	330	456
	1984	93	315	408
	1985	162	536	698
	1986	174	501	675
	Mean	131	454	585
	1987	202	744	946

Table 8. Biological characteristics of adult salmon sampled at Millbank trap, 1987.

Sea Age	n	FL	(SD)	n	W	(SD)	n	% male
1SW	309	52.6	(3.15)	310	1.52	(0.24)	127	64.6
2SW	51	75.9	(3.25)	51	4.70	(0.76)	16	6.3
PS	12	87.5	(6.88)	11	7.96	(2.35)	4	25.0
MSW	63	78.1	(6.18)	62	5.28	(1.72)	20	10.0

		Percent at smolt age		
	n	2	3	4
1SW	310	41.0 (1984)[1]	58.1 (1983)	0.9 (1982)
2SW	51	47.1 (1983)	52.9 (1982)	0.0

[1]Year-class in parentheses

Table 9. Juvenile Atlantic salmon densities (number .100 m^{-2}) in the Miramichi River, 1970 to 1987. (n = number of sites.)

1 Year	2 n	3 Age 0+	4 Age 1+	5 n	6 Age 0+	7 Age 1+
1970	44	14.6	3.0	8	35.3	6.1
1971	66	14.5	5.1	14	20.1	7.9
1972	66	5.5	5.1	15	9.8	8.3
1973	73	17.5	1.6	15	24.9	3.0
1974	90	24.4	9.7	15	34.2	11.0
1975	89	25.7	11.2	15	40.0	12.8
1976	80	18.8	9.9	15	25.1	11.7
1977	86	34.8	9.6	15	51.8	8.4
1978	87	22.7	10.0	15	36.4	10.7
1979	48	13.4	7.4	15	19.7	9.0
1980	45	21.5	6.3	15	34.5	8.3
1981	47	41.3	9.1	15	53.6	7.0
1982	85	11.1	9.4	15	15.0	9.8
1983	85	27.9	10.4	15	44.5	6.7
1984	83	16.6	6.8	15	19.1	6.5
1985	40	49.5	9.7	14	56.4	8.9
1986	32	54.4	14.5	15	55.4	12.2
1970-86 mean		24.4	8.2		33.9	8.7
1987	15	74.5	13.1	15	74.5	13.1

Correlations:

	n	r	P
3 with 6	17	0.92	0.001
4 with 7	17	0.78	0.001

Table 10. Mark-recapture statistics for Miramichi River, 1973 and 1985 to 1987. Legend: M - number fish tagged (assuming 0.20 tag loss rate in parenthesis); C - number caught upstream; R - number of recaptures; N - estimated population size; and efficiency is the Millbank catch efficiency. Further details of mark-recapture data are given in Appendicies III and IV.

	M	C	R
1973			
1SW	604 (483)	7,333	79
MSW	612 (490)	3,003	55
1985			
1SW	600 (480)	1,543	15
MSW	219 (175)	690	4
1986			
1SW	1,587 (1,270)	2,351	26
MSW	400 (320)	849	8
1987			
1SW	1,103 (882)	1,539	13
MSW	275 (220)	486	7

	N (± 95% CL)	Efficiency (± 95% CL)
1973		
1SW	44,371 (35,675- 55,119)	0.055 (0.044-0.069)
MSW	26,339 (20,316- 34,064)	0.043 (0.033-0.056)
1985		
1SW	46,417 (28,785- 79,007)	0.020 (0.012-0.032)
MSW	24,323 (10,859- 60,808)	0.013 (0.005-0.029)
1986		
1SW	110,718 (76,651-166,077)	0.016 (0.011-0.023)
MSW	30,317 (16,241- 62,011)	0.016 (0.008-0.029)
1987		
1SW	97,130 (58,361-172,129)	0.013 (0.007-0.022)
MSW	13,453 (6,987- 28,323)	0.022 (0.010-0.042)

Table 11. Estimates of spawning escapement (S) and total returns (R) of MSW salmon to the Miramichi River, 1971 to 1987, using unadjusted (upper) and adjusted (lower) catch efficiencies for Millbank, 1981 to 1984.

Year	HE	HR	MIL	E	MILR	PAD	S	R
Unadjusted								
1971	18,268	1,792	399	0.043	9,279	1,000	6,487	27,547
1972	2,445	8,933	1,151	0.043	26,767	1,000	16,834	29,212
1973	866	5,977	1,132	0.043	26,326	1,000	19,349	27,192
1974	963	7,184	1,791	0.043	41,651	1,000	33,467	42,614
1975	743	6,626	1,208	0.043	28,093	1,000	20,467	28,836
1976	878	7,591	943	0.043	21,930	1,000	13,339	22,808
1977	6 865	12,060	1,934	0.043	44,977	1,000	31,917	51,842
1978	8,377	5,287	693	0.043	16,116	1,000	9,829	24,493
1979	1,659	2,854	318	0.043	7,395	1,000	3,541	9,054
1980	10,899	6,546	1,093	0.043	25,419	1,000	17,873	36,318
1981	7,836	3,738	199	0.043	4,628	1,000	-110	12,464
1982	12,511	4,989	408	0.043	9,488	1,000	3,499	21,999
1983	17,055	2,411	245	0.043	5,698	1,000	2,287	22,753
1984	0	468	333	0.043	7,744	1,000	6,276	7,744
1985	0	616	311	0.013	24,323	1,000	22,707	24,323
1986	0	1,069	469	0.016	30,317	1,000	28,248	30,317
1987	0	1,134	291	0.022	13,453	1,000	11,319	13,453
Adjusted Efficiencies, 1981-1984								
Year	HE	HR	MIL	E	MILR	PAD	S	R
1971	18,268	1,792	399	0.043	9,279	1,000	6,487	27,547
1972	2,445	8,933	1,151	0.043	26,767	1,000	16,834	29,212
1973	866	5,977	1,132	0.043	26,326	1,000	19,349	27,192
1974	963	7,184	1,791	0.043	41,651	1,000	33,467	42,614
1975	743	6,626	1,208	0.043	28,093	1,000	20,467	28,836
1976	878	7,591	943	0.043	21,930	1,000	13,339	22,808
1977	6 865	12,060	1,934	0.043	44,977	1,000	31,917	51,842
1978	8,377	5,287	693	0.043	16,116	1,000	9,829	24,493
1979	1,659	2,854	318	0.043	7,395	1,000	3,541	9,054
1980	10,899	6,546	1,093	0.043	25,419	1,000	17,873	36,318
1981	7,836	3,738	199	0.022	9,045	1,000	4,307	16,881
1982	12,511	4,989	408	0.022	18,545	1,000	12,556	31,056
1983	17,055	2,411	245	0.022	11,136	1,000	7,725	28,191
1984	0	468	333	0.022	15,136	1,000	13,668	15,136
1985	0	616	311	0.013	24,323	1,000	22,707	24,323
1986	0	1,069	469	0.016	30,317	1,000	28,248	30,317
1987	0	1,134	291	0.022	13,453	1,000	11,319	13,453

HE = harvest in estuary; HR = harvest in river; MIL = Millbank catch; E = catch efficiency; MILR = returns to Millbank; PAD = poaching and disease; S = spawners; R = total returns.

Table 12. Estimates of spawning escapement (S) and total returns (R) of 1SW salmon to the Miramichi River, 1971 to 1987, using a constant catch efficiency (E) for Millbank of 0.055 for 1971 to 1984 (upper) and adjusted efficiencies for 1981 to 1984 (lower).

Year	HE	HR	MIL	E	MILR	PAD	S	R
Unadjusted								
1971	0	13,727	1,962	0.055	35,673	4,000	17,946	35,673
1972	39	19,101	2,543	0.055	46,236	4,000	23,135	46,275
1973	0	13,857	2,450	0.055	44,545	4,000	26,688	44,545
1974	0	18,232	4,038	0.055	73,418	4,000	51,186	73,418
1975	393	16,040	3,548	0.055	64,509	4,000	44,469	64,902
1976	1,819	27,381	4,939	0.055	89,800	4,000	58,419	91,619
1977	407	14,089	1,505	0.055	27,364	4,000	9,275	27,771
1978	1,234	8,700	1,268	0.055	23,055	4,000	10,355	24,289
1979	5,512	14,605	2,500	0.055	45,455	4,000	26,850	50,967
1980	2,697	11,997	2,139	0.055	38,891	4,000	22,894	41,588
1981	1,628	23,716	2,174	0.055	39,527	4,000	11,811	41,155
1982	2,311	22,068	2,665	0.055	48,455	4,000	22,387	50,766
1983	1,588	8,747	810	0.055	14,727	4,000	1,980	16,315
1984	0	11,611	1,010	0.055	18,364	4,000	2,753	18,364
1985	0	18,985	912	0.020	46,417	4,000	23,432	46,417
1986	0	28,151	1,763	0.016	110,718	4,000	78,567	110,718
1987	0	17,864	1,272	0.013	97,130	4,000	75,266	97,130
Adjusted								
Year	HE	HR	MIL	E	MILR	PAD	S	R
1971	0	13,727	1,962	0.055	35,673	4,000	17,946	35,673
1972	39	19,101	2,543	0.055	46,236	4,000	23,135	46,275
1973	0	13,857	2,450	0.055	44,545	4,000	26,688	44,545
1974	0	18,232	4,038	0.055	73,418	4,000	51,186	73,418
1975	393	16,040	3,548	0.055	64,509	4,000	44,469	64,902
1976	1,819	27,381	4,939	0.055	89,800	4,000	58,419	91,619
1977	407	14,089	1,505	0.055	27,364	4,000	9,275	27,771
1978	1,234	8,700	1,268	0.055	23,055	4,000	10,355	24,289
1979	5,512	14,605	2,500	0.055	45,455	4,000	26,850	50,967
1980	2,697	11,997	2,139	0.055	38,891	4,000	22,894	41,588
1981	1,628	23,716	2,174	0.034	63,941	4,000	36,225	65,569
1982	2,311	22,068	2,665	0.034	78,382	4,000	52,314	80,693
1983	1,588	8,747	810	0.034	23,824	4,000	11,077	25,412
1984	0	11,611	1,010	0.034	29,706	4,000	14,095	29,706
1985	0	18,985	912	0.020	46,417	4,000	23,432	46,417
1986	0	28,151	1,763	0.016	110,718	4,000	78,567	110,718
1987	0	17,864	1,272	0.013	97,130	4,000	75,266	97,130

HE, harvest in estuary; HR, river harvest; MIL, Millbank catch; E, trap efficiency; MILR, returns to Millbank; PAD, poaching and disease; S, spawners; and R, total returns to estuary.

Table 13. Adjusted catch efficiencies for Millbank trap, 1981 to 1984. Adjustments were based on regression between Millbank catch (y) and DNRE catch (x) from 1969 to 1980 (see equations below).

Year	DNRE	Y	$\hat{Y}$	$(Y/\hat{Y})(0.055)$	M/R
1. 1SW Salmon					
1981	22,716	2,174	3,942	0.030	
1982	21,402	2,665	3,697	0.040	
1983	8,390	810	1,264	0.035	
1984	11,230	1,010	1,795	0.031	
1985	18,439	912	3,143	0.016	0.020
1986	26,163	1,763	4,587	0.021	0.016
1987	[16,590][1]	1,272	[2,797]	0.025	0.013
2. MSW Salmon					
				$Y/\hat{Y}$ (0.043)	
1981	3,238	199	521	0.016	
1982	4,608	408	753	0.023	
1983	2,240	245	352	0.030	
1984	5,299	333	870	0.017	
1985	9,622	311	1,600	0.008	0.013
1986	14,266	469	2,386	0.009	0.016
1987	[4,234][1]	291	689	0.018	0.022

[1] DNRE catches in 1987 predicted from Table 1.

Regressions were: 1SW $Y = -304.35 + 0.19\ (x)$; $R^2 = 0.74$, df = 10, $P<0.001$
MSW $Y = -26.43 + 0.17\ (x)$; $R^2 = 0.77$, df = 10, $P<0.001$

Table 14. Indices of spawning escapement in Miramichi River, 1970 to 1987.

1 Year (i)	2 Kelt (i)	3 Bright (i-1)	4 0+ (i)	5 1+ (i+1)	6 Spawners (i-1)
1970	1,647	3,804	.	7.9	.
1971	1,352	3,268	20.1	8.3	.
1972	547	1,792	9.8	3.0	6,487
1973	2,970	8,933	24.9	11.0	16,834
1974	3,037	5,977	34.2	12.8	19,349
1975	3,111	7,184	40.0	11.7	33,467
1976	1,446	6,288	25.1	8.4	20,467
1977	2,156	7,374	51.8	10.7	13,339
1978	2,126	11,617	36.4	9.0	31,917
1979	1,668	4,893	19.7	8.3	9,829
1980	1,504	2,656	34.5	7.0	3,541
1981	2,118	6,546	53.6	9.8	17,873
1982	1,368	3,238	15.0	6.7	4,307
1983	960	4,608	44.5	6.5	12,556
1984	731	2,240	19.1	8.9	7,725
1985	3,771	5,299	56.4	12.2	13,668
1986	6,856	9,622	55.4	13.1	22,707
1987	.	14,266	74.5	.	28,248

Correlations:

	n	r	P
2 with 3	17	0.63	0.007
2 with 4	16	0.63	0.010
2 with 5	17	0.79	0.002
2 with 6	15	0.48	0.067
3 with 4	17	0.68	0.003
3 with 5	17	0.63	0.007
3 with 6	16	0.81	<0.001
4 with 5	16	0.63	0.008
4 with 6	16	0.51	0.044
5 with 6	15	0.57	0.027

Table 15. Data used to forecast MSW salmon returns to Miramichi River. Variables are: X1, total returns of 1SW salmon (yr i); X2, proportion female 1SW salmon (yr i; arcsine); MSWRET, MSW returns (yr i+1).

Year (i)	X1 (i)	X2 (i)	MSWRET (i + 1)
1971	35,673	19.37	29,212
1972	46,275	27.97	27,192
1973	44,545	24.27	42,614
1974	73,418	33.34	28,836
1975	64,902	31.56	22,808
1976	91,619	29.40	51,842
1977	27,771	28.52	24,493
1978	24,289	37.70	9,054
1979	50,967	31.56	36,318
1980	41,588	26.06	16,881
1981	65,569	30.07	31,056
1982	80,693	32.90	28,191
1983	25,412	32.71	15,136
1984	29,706	27.76	24,323
1985	46,417	28.52	30,317
1986	110,718	27.97	13,453
1987	97,130	36.51	.

Table 16. Results of the multiple regression to predict MSW salmon returns to the Miramichi River in 1988. Data are in Table 15.

Year	1SW	MSW	F	P>F	R^2	Prediction
1. Including 1987 MSW salmon returns						
1986	110,718	30,317				
1987	97,130	13,453	1.44	0.27	0.18	26,405
2. Not including 1987 returns						
1986	110,718	30,317				
1987	97,130	.	9.23	0.004	0.61	36,378 (16,950-55,805)

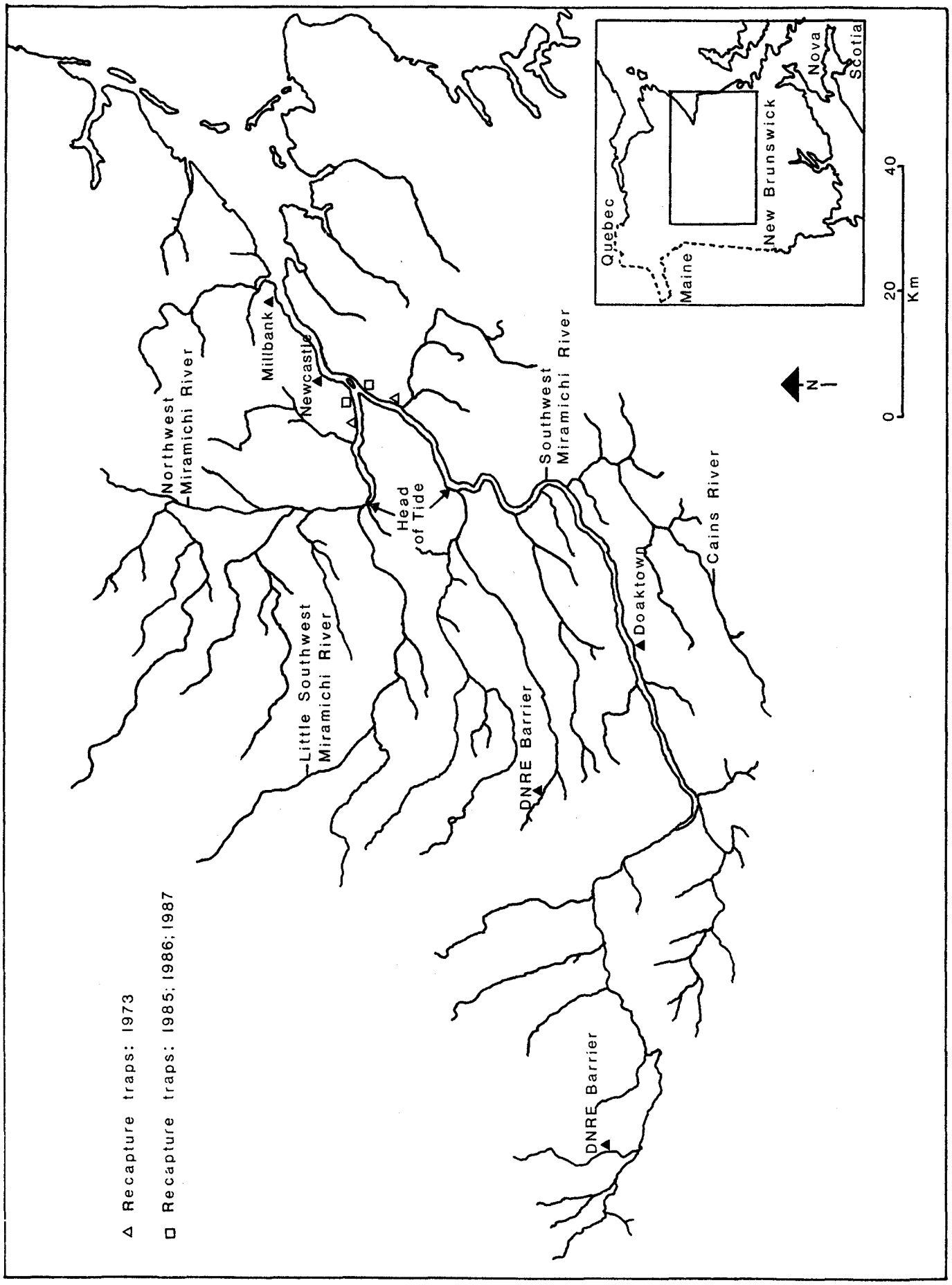


Fig. 1. General location of recapture traps in the Northwest and Southwest tributaries of the Miramichi River system.

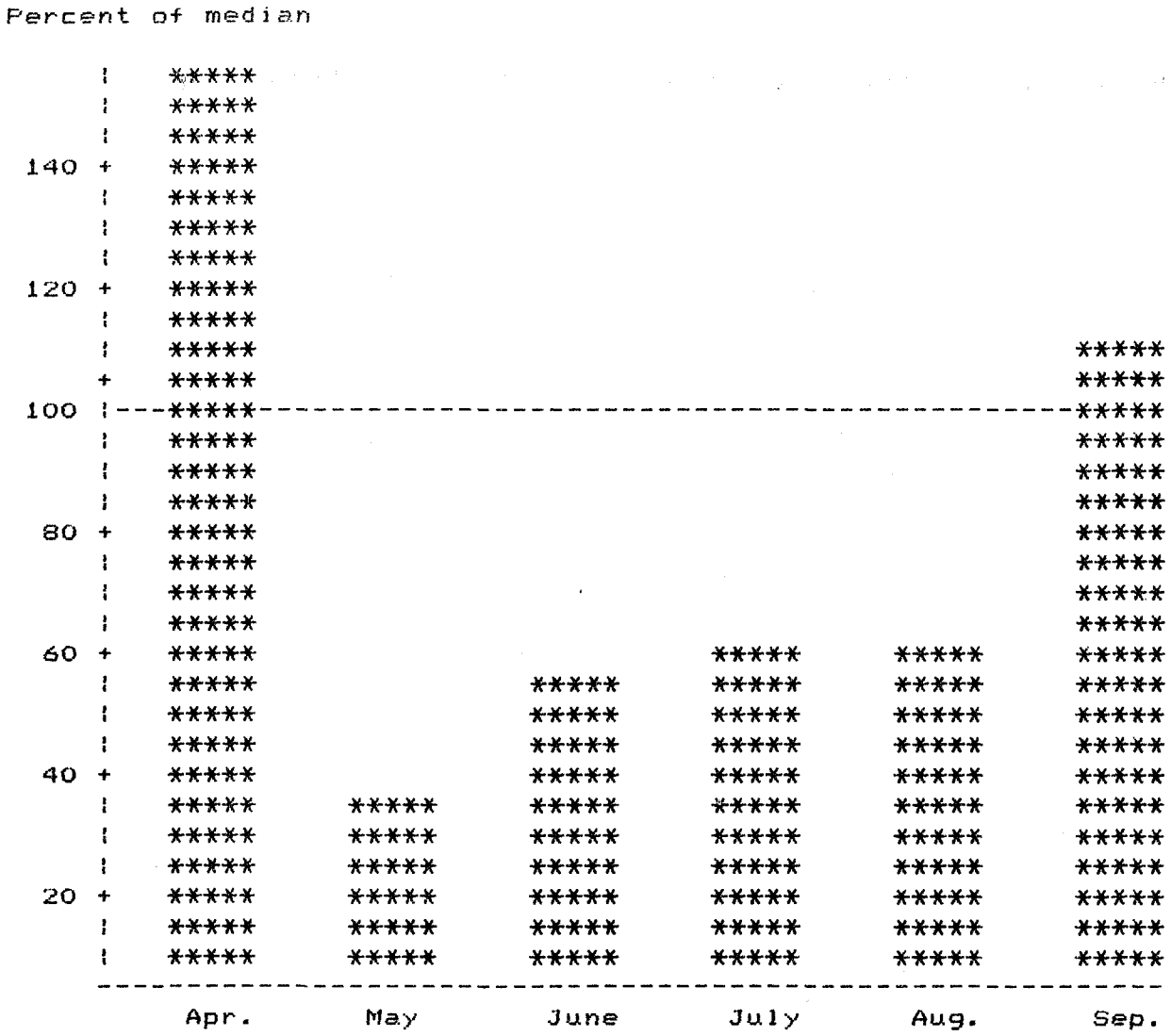
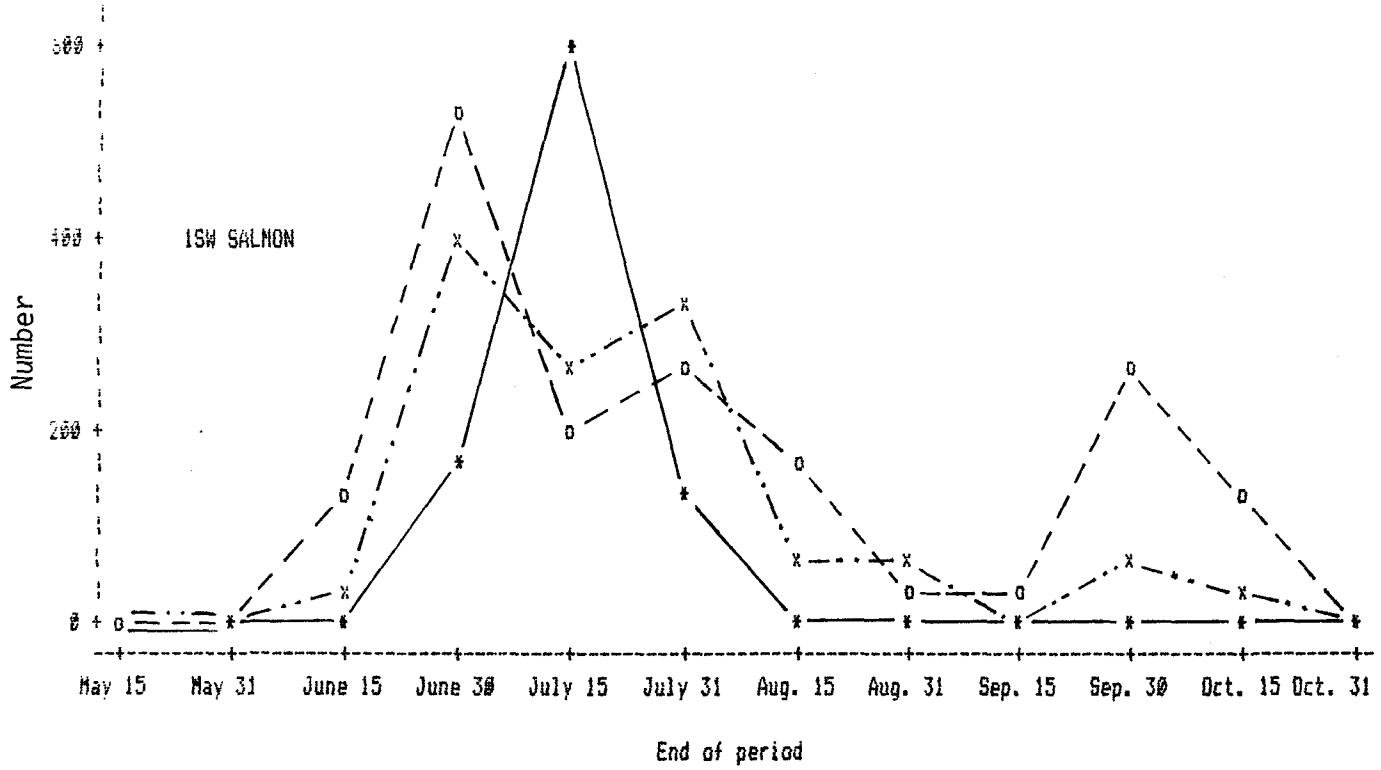


Fig. 2 . Mean monthly discharge, cubic meters per sec, of surface water in the Southwest Miramichi River, 1987, expressed as a percent of the long term median



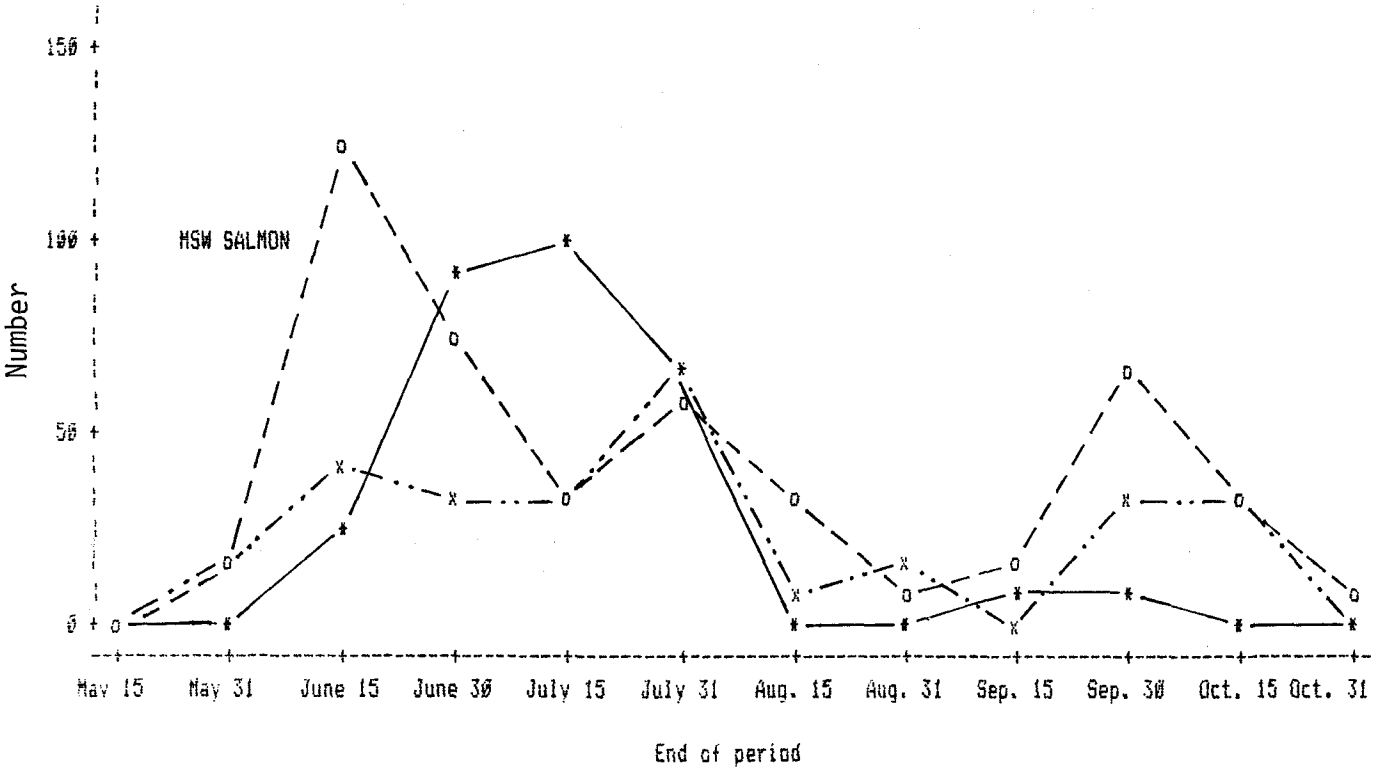
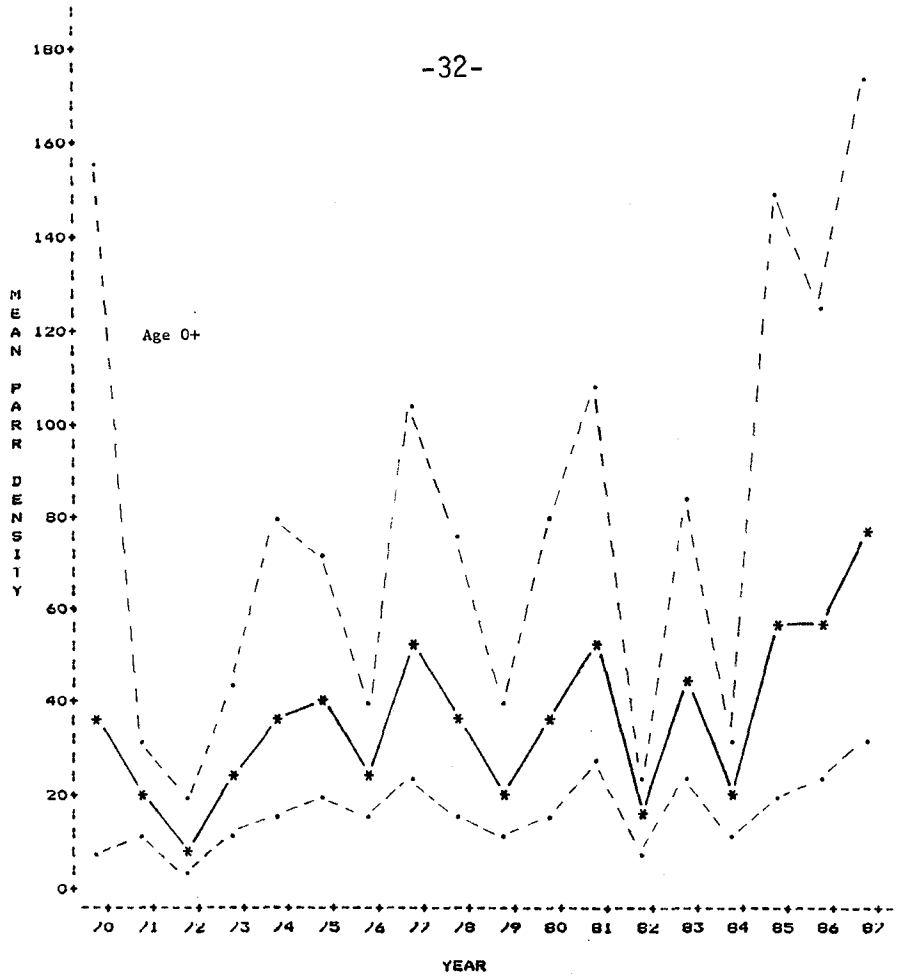


Fig. 3. Salmon caught in half-month periods at Millbank, 1985 (*), 1986 (o) and 1987 (x)



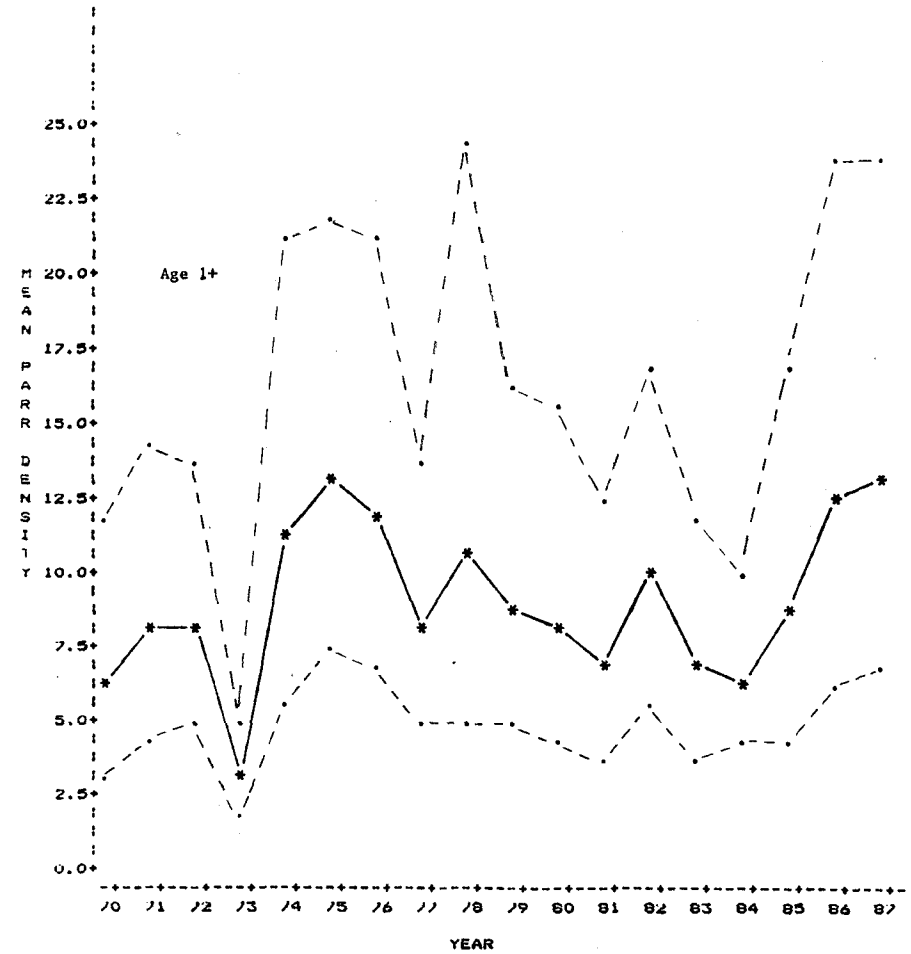


Fig. 4. Mean densities (per $100m^2$) of juvenile Atlantic salmon in the Miramichi River, 1970-87. (95% confidence intervals are indicated).

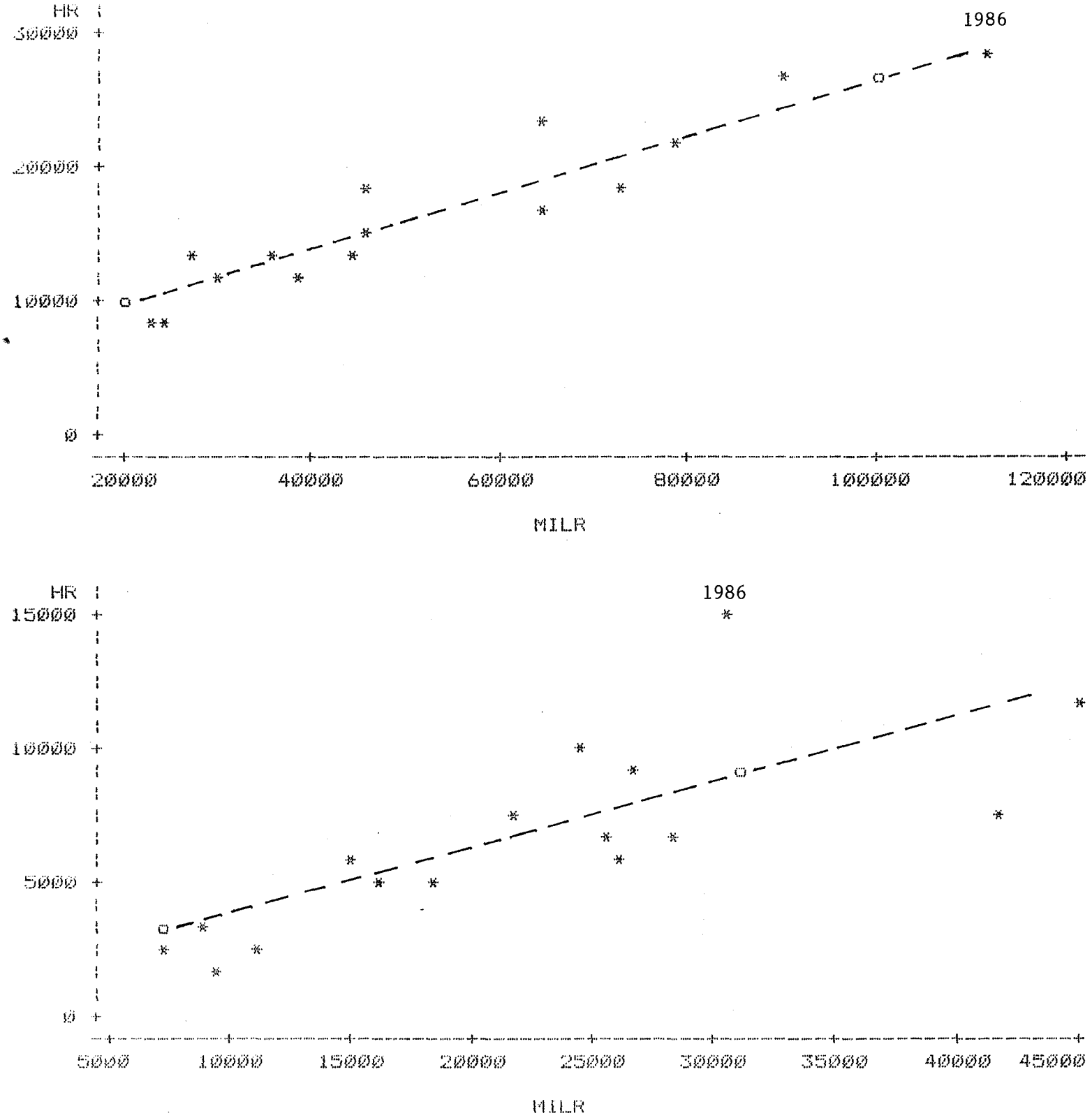


Fig. 5. Correlation between estimated salmon returns to Millbank (MILR) and harvest in the river above Millbank (angling + Native; HR). Age 1SW salmon (upper) and MSW salmon (lower).

APPENDIX I. Angling seasons on Miramichi tributaries, 1987 and 1986.

Tributary	Season 1986	Season 1987[1]
General (bright salmon)	8 June - 30 September	8 June - 30 September
Exceptions		
Bartholomew	Closed	Closed
Bartibog	1 July - 15 October	1 July - 29 October
Cains	1 July - 15 October	1 July - 15 October
Dungarvon (above Underwood Brook)	8 June - 15 September	8 June - 15 September
Little Southwest (above Catamaran)	8 June - 15 September	8 June - 15 September
Southwest (above MacKeil Brook)	8 June - 15 September	8 June - 15 September
Northwest (above Little River)	8 June - 31 August	1 June - 31 August
Renous (above North & South Banches of Renous)	8 June - 15 September	8 June - 15 September
Rocky Brook	1 June - 31 August	1 June - 31 August
Sevogle (above Square Forks)	8 June - 15 September	8 June - 15 September
Other tributaries of Main Southwest Miramichi (above Cains River - except Rocky Brook)	8 June - 15 September	8 June - 15 September

[1] Because of low water, the Northwest, Little Southwest, Sevogle, Renous and Dungarvon tributaries were closed from 15 July to 27 July.

APPENDIX II. Proportion of salmon caught at Millbank in early May (1-15) and late October (15-30), early November, 1971 to 1986. N/A is not applicable.

Year	Trapping Period		Proportion of total run		
	Start	Finish	May 1-15	Oct. 15-30	Nov.
1SW Salmon					
1971	20 May	15 Nov.	N/A	0.000	0.001
1972	24 May	31 Oct.	N/A	0.000	N/A
1973	13 May	1 Nov.	N/A	0.002	N/A
1974	15 May	8 Nov.	N/A	0.002	0.000
1975	17 May	14 Nov.	N/A	0.004	0.000
1976	2 May	2 Nov.	0.000	0.000	N/A
1977	5 May	4 Nov.	0.000	0.000	0.000
1978	15 May	3 Nov.	N/A	0.000	0.000
1979	3 May	31 Oct.	0.003	0.000	N/A
1980	3 May	3 Nov.	0.000	0.000	0.000
1981	30 Apr.	2 Nov.	0.000	0.001	N/A
1982	7 May	1 Nov.	0.000	0.000	N/A
1983	6 May	28 Oct.	0.000	0.000	N/A
1984	12 May	29 Oct.	N/A	0.010	N/A
1985	14 May	7 Nov.	N/A	0.001	N/A
1986	13 May	24 Oct.	N/A	0.002	N/A
MSW Salmon					
1971	20 May	15 Nov.	N/A	0.000	0.003
1972	24 May	31 Oct.	N/A	0.003	N/A
1973	13 May	1 Nov.	N/A	0.004	N/A
1974	15 May	8 Nov.	N/A	0.004	0.002
1975	17 May	14 Nov.	N/A	0.038	0.000
1976	2 May	2 Nov.	0.000	0.000	N/A
1977	5 May	4 Nov.	0.000	0.000	0.000
1978	15 May	3 Nov.	N/A	0.000	0.000
1979	3 May	31 Oct.	0.006	0.006	N/A
1980	3 May	3 Nov.	0.005	0.000	0.000
1981	30 Apr.	2 Nov.	0.005	0.000	N/A
1982	7 May	1 Nov.	0.000	0.000	N/A
1983	6 May	28 Oct.	0.012	0.000	N/A
1984	12 May	29 Oct.	N/A	0.063	N/A
1985	14 May	7 Nov.	N/A	0.013	N/A
1986	13 May	24 Oct.	N/A	0.015	N/A

APPENDIX III. Summary of mark-recapture data in the Miramichi River, 1987. Data from 1985 and 1986 are given for comparison.

		Recapture traps		
	Millbank	Southwest	Northwest	Total
1987				
MSW salmon				
Catch	291	273	213	486
Meshed	9	12	4	16
Broodstock	0	41	23	64
Tagged	275	---	---	
Recaptures	0	4	3	7
1SW salmon				
Catch	1,272	815	724	1,539
Meshed	0	0	0	0
Tagged	1,103	---	---	---
Recaptured	7	6	7	13
1986				
MSW salmon				
Catch	469	585	264	849
Meshed	48	39	30	69
Broodstock	0	34	20	54
Tagged	404 (4)[1]	---	---	
Recaptures	2	3	5	8
1SW salmon				
Catch	1,763	1,519	832	2,351
Meshed	25	---	2	2
Tagged	1,587	---	---	---
Recaptured	8	17	9	26
1985				
MSW salmon				
Catch	311	486	204	690
Meshed	27	41	13	54
Broodstock	40	61	0	61
Tagged	222 (3)[1]	---	---	---
Recaptures	3	4	0	4
1SW salmon				
Catch	912	848	695	1,543
Meshed	0	0	0	0
Tagged	600	---	---	---
Recaptured	1	10	5	15

[1] Considered inaccessible to recapture traps.

APPENDIX IV. Summary of tags applied at Millbank and recaptured in various fisheries in 1985 to 1987.

	1985		1986		1987	
	MSW	1SW	MSW	1SW	MSW	1SW
Marked (Millbank)						
Tags	222	600	356	1,420	271	1,034
Fin-clips	---	---	48	167	4	69
Total	222	600	404	1,587	275	1,103
Recaptures						
Recapture traps						
Tags	4	15	8	26	7	13
Fin-clips	---	---	---	---	0	0
Native fishery	2	6	6	50	3	11
Anglers						
Bright	15	69	15	141	2	85
Kelts (yr i + 1)	6	8	12	15	---	---
Mortalities	0	2	0	1	0	1
Dungarvon	2	6	0	3	0	2
SW Miramichi	0	0	0	1	0	0
Bartholomew	0	1	0	1	2	12
Other	1	1		1	0	1
Millbank	3	1	2	8	0	7
Commercial (yr i + 1)						
Québec	0	0	0	1		
Nfld.	0	0	1	5		
Greenland	0	0	0	1		
Labrador	0	3	1	0		