EFFECT OF THE 1984-1988 MANAGEMENT PLAN ON HARVEST AND SPAWNING LEVELS OF ATLANTIC SALMON IN THE RESTIGOUCHE AND MIRAMICHI RIVERS, NEW BRUNSWICK

by

R.G. Randall
Science Branch, Gulf Region
Department of Fisheries & Oceans
P.O. Box 5030
Moncton, New Brunswick, E1C 9B6

ABSTRACT

The five-year management plan which was introduced in 1984 significantly reduced the harvest of MSW salmon in the Restigouche and Miramichi Rivers. Angling quality remained high because of average or above average returns of 1SW salmon during years when the management plan was in effect (1984 to 1988), and also because of average or above average catches of MSW salmon (which were released back into the river). Nominal harvests of 1SW and MSW salmon from native fisheries in northeast New Brunswick equalled or exceeded harvests in pre-plan years. Because of significant reductions in the overall harvest of MSW salmon in homewaters, however, spawning escapements and egg deposition levels increased from pre-plan to plan years in both rivers. Electrofishing surveys indicated average or above average juvenile densities in recent years, confirming that spawning escapements generally increased. Numbers of MSW salmon enumerated at various headwater counting fences generally increased during plan years, although these increases probably resulted in part from factors other than the management plan (hatchery stocking and protection of spawners).

RESUME

Le plan de gestion quinquennal adopté en 1984 a considérablement réduit la récolte de saumons redibermarins dans les rivières Restigouche et Miramichi. La pêche à la ligne a continué d'être fructueuse parce que les remontées d'unibermarins ont été égales ou supérieures à la moyenne durant la période d'application du plan (1984-1988) et parce que les prises de redimerbarins ont également été égales ou supérieures á la moyenne (saumons relâchés dans les rivières). Les prises nominales d'unibermarins et de redibermarins dans les pêcheries autochtones du nord-est du Nouveau-Brunswick ont été égales ou supérieures à celles des années antérieures au plan. Toutefois, en raison d'une baisse importante des prises globales de redibermarins dans les eaux d'origine, les échappées de reproducteurs et le nombre d'oeufs déposés ont augmenté depuis l'entrée en vigueur du plan dans les deux rivières considérées. D'après les études par électropêche, les densitiés de juvéniles ont égalé ou dépassé la moyenne au cours des dernières années, ce qui confirme la hausse générale du nombre de reproducteurs. Dans l'ensemble, les redibermarins recensés aux diverses barrières de dénombrement des eaux de tête ont été plus nombreux après l'entrée en vigueur du plan, quoique cette augmentation soit sans doute partiellement due à d'autres facteurs que le plan de gestion (empoissonnement aux saumons d'élevage et protection des reproducteurs).

INTRODUCTION

In 1984, an Atlantic salmon management plan was initiated in eastern Canada which was designed to significantly increase the survival of multi-sea winter (MSW) salmon in Maritime rivers. Regulations were introduced which restricted the harvest of salmon moreso than at any other time in the history of the salmon fisheries. For salmon stocks in northeastern New Brunswick, major elements of the plan which affected the survival of salmon in homewaters included: the closure of commercial fisheries in all Maritime coastal areas and rivers; the mandatory release of all MSW salmon by anglers; and the prohibition of landing any salmon caught in non-salmon fishing gear (by-catch).

The objective of this report is to compare the harvest and spawning levels of Atlantic salmon in the Restigouche and Miramichi Rivers in years preceding and during the management plan initiated in 1984.

DATA SOURCES AND METHODS

Potential effects of the Atlantic salmon management plan were evaluated by comparing salmon data between two 5-year time periods, a pre-plan period (1979 to 1983) and a plan period (1984 to 1988). Variables compared between periods included: angling catches (numbers of fish), effort (rod-days), catch-per-unit of effort (CPUE), native fishery catches (numbers), total river returns of salmon (numbers), returns to specific counting fences (numbers), numbers of spawners, egg deposition (eggs per m^2), and juvenile salmon densities (numbers per m^2). For all above variables except juvenile salmon densities, statistical comparisons were made using the General Linear Models (GLM) of SAS (SAS 1982). Analyses were performed on rank transformed data (Conover 1980; Conover and Iman 1981) using the Rank procedure of SAS (SAS 1982). For testing for differences in mean densities of juvenile salmon between periods, 2-way ANOVA (SAS GLM procedures; SAS 1982) tests were used. For age 0+ salmon, comparisons were made of pre-plan years 1981 to 1984, and of plan years 1985 to 1988. Similarly for age 1+ parr, comparisons were made of pre-plan years 1983 to 1985 and of plan years 1986 to 1988.

Salmon data used in this report have been presented previously in annual CAFSAC assessments of the Restigouche and Miramichi salmon stocks. Sources of data, and methodology for estimating salmon returns, spawning escapement, egg deposition levels and juvenile salmon densities are described in detail in Randall et al. (1989a and b). Brief descriptions of some of the major changes in regulations affecting the harvest of Atlantic salmon by anglers, commercial fishermen and native fishermen from 1979 to 1988 are given in Appendices I to III.

As mentioned above, anglers were required to release all MSW salmon back into the rivers since 1984. Therefore, it should be emphasized that estimates of the numbers of MSW salmon caught by anglers are not directly comparable between

the five-year pre-plan and plan periods. Estimates of the numbers of salmon caught and released are probably overestimates of landable fish for two reasons: first, some MSW salmon hooked and released may be recaptures, and second, estimates of catch and release can include salmon that may not have been landable. For these reasons, increases in angling catches since 1984 may not reflect increases in MSW salmon abundance.

HARVEST

1. Commercial

In pre-plan years, the numbers of salmon harvested in commercial and by-catch fisheries of the Restigouche zone averaged about 1,800 1SW salmon and 2,600 MSW salmon (Randall et al. 1989a). Average pre-plan landings in Miramichi River were about 2,700 1SW salmon and about 10,000 MSW salmon (Randall et al. 1989b). During plan years, there was a short commercial fishery in the Restigouche zone in 1984 only (landings were about 7,200 1SW salmon and 2,000 MSW salmon). For other plan years (1985 to 1988) in the Restigouche, and for all plan years in the Miramichi commercial salmon fisheries were closed and landing of salmon from non-salmon commercial gear (by-catch) was prohibited.

2. Angling catch, effort, CPUE and harvest

Angling catches of Atlantic salmon in the Restigouche River from 1970 to 1988 averaged about 6500 fish, of which 63% were MSW salmon (Randall et al. 1989a). Angling catches during this period are illustrated for New Brunswick and Quebec separately in Fig. 1. In New Brunswick, mean catches of salmon increased during plan years from pre-plan years, for both 1SW salmon (+83%) and MSW salmon (61%); however, the increases were significant only at $P<0.10$ (Table 1). In 1984, following the introduction of the plan, angling effort decreased from pre-plan years, but then increased to levels exceeding those of the pre-plan years (Fig. 1). On average, however, effort increased only slightly between the pre-plan and plan periods (10%). Catch-per-unit of effort (CPUE) increased for both 1SW and MSW salmon following introduction of the plan, but not significantly (Table 1). In Quebec, angling effort, harvest and CPUE did not change significantly between the pre-plan and plan periods (Table 1).

In the Miramichi River, harvest of bright 1SW salmon increased but not significantly from pre-plan to plan years (Table 2). Catch of MSW salmon increased significantly by 162 percent. As in the Restigouche River, angling effort decreased markedly during the first year of the plan, but then increased annually each year to reach pre-plan levels by 1988 (Fig. 2). Mean effort (rod-days) was slightly lower in plan years than in pre-plan years (Table 2; -12%). CPUE increased for both 1SW and MSW salmon between the pre-plan and plan periods, but the increase was significant only for MSW salmon (Fig. 2 and Table 2).

For the spring kelt fishery in the Miramichi, harvest of 1SW salmon increased each year during the plan, averaging 2542 fish during the five year

period, which was 25% greater harvest than in pre-plan years (Table 2). Catch of MSW salmon also increased during the plan period. Increased catches of both sea ages, however were not statistically significant (Table 2). Angling effort for kelts increased by 50% from pre-plan to plan years (Table 2). Except for 1988 when CPUE exceeded historic levels (Fig. 2), average CPUE for 1SW salmon was similar in pre-plan and plan periods. Although average CPUE for MSW kelts increased, differences in angling success between pre-plan and plan years were not significant (Table 2).

3. Native fisheries

In northeastern New Brunswick, there are five native fisheries which exploit Atlantic salmon from the Restigouche River (Restigouche and Eel River Bar) and Miramichi River (Burnt Church, Eel Ground and Red Bank). Average nominal harvests from these fisheries in years preceding and during the management plan are summarized in Table 3. No statistical comparisons were made of the numbers of salmon harvested between periods because of unequal and often inadequate sample sizes (Table 3).

Native fishermen at Restigouche, Quebec reported catching their quota of 6995 kg in most years from 1984 to 1988. Nominal harvest for this fishery during this period was less than in years preceding the introduction of the plan (Table 3). Decreases in nominal harvest resulted from a reduction in the quota in 1984 and from shorter fishing seasons (Appendix III). Nominal harvest of salmon increased at Eel River Bar, by 27% for 1SW salmon and by 122 % for MSW salmon during the plan years. Effort at Eel River increased in 1986 and 1987 when trap nets were added to the fishery (Appendix III).

Native fishermen in the Miramichi River at all three locations reported increased harvests of 1SW and MSW salmon during the plan years (Table 3). Fishing effort increased at two locations: Burnt Church where native fishermen began setting their gill nets further offshore in 1987; and at Eel Ground, where nets were set at Big Hole in the Northwest Miramichi River proper for the first time in 1987. Historically, fishermen from Eel Ground restricted their fishing to tidal waters. No estimates of harvest were available from the Big Hole fishery.

4. Total harvest

Total harvest (angling plus native, but excluding commercial fisheries) of salmon during the years when the management plan was in effect (1984 to 1988) is compared to harvest in the five years preceding the plan in Table 4. In Restigouche River, harvest of 1SW salmon increased but not significantly , while harvest of MSW salmon decreased significantly (by 58%) during the plan years. In the Miramichi River, similar changes in harvest levels were observed. Mean harvests of 1SW salmon during the plan years increased slightly, while the harvest of MSW salmon decreased significantly to negligible levels compared to pre-plan harvest levels. Numbers of fish harvested from 1970 to 1988 are illustrated for the Restigouche River in Fig. 3 and for Miramichi River in Fig. 4.

TOTAL RETURNS AND SPAWNING ESCAPEMENT

Total returns of salmon to Restigouche River for the period 1970 to 1988 are illustrated in Fig. 3. Returns of 1SW salmon increased by an average of 48% (significant at $P<0.10$) from pre-plan to plan years (Table 4). Returns of MSW salmon averaged about 11000 fish during both periods. As mentioned above, harvest of MSW salmon was reduced when the plan was in effect, and therefore spawning escapement increased significantly (173%; $P<0.01$) as a result of the plan. Because of increases in total returns, the numbers of 1SW salmon that spawned also increased from the pre-plan to the plan years, although the increase was not statistically significant (Table 4).

Trends in total returns and spawning levels in the Miramichi River in years preceding and during the 1984 management plan were similar to the Restigouche River. Average returns of 1SW salmon were greater but not significantly so during the plan years (Table 4). Numbers of 1SW salmon harvested also increased, probably as a result of the increased returns. Despite increased harvests, however, the numbers of 1SW salmon that potentially survived to spawn also increased substantially (91%). Returns of MSW salmon during the 1984 to 1988 period decreased slightly (10%) from the five preceding years. However, because of the significant reductions in the numbers of MSW salmon harvested, spawning escapement increased significantly (121%) while the management plan was in effect (Table 4).

Average ratios of MSW spawners to total returns increased significantly in both rivers, from 0.22 to 0.58 in Restigouche and from 0.35 to 0.91 in Miramichi River.

EGG DEPOSITION

Increased numbers of MSW salmon spawners in the Restigouche River following the introduction of the 1984 management plan resulted in substantial increases in egg deposition levels (Fig. 5). Average egg deposition levels increased from 13.2 during the period from 1979 to 1983 to 38.5 million eggs during the period 1984 to 1988. Egg deposition requirements for the Restigouche River for adequate smolt production are 71.4 million eggs (Randall 1984); these deposition levels have apparently not been met even in recent years. Because few 1SW salmon in the Restigouche River are females (only 2%), total egg contributions from 1SW salmon averages only 1% of the total egg deposition in this river (Randall 1989).

The target egg deposition level for the Miramichi River is 132 million eggs (Randall 1985). Target deposition rates were met in four of the five years following the introduction of the 1984 management plan (Fig. 5). Average egg depositions in the five plan years were greater than in the five years preceding the plan. Egg depositions increased for both 1SW and MSW salmon from pre-plan to plan years (Fig. 5). In contrast to the Restigouche River, age 1SW salmon contribute significantly to egg deposition in the Miramichi River. The percent contribution to total egg deposition by 1SW salmon averaged 36% in the five years preceding the plan, and 26% during the plan.

RECRUITMENT

Average juvenile Atlantic salmon densities at 15 electrofishing sites in the Restigouche River are compared for the pre-plan and plan periods in Fig. 6. Densities of age 0 salmon increased significantly between periods (ANOVA; $P<0.01$). In contrast, there was very little difference in mean densities of age 1 parr. In the Miramichi River, mean densities of both age 0 and age 1 salmon increased significantly during the plan years (Fig. 6; $P<0.01$ for both age groups).

Stock-recruitment curves for Restigouche and Miramichi salmon, where stock was an estimate of egg deposition and recruitment was resulting fry and parr densities, are illustrated in Fig. 7. In most cases, fry and parr densities in years when the 1984 management plan was in effect were above average. All curves were statistically significant ($P<0.01$).

COUNTING FENCE DATA FOR THE RESTIGOUCHE AND MIRAMICHI ZONES

In the Restigouche zone, two counting fences have been operated in recent years: a protection barrier in the headwaters of Upsalquitch River (tributary of the Restigouche) since 1980, and a counting fence in the main trunk of Nepisiquit River since 1981. Average counts of both 1SW and MSW salmon increased at these two locations during the management plan; increases of MSW salmon were significant (Fig. 8; Table 5). Nepisiquit River has been subjected to extensive hatchery stocking of salmon in recent years, and this may have resulted in the increased returns of salmon to this site. Increased counts at the Upsalquitch barrier may have resulted from the increased protection of spawners above the barrier since 1980.

Four counting fences have been operated in the Miramichi watershed: at Millbank (located in the estuary) and at the Bartholomew, Dungarvon and Southwest Miramichi tributaries. Counts of 1SW and MSW salmon increased at all tributary counting fences in recent years (Fig. 8; Table 5). Increases in numbers of salmon were significant at the Bartholomew (both sea ages) and Southwest Miramichi sites (MSW salmon). As in the Restigouche River, increases in salmon abundance at the Miramichi sites probably resulted at least in part from factors other than the management plan. Bartholomew River has been stocked with hatchery salmon for the past several years. As at the Upsalquitch barrier, returns of salmon to the SW Miramichi and Dungarvon protection barriers in recent years may have been affected by the increased protection of spawners at these sites. In contrast to the tributary, counts of 1SW and MSW salmon at Millbank decreased by 34 and 24%, respectively, from the pre-plan to the plan period. Note however that Millbank counts are not adjusted for changes in trap efficiency which probably occurred in 1981 (Randall et al. 1989b).

SYNOPSIS

Recent data from the Restigouche and Miramichi rivers indicate that the Atlantic salmon populations and fisheries have probably been affected in both positive and negative ways by the management plan introduced in 1984. Specifically:

1. Total river harvest of MSW salmon decreased significantly from pre-plan to the plan periods (1984-1988) in both the Restigouche and Miramichi rivers. Mean harvests decreased by 58% in Restigouche River and by 94% in the Miramichi River. Reductions in harvest were proportionally less in the Restigouche River because Quebec anglers were allowed to retain MSW salmon, and also because there was a short commercial fishery in 1984.

2. There was a substantial decrease in angling effort (rod-days) in the first year of the plan (1984) in both the Miramichi and Restigouche rivers. Following this, angling effort gradually increased to equal or exceed pre-plan levels by the end of the five-year period.

3. Angling harvests of 1SW salmon increased in both the Miramichi River and in New Brunswick tributaries of the Restigouche River during the plan (by 35 and 83%, respectively). Angling harvest of 1SW salmon in Quebec tributaries increased only slightly (10%). Angling quality was also enhanced by the catch-and-release policy for MSW salmon; catches of MSW salmon during plan years equalled or exceeded catches in pre-plan years. Similarly, CPUE ratios in the angling fishery during the plan equalled or exceeded CPUE ratios in pre-plan years.

4. Nominal harvests of both 1SW and MSW salmon increased at native fisheries located at Eel River Bar, Burnt Church, Eel Ground and Red Bank during the plan period. Fishing effort increased at the former three locations. Nominal harvests at Restigouche decreased slightly in recent years, because of a reduced quota and shorter fishing seasons.

5. The numbers of MSW salmon spawners increased significantly in both the Restigouche (173%) and Miramichi rivers (121%) during the management plan. Increased spawning escapement resulted from the reduced homewater harvests (commercial and angling) of MSW salmon.

6. Egg deposition levels increased between the pre-plan and plan periods. Despite the increases in egg deposition in the Restigouche River, target deposition levels have apparently not been met in this river. (Note, however, that estimates of salmon returns, spawning escapement and egg deposition levels in the Restigouche River are based on angling catches and an assumed angling exploitation rate. If the assumed exploitation rate was too high, egg deposition

levels have been significantly and consistently underestimated. Angling exploitation rates in the Restigouche River are presently being investigated (Randall et al. 1990)). In the Miramichi River, target egg deposition levels were met in 4 of 5 years since the initiation of the 1984 plan.

7. Mean densities of age 0 salmon fry at 15 electrofishing sites increased significantly in Restigouche River and in the Miramichi River. Mean densities of age 1 parr also increased significantly in the Miramichi River, but not in the Restigouche River. Relationships between estimated egg deposition levels and resulting fry and parr densities (stock and recruitment) were statistically significant in both rivers.

8. Counts of 1SW and MSW salmon increased at most counting fences in the Restigouche and Miramichi watersheds from the pre-plan to the plan period. It is difficult to attribute all increases directly to the management plan, however. Enhancement activities other than the management plan, including hatchery stocking and protection of spawners from poachers, probably affected fence counts as well. Generally, though, returns of MSW salmon increased moreso than returns of 1SW salmon, which was consistent with the intention management plan (i.e., reduced exploitation of MSW salmon).

ACKNOWLEDGEMENTS

I thank R. Claytor and D. Swain for reviewing this manuscript and providing helpful comments.

REFERENCES

SAS 1982. SAS Institute Inc. SAS User's Guide: Statistics. Cary, North Carolina, U.S.A.

Conover, W.J. 1980. Practical nonparametric statistics. 2nd. Ed. J. Wiley and Sons, New York.

Conover, W.J. and R.L. Iman. 1981. Rank transformations as a bridge between parametric and nonparametric statistics. The American Statistician 35: 124-129.

Randall, R.G. 1989. Effect of sea age on the reproductive potential of Atlantic salmon (Salmo salar) in eastern Canada. Can. J. Fish. Aquat. Sci. 46: 2210-2218.

Randall, R.G., G. Landry, A. Madden and R. Pickard. 1989a. Biological assessment of Atlantic salmon in the Restigouche River, 1988. CAFSAC Res. Doc. 89/33.

Randall, R.G., P.R. Pickard and D. Moore. 1989. Biological assessment of Atlantic salmon in the Miramichi River, 1988. CAFSAC Res. Doc. 89/73.

Randall, R.G., G. Landry, A. Madden and R. Pickard. 1990. Status of Atlantic salmon in the Restigouche River in 1989. CAFSAC Res. Doc. 90/2.

Table 1. Comparison of angling catch, effort (rod-days) and catch-per-unit-effort (CPUE) in the Restigouche River in years preceding (1979 - 1983) and during (1984 - 1988) the 1984 management plan.

		Pre-plan			Plan			% Change		
		Catch	Effort	CPUE	Catch	Effort	CPUE	Catch	Effort	CPUE
NB	1SW	2199	8955	0.25	4029	9820	0.40	+ 83	+ 10	+ 60
	MSW	2206	8955	0.24	3549	9820	0.35	+ 61	+ 10	+ 46
PQ	1SW	437	7889	0.06	478	7233	0.06	+ 10	- 08	00
	MSW	1168	7889	0.14	928	7233	0.13	- 21	- 08	- 7

[1] none of the changes in angling catches, effort or CPUE were significant ($P > 0.05$)

Table 2. Comparison of angling catch, effort (rod-days) and catch-per-unit-effort (CPUE) in the Miramichi River in years preceding (1979 - 1983) and during (1984 - 1988) the 1984 management plan.

		Pre-plan			Plan			% Change	
		Catch	Effort	CPUE	Catch	Effort	CPUE	Catch	Effort	CPUE
Brights	1SW	15803	75920	0.21	21277	66951	0.31	+ 35	- 12	+ 47
	MSW	3858	75920	0.05	10121	66951	0.15	+ 162**	- 12	+ 200**
Kelts	1SW	2040	3923	0.52	2542	5802	0.49	+ 25	+ 50	- 6
	MSW	1524	3923	0.39	4618	5802	0.84	+ 203	+ 50	+ 115

** significant at $P < 0.05$

Table 3. Comparison of mean harvests by native fishermen of 1SW and MSW salmon in years preceding (1979 - 1983) and during (1984 - 1988) the 1984 Atlantic salmon management plan.

Native Band	Sea age	Pre-plan	Plan	% Change
Restigouche	1SW	72[1]	45	- 38
	MSW	1262[1]	1020	- 19
Eel River	1SW	30	38	+ 27
	MSW	208	462	+ 122
Red Bank	1SW	206[2]	552	+ 168
	MSW	189[2]	272	+ 44
Eel Ground	1SW	251[3]	457	+ 82
	MSW	91[3]	208	+ 129
Burnt Church	1SW	incidental	17	-
	MSW	incidental	25	-
Big Cove	1SW	23[3]	41[1]	+ 78%
	MSW	74[3]	61[1]	- 18%

[1] n = 4; [2] n = 3; [3] n = 2

Table 4. Comparison of average returns, harvest and numbers of spawners in the Restigouche and Miramichi Rivers in years preceding (1979 - 1983) and during (1984 - 1988) the 1984 management plan.

		Pre-plan			Plan			% Change		
		Returns	Harvest	Spawners	Returns	Harvest	Spawners	Returns	Harvest	Spawners
Restigouche	1SW	7066	4491	1845	10424	6022	3155	+ 48*	+ 34	+ 71
	MSW	10616	7162	2362	10922	3025	6452	+ 3	- 58***	+ 173***
Miramichi	1SW	52678	18974	29704	82958	22319	56639	+ 57	+ 18	+ 91
	MSW	24047	14100	8948	21665	849	19816	- 10	- 94***	+ 121**

* significant at P < 0.10
** significant at P < 0.05
*** significant at P < 0.01

Table 5. Comparison of counts of 1SW and MSW salmon at various counting fences in the Restigouche and Miramichi Zones during pre-plan (1979 - 1983) and plan years (1984 - 1988).

Zone	Location		Pre-plan[1]	Plan	% Change
Restigouche	Upsalquitch	1SW	721	1139	+ 58
		MSW	574	861	+ 50*
	Nepisiguit	1SW	650	1408	+ 117
		MSW	336	1083	+ 222**
Miramichi	Millbank	1SW	2058	1357	- 34
		MSW	453	346	- 24
	Bartholomew	1SW	384	848	+ 121**
		MSW	114	380	+ 233***
	S.W. Mir.	1SW	527	1019	+ 92
		MSW	185	847	+ 358**
	Dungarvon	1SW	456	589	+ 29
		MSW	119	182	+ 53

[1] Sample sizes in pre-plan years sometimes less than 5

* significant at P < 0.10
** significant at P < 0.05
*** significant at P < 0.01

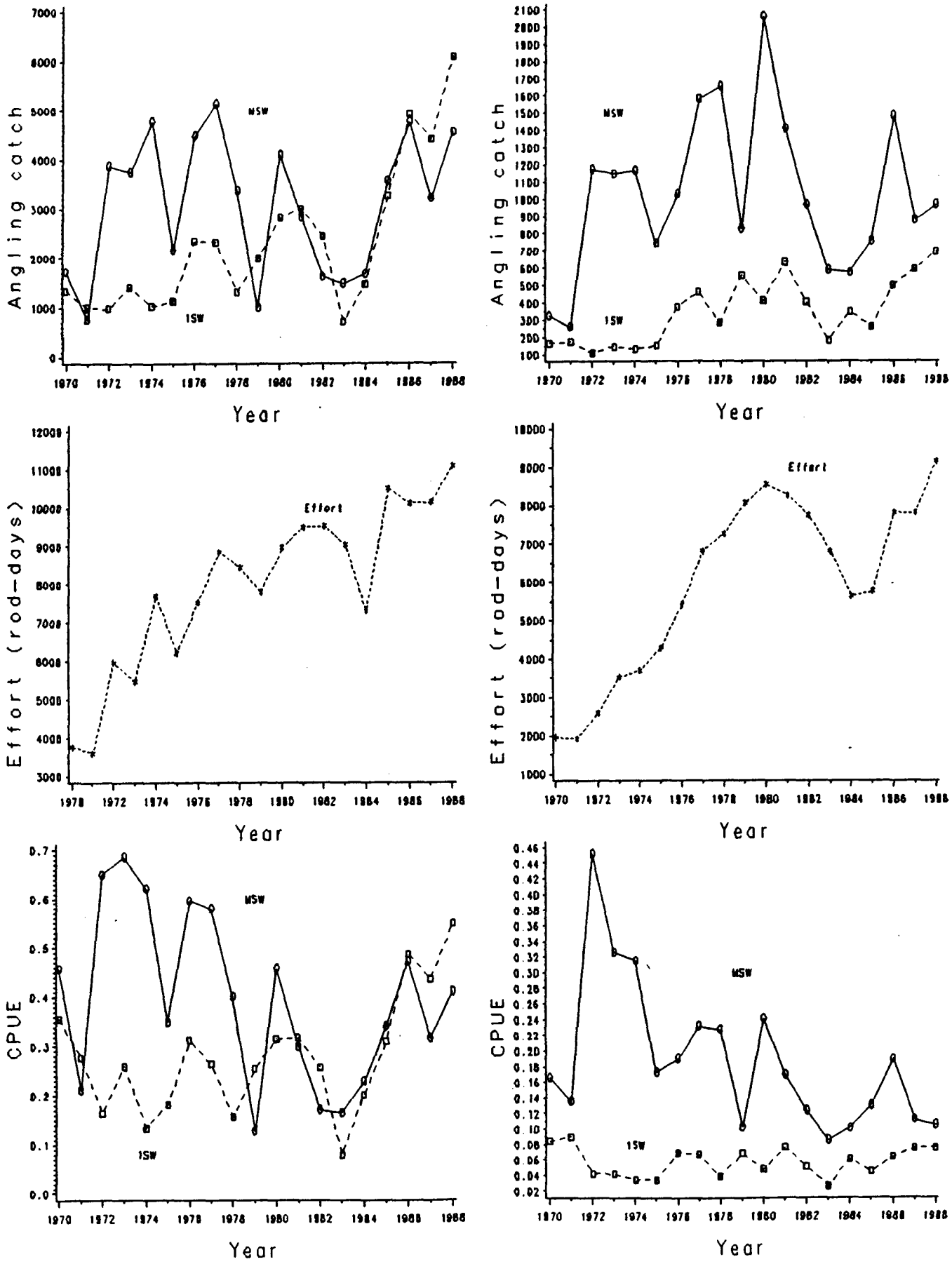

Figure 1. Angling catch, effort, and CPUE in New Brunswick (left three panels) and Quebec tributaries of the Restigouche River, 1969 to 1988. Note that MSW salmon catches in New Brunswick from 1984 to 1988 are estimates of the numbers of salmon caught and released, rather than actual harvests.

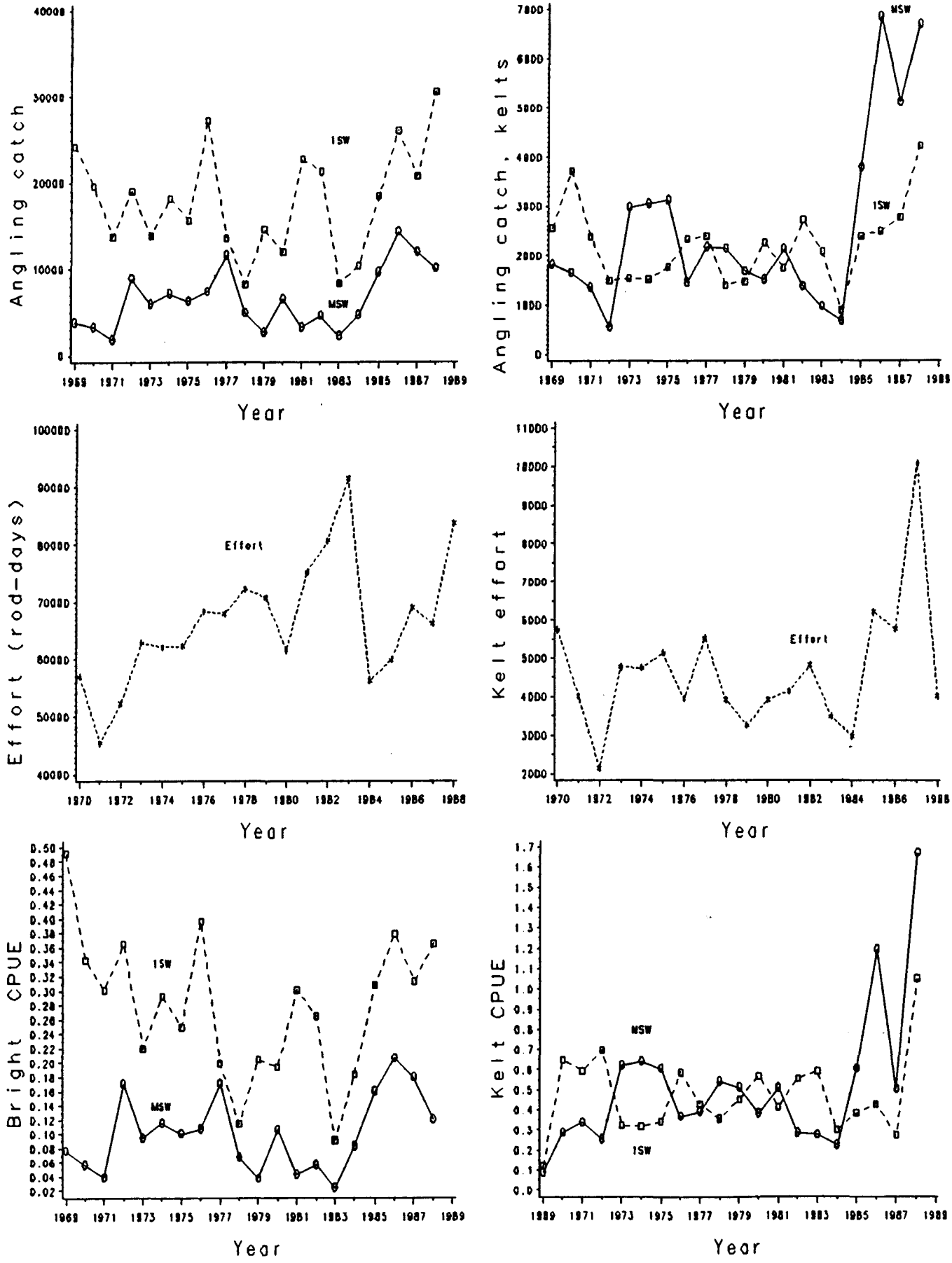

Figure 2. Angling catch, effort, and CPUE in the Miramichi River, 1970 to 1988. Angling data for bright salmon is illustrated in the left three panels, and for kelts in the right three panels. Note that MSW salmon catches are for numbers of fish caught and released from 1984 to 1988 for bright salmon and from 1985 to 1988 for kelts.

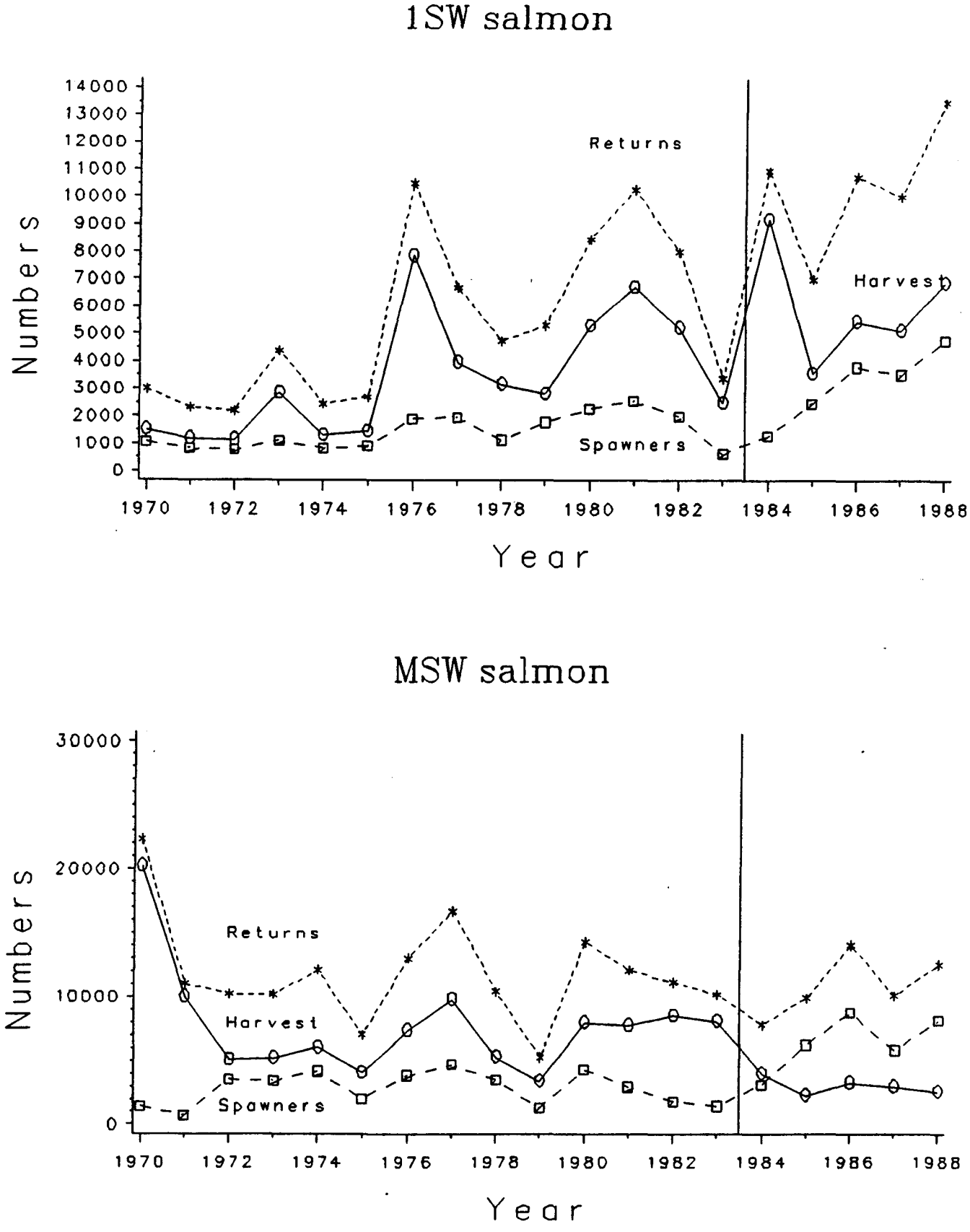

Figure 3. Estimates of the total number of salmon returns, spawners and harvests in the Restigouche River, 1970 to 1988 (upper figure, 1SW salmon and lower figure, MSW salmon). The vertical line indicates the beginning of the 1984 management plan.

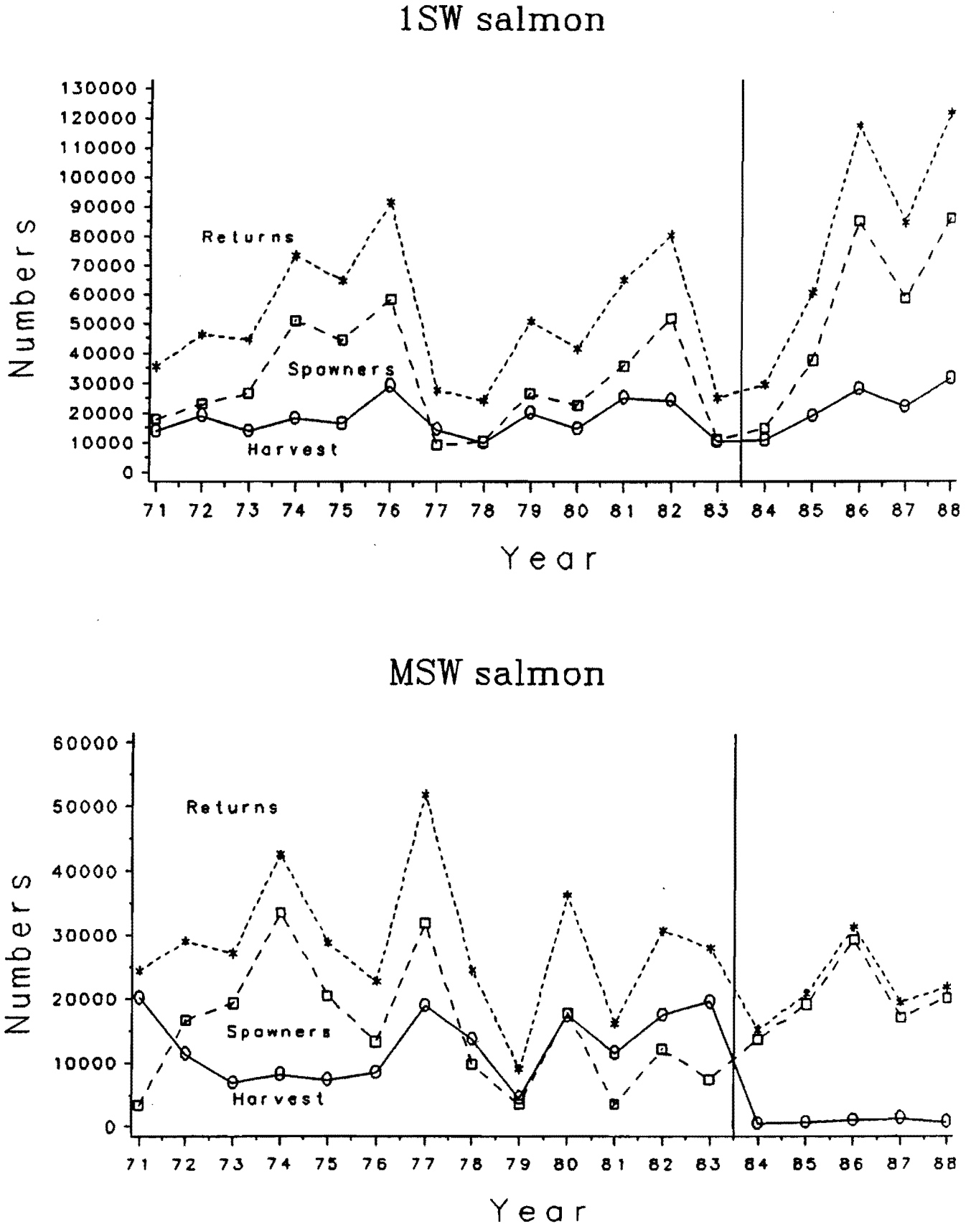

Figure 4. Estimates of the total numbers of salmon returns, spawners and harvests in the Miramichi River, 1970 to 1988.

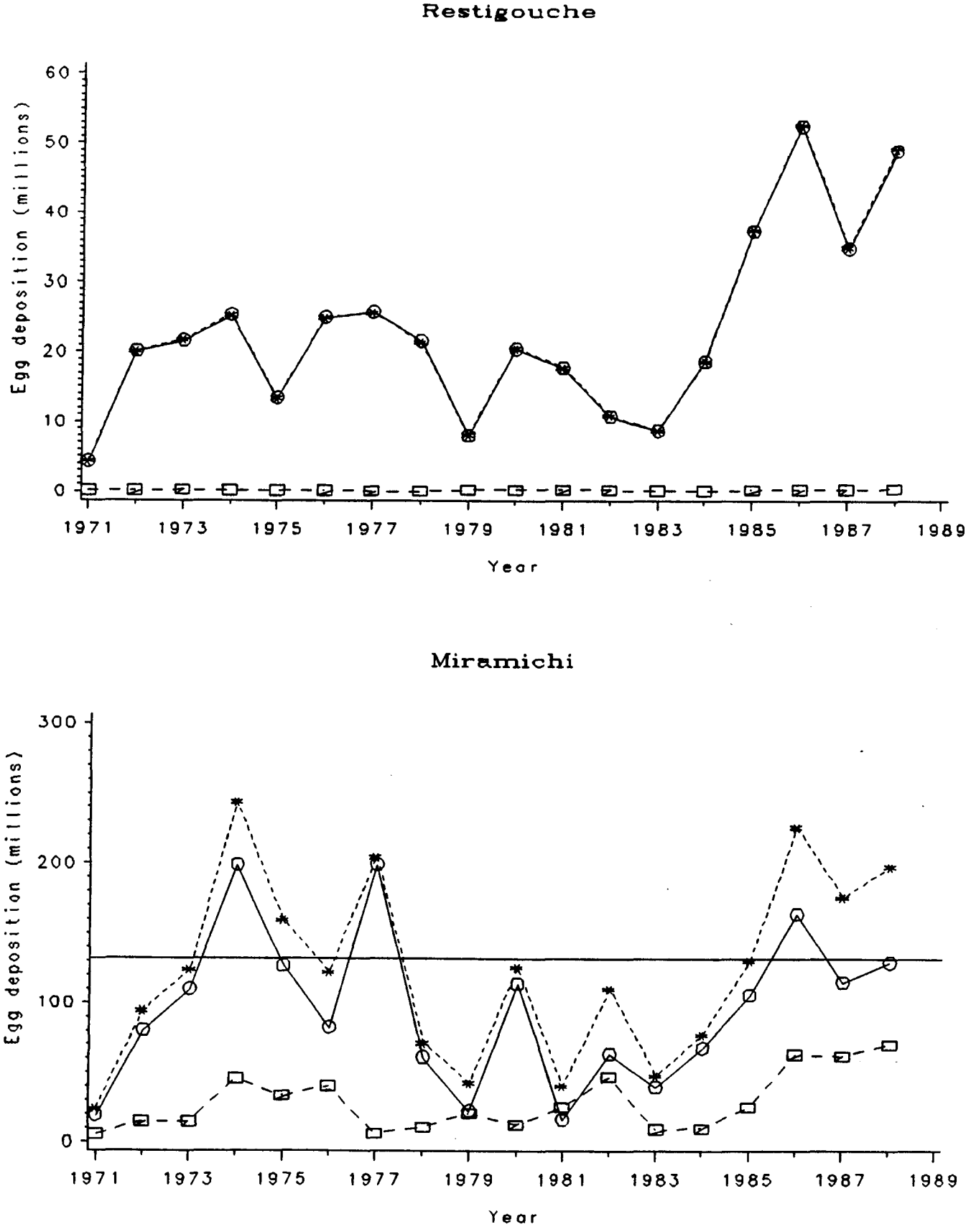

Figure 5. Estimate of total egg depositions (millions of eggs) in the Restigouche (upper) and Miramichi rivers, 1971 to 1988. Legend: squares, depositions by 1SW fish; circles, depositions by MSW salmon; asterisks, total egg depositions.

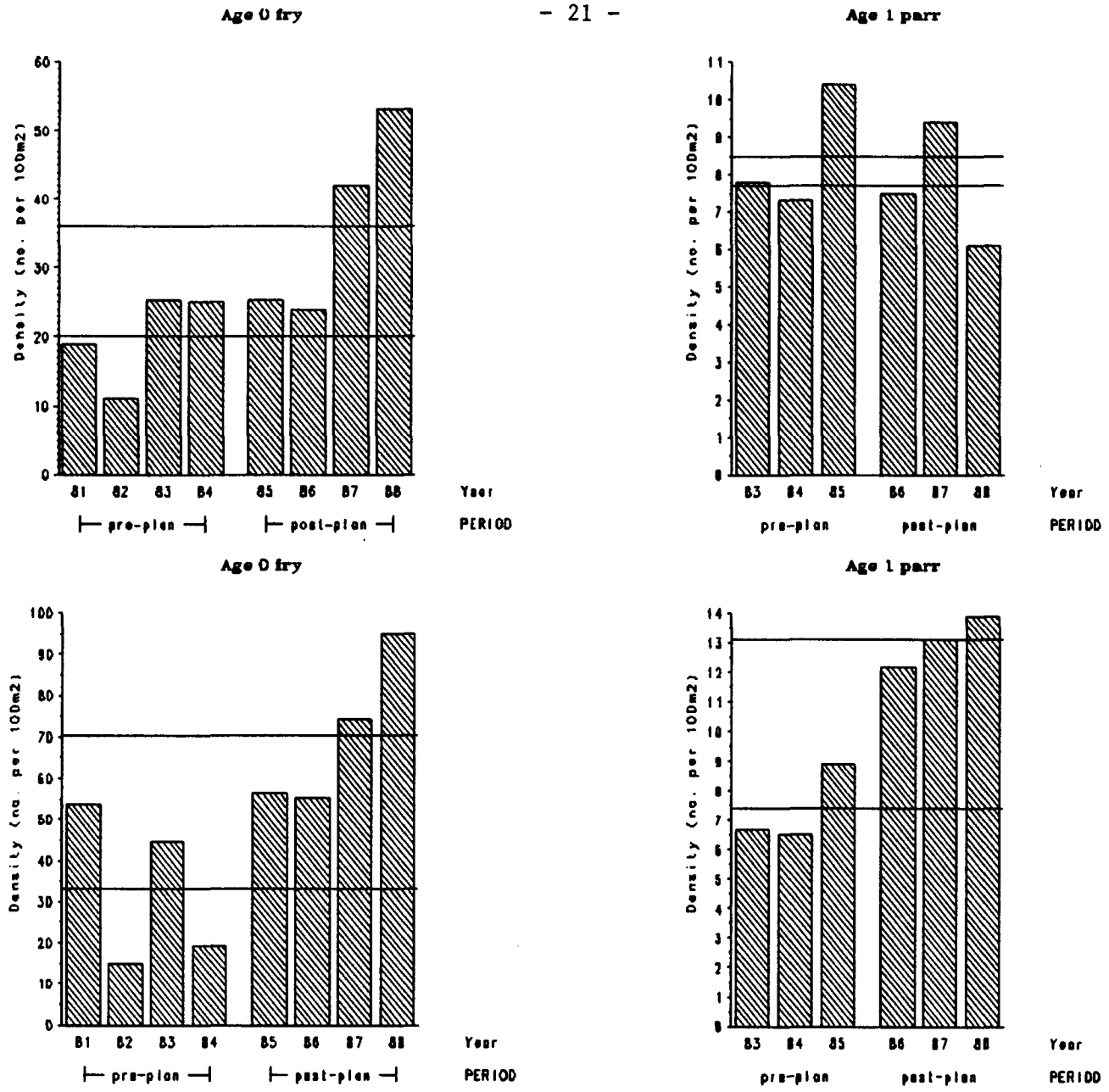

Figure 6. Average age 0 and age 1 juvenile salmon densities in the Restigouche River (upper) and Miramichi River (lower) at 15 electrofishing sites from 1979 to 1988. Lower and upper horizontal lines indicate mean densities for the pre-plan and plan periods, respectively.

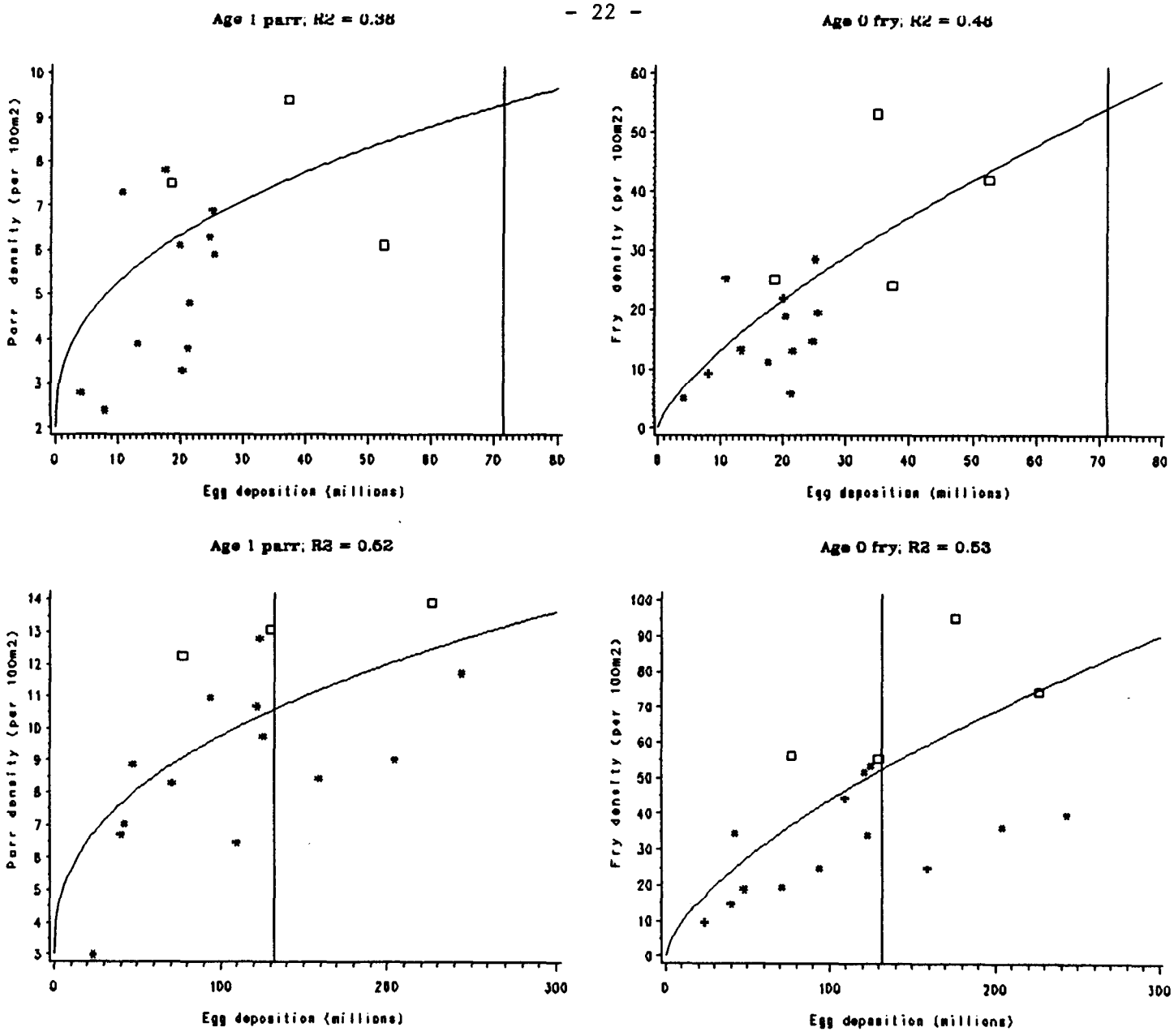

Figure 7. Relationship between estimated egg deposition and resulting age 0 and age 1 juvenile salmon densities in the Restigouche River (upper) and Miramichi River (lower) from 1971 to 1988. Square data points are for years during the 1984 management plan.

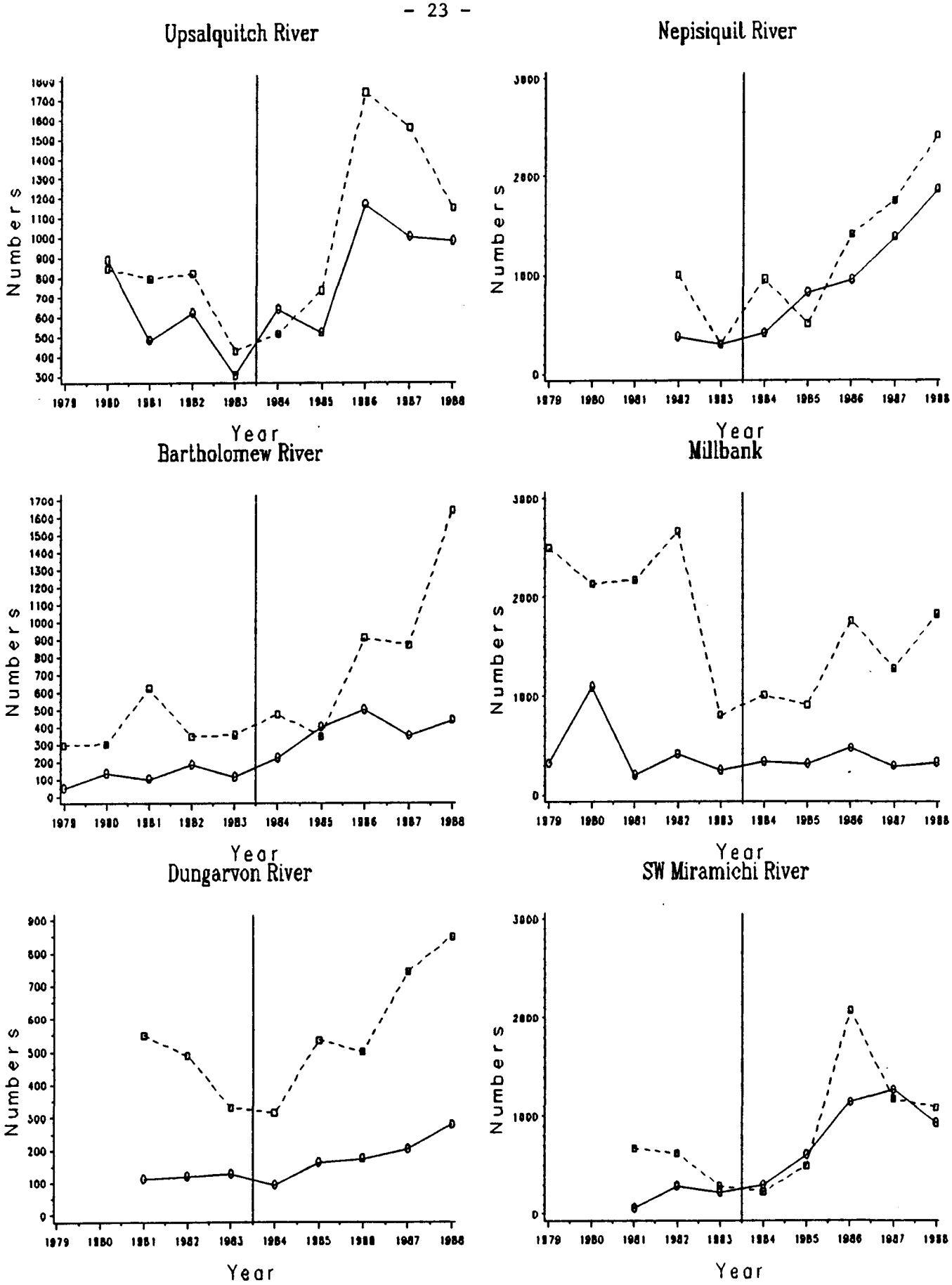

Figure 8. Counts of 1SW (dashed lines) and MSW salmon (solid lines) at various counting fences in the Restigouche (upper two figures) and Miramichi zones. Vertical lines indicate the initiation of the 1984 management plan.

Appendix I. Angling bag limits and seasons in New Brunswick and Quebec, 1979 - 1988.

	New Brunswick					Quebec			
	Bag limits			Restigouche	Miramichi	Bag limits			
Year	Daily	Season	Comments	Season	Season	Daily	Season	Comments	Season
1979	2	10	S or G	June 1 - Aug 31	May 15 - Sept 30	2	None	S or G	June 1 - Aug 31
1980	2	15	S or G	June 8 - Sept 7	June 1 - Oct 15	2	None	S or G	June 1 - Aug 31
1981	2	15	S or G	June 1 - Aug 31	June 1 - Oct 15	2	None	S or G	June 1 - Aug 31
1982	2	10	5S/5G	June 14 - Aug 31	June 1 - Oct 15	2	None	S or G	June 1 - Aug 31
1983	2	10	5S/5G	June 15 - Aug 31	June 15 - Oct 15	2	None	S or G	June 1 - Aug 31
1984	2	10	G only	June 15 - Aug 31	June 15 - Oct 15	1	7	S or G	June 11 - Aug 31
1985	2	10	G only	June 1 - Aug 31	June 1 - Oct 15	1	7	S or G	June 11 - Aug 31
1986	2	10	G only	June 1 - Aug 31	June 1 - Oct 15	1	7	S or G	June 1 - Aug 31
1987	2	10	G only	June 1 - Aug 31	June 1 - Oct 15	1	7	S or G	June 1 - Aug 31
1988	2	10	G only	June 1 - Aug 31	June 1 - Oct 15	1	7	S or G	June 1 - Aug 31

Appendix II. Quotas and seasons of the commercial fisheries in the Restigouche and Miramichi Rivers during years of operation, 1979 to 1988.

	Restigouche				Miramichi	
	P.Q.		N.B.			
Year	Quota	Season	Quota	Season	Quota	Season
1979	closed				closed	
1980	closed				closed	
1981	closed		4000S, 14000G	June 8 - July 31	15,000S, 3000G	June 1 - July 31
1982	4000S, 4000G	June 14 - July 9	4000S, 4000G	June 14 - July 31	10,000S, 4000G	June 1 - July 31
1983	1600S, 1600G	June 13 - July 8	2400S, 2400G	June 13 - July 29	10,000S, 4000G	June 13 - July 29
1984	closed		no quota	July 9 - July 29	closed	
1985	closed				closed	
1986	closed				closed	
1987	closed				closed	
1988	closed				closed	

Appendix III. Changes in fishing seasons, quotas and fishing effort in native fisheries of Gulf New Brunswick.

1.	Restigouche	Year	Quota (kg)	Season
		1979	11340	June 6 - Aug 1
		1980	11340	June 2 - July 28
		1981	-	-
		1982	16648	June 9 - Aug 2
		1983	16648	June 3 - Aug 7
		1984	6995	June 5 - Aug 10
		1985	6995	June 3 - July 31
		1986	6995	June 2 - June 26
		1987	6995	June 1 - June 30
		1988	6995	June 6 - July 6

2. Eel River Bar

No quota or season limits.
New trap net installed in 1986.
Second trap net installed in 1987.

3. Burnt Church

No quota or season limits.
Allowed to set nets further offshore beginning in 1987.

4. Red Bank

No quota or season limits.

5. Eel Ground

No quota or season limits.
Began fishing at Big Hole Tract (Northwest Miramichi) in 1987.