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Assessments of Atlantic salmon stocks of the Maritimes Region, 1998

by

T.L. Marshall[1], G.J. Chaput[2], P.G. Amiro[1], D.K. Cairns[3],
R.A. Jones[2] S.F. O'Neil[1], and J.A. Ritter[1]

Department of Fisheries and Oceans
Science Branch, Maritimes Region
[1]P.O. Box 1006, Dartmouth, NS B2Y 4A2
[2]P.O. Box 5030, Moncton, NB E1C 9B6
[3]P.O. Box 1236, Charlottetown, PEI C1A 7M8

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Abstract

This document provides assessments of the Atlantic salmon stocks in more than 40 rivers within the Maritime Provinces. The status of the resource is determined from the annual returns and spawning escapements relative to the conservation requirements, the abundance of juveniles and smolts, corresponding trends in the juvenile stages from measures of sea survival, and the extent of habitat constraints on production. For most of these rivers the probabilities of meeting/exceeding conservation requirements in 1999 and of egg losses for some previously considered management scenarios are also provided. In the absence of river-specific salmon escapement information and where quantitative electrofishing for juvenile salmon has been conducted, the status of stocks were assessed relative to an "normal index of abundance" for Maritime streams.

Many of the stocks of the southern Gulf of St. Lawrence, especially the Miramichi and Restigouche have declined in recent years, but juvenile abundance is at medium to high levels and most of the rivers are near or above conservation. The rivers along the Northumberland Strait shore of New Brunswick are presently at low abundance but those in Nova Scotia, including Cape Breton generally exceeded conservation requirements. The majority of returns to PEI rivers are of hatchery origin. Assessments indicate that stocks of the Atlantic coast of Nova Scotia and outer Bay of Fundy have declined to low levels with reduced recovery potential. Stocks in rivers of the inner Bay of Fundy are all critically low and require immediate action to prevent their extirpation.

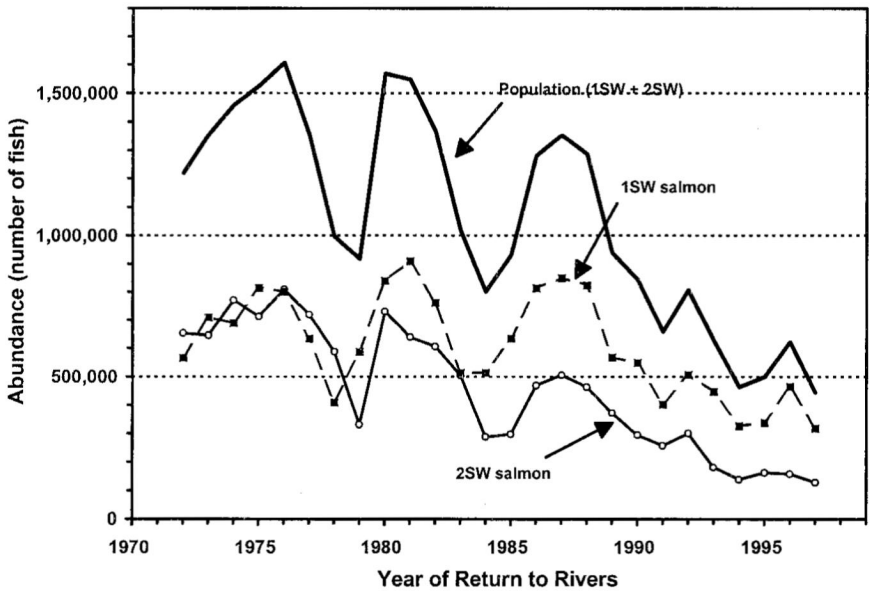
Résumé

Ce document présente des évaluations des stocks de saumon de l'Atlantique dans plus de 40 rivières des provinces Maritimes. L'état de la ressource est déterminé à partir des remontes annuelles et des échappées de géniteurs par rapport aux besoins de conservation, de l'abondance des juvéniles et des saumoneaux, des tendances correspondantes des stades juvéniles à participer des mesures des niveaux de survie en mer et de l'importance des limites de l'habitât sur la production. Le document fournit également, pour la plupart de ces rivières, les probabilités de respect/dépassement des besoins de conservation en 1999 et de perte d'oeufs pour certains scénarios de gestion déjà envisagés. En l'absence d'information sur les échappées de saumon des rivières particulières et là où on a effectué une pêche électrique quantitative des saumons juvéniles, l'état des stocks a été évalué par rapport à un « indice normal d'abondance » pour les cours d'eau des Maritimes.

Beaucoup des stocks du sud du golfe du Saint-Laurent, surtout de la Miramichi et de la Restigouche ont fléchi au cours des dernières années, mais l'abondance des juvéniles est à des niveaux moyens à élevés et la plupart des rivières en sont presque au niveau de conservation ou les ont dépassés. À l'heure actuelle, les niveaux d'abondance des rivières situées le long du détroit de Northumberland au Nouveau-Brunswick sont faibles, mais ceux de la Nouvelle-Écosse, y compris le Cap-Breton, dépassent généralement les impératifs de conservation. La majorité des saumons de remonte dans les rivières de l'Î.P.-É. proviennent de pisciculture. Les évaluations révèlent que les stocks de la côte Atlantique de la Nouvelle-Écosse et de l'avant-bassin de la baie de Fundy sont tombés à des niveaux bas avec possibilités de rétablissement réduites. Les stocks des rivières de l'intérieur de la baie de Fundy en sont tous à des niveaux critiques et exigent des mesures immédiates pour en empêcher la disparition.

Introduction

The estimated total population of North American origin one-sea-winter (1SW) and two-sea-winter (2SW) Atlantic salmon (*Salmo salar*) in the northwest Atlantic has oscillated around a declining trend since the 1970s, and the abundance recorded in 1993-1997 was lower than in any previous years (Anon MS1998).



These fish mostly originated from approximately 550 Atlantic salmon rivers in eastern Canada. Within the Maritime Provinces, there are more than 150 rivers with reported Atlantic salmon populations characterized by differences in life history traits including freshwater residence time, age at maturity, and the extent of ocean migrations.

Previous summaries of stock status described a geographically defined pattern of returns of small salmon and large salmon in the Maritimes (DFO 1998):

- Bay of Fundy and Atlantic coast of Nova Scotia stocks are characterized by a strong decline in abundance,
- Southern Gulf of St. Lawrence rivers are characterized by declining through stable through slight increased abundance.

A general decline in returns to rivers of the Maritimes of small (< 2.27 kg or < 63 cm; usually synonymous with 1SW) salmon and large (≥ 2.27 kg or ≥ 63 cm; usually synonymous with MSW) salmon occurred in 1997 relative to 1996 (DFO 1998). Relative to the recent five-year period, returns in 1997 to the Maritimes and Québec were the lowest or second lowest in 75% and 68% of the monitored rivers for small salmon and large salmon, respectively (DFO 1998). Although no single factor was identified that

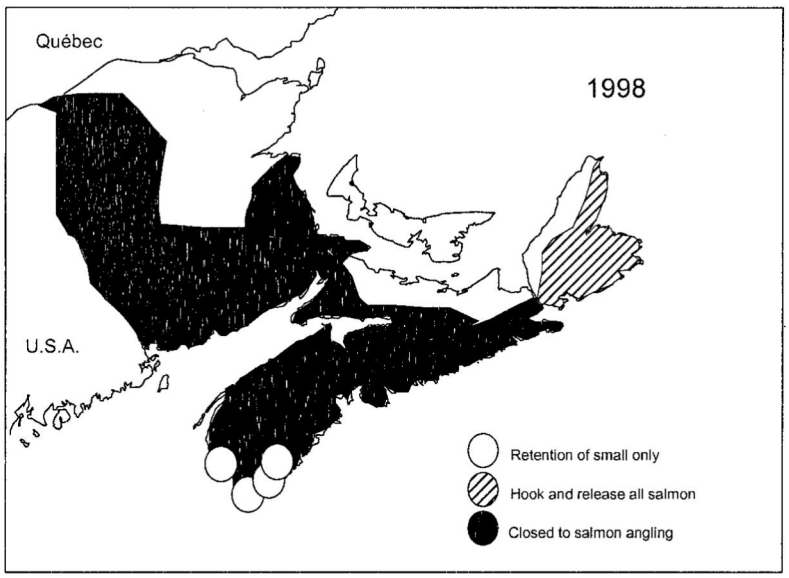
explained the cause of the lower than expected returns in 1997, four factors were discounted:

1. Freshwater production potentially contributing to adult returns remained high and therefore was not a factor.
2. Commercial fisheries catches were declining and were considerably lower than historical levels.
3. There was no evidence of increasing by-catches or illegal fishing at sea.
4. Salmon returning to rivers in 1997 were equal or larger in size than in recent years suggesting annually consistent availability of food for surviving salmon.

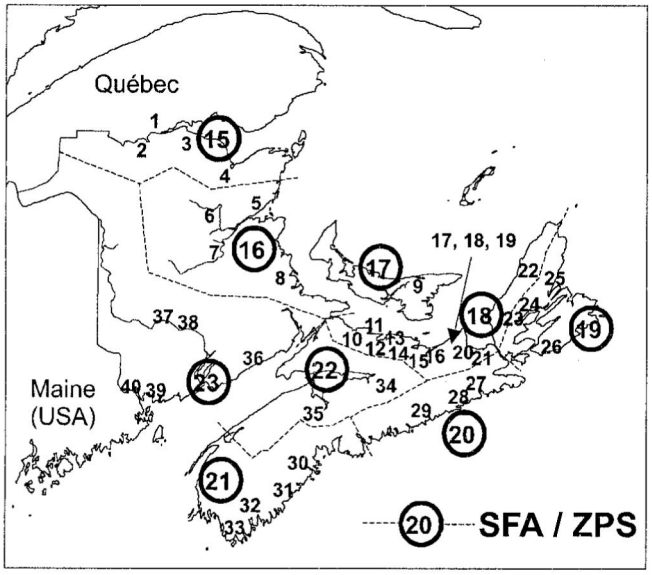
These observations lead to the conclusion that a major mortality occurred while salmon were at sea (DFO 1998).

Generally, forecasts of large salmon to Maritime rivers for recent years have been higher than actual returns. Forecasts of multi-sea-winter (MSW) salmon returns to Maritime rivers, where forecasts were made for 1998, were equal to or fewer than those returning in 1997 and below conservation requirements (DFO 1998). As a result, fisheries managers were advised to follow a cautious approach in 1998. Management plans were therefore based on river-specific assessments with flexibility for adjustments based on results of in-season monitoring.

The persistent failure of stocks in some areas of the Maritimes to achieve their conservation requirements resulted in the progressive closures of Atlantic salmon in-river fisheries. Salmon fishery closures began in 1990 in the inner Bay of Fundy rivers and by 1998 the most restrictive measures to date were enacted when retention fisheries for small salmon were allowed only in southern Gulf of St. Lawrence and in four acid toxic rivers of the Atlantic coast where returns are sustained with hatchery stocking.



A new timeline for drafting of fisheries management plans for 1999 was requested in 1998, and required provisionary assessments of the Atlantic salmon stocks of the Maritime provinces by the end of December, 1998. This document provides assessments for 40 rivers within the Maritimes with the caveat that the information for some rivers may be incomplete pending the receipt and processing of data and formal peer review of new approaches used to assess the status of the resource.



Index to River Numbers

1&2 Restigouche System	20. West (Ant.)
1. Matapedia	21. South
2. Restigouche-NB	22. Margaree
3. Jacquet	23. Middle
4. Nepisiguit	24. Baddeck
5. Tabusintac	25. North
6&7 Miramichi	26. Grand
6. NW Miramichi	27. St. Mary's
7. SW Miramichi	28. Liscomb
8. Buctouche	29. West Sheet Har.
9. Morell	30. LaHave
10. River Philip	31. Mersey
11. Wallace	32. Jordan
12. French, (Col.)	33. Clyde
13. Waugh	34. Stewiacke
14. River John	35. Gaspereau
15. West (Pictou)	36. Big Salmon
16. East (Pictou)	37. Mactaquac
17. Sutherlands	38. Nashwaak
18. French (Pictou)	39. Magaguadavic
19. Barney's	40. St. Croix

Fisheries removals during the last five years from each of the assessed river stocks are summarized in Table 1; summary stock status in formation is provided in Table 2. Trends in the data (Table 2), or lack thereof, were assessed by regression methods. The abundance of juvenile salmon was assessed against an index of normal abundance (29 fry and 38 parr per 100 m^2) proposed by Elson (1967); the abundance of adults was assessed against recent historical records of returns.

The document also presents summary results of losses in terms of eggs and probabilities of meeting/exceeding egg conservation requirements in 1999 for some previously considered management scenarios. Inputs to the probability analysis included the forecast estimate and probability distribution of 1SW and MSW returns in 1999 (calculated from the mean and standard deviation of the previous five years), estimated eggs per 1SW and MSW fish, conservation egg requirements, numbers of fish allocated to aboriginal fisheries, recreational catch rates and catch-and-release mortality rates. Although management scenarios presented are not exhaustive, results do provide a measure of the relative impact of particular management scenarios on achieving conservation requirements and the change in associated probability of achieving that goal.

Status and Outlook by SFA

Chaleur Bay (SFA 15)

Restigouche River

The Restigouche River was assessed as two components (Chaput *et al.* MS1999b). The Matapédia River empties into the Restigouche River just above the head of tide and there is minimal angling activity in the main Restigouche River below the mouth of the Matapédia. Most of the remaining watershed, referred to as Restigouche (NB) is in New Brunswick or borders the two provinces. The province of Québec has the authority to manage the anadromous fish resources of its provincial waters.

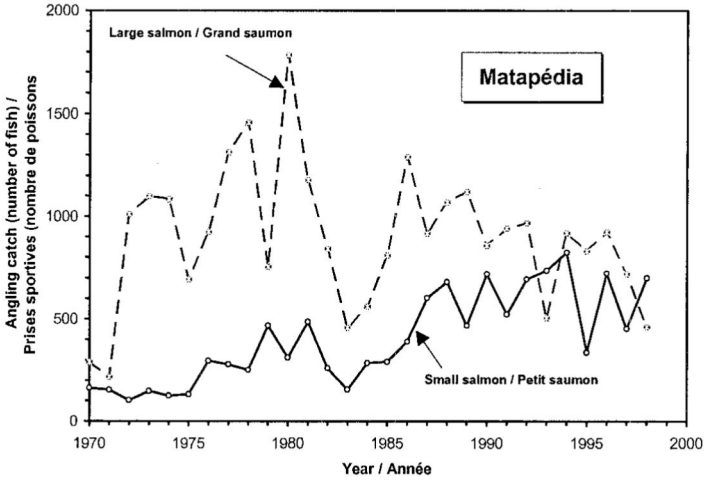
Fishery

Aboriginal fisheries and recreational fisheries exploited Atlantic salmon in the Restigouche River in 1998. The Restigouche First Nation fished under an agreement completed with the province of Québec which provided for a mandatory two-day per week tie-up of gillnets in the tidal waters on the Québec side of the estuary. Eel River Bar fished in the estuary with gillnets and in the Restigouche (NB) river by angling under a communal fishing agreement with DFO. The New Brunswick Aboriginal Peoples Council had access by angling under a fishing agreement with DFO. The St. Basile First Nation also had access by angling.

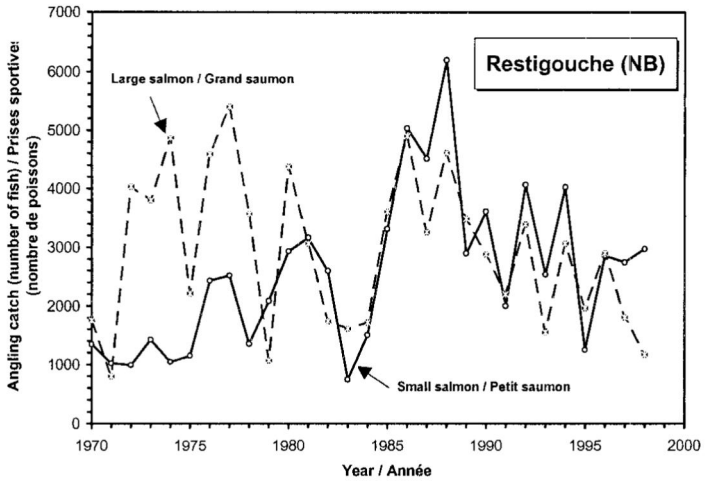
Harvest data by Listiguij First Nation were not available. The partial Aboriginal fisheries harvests (excluding Listiguij First Nation) in 1998 were 234 large salmon (197 from the estuary) and 26 small salmon (all from the Restigouche (NB)) (Table 1). The 1998 harvests were a 28% decline for small salmon and 7% decline for large salmon from the previous five-year average (excluding Listiguij First Nation harvests). Between 1982 and 1993, the harvests of large salmon by the Listiguij First Nation was 52 to 91% of the total Aboriginal fisheries estuary harvest. Small salmon harvest was 4 to 100% of the Aboriginal estuary harvest.

The recreational fishery in New Brunswick and the border waters with Québec was managed under reduced daily limits of one small salmon retained or a maximum of two hook-and-release salmon (of any size). The season retention limit was unchanged at eight small salmon. The recreational fishery in the Matapédia River and in sections of the Patapedia and Kedgwick rivers within the province of Québec were managed under Québec regulations: maximum of seven retentions for the year, one large salmon per day or if the first fish retained was a small salmon, a second fish of any size could be retained.

The angling catch in the Matapédia River in 1998 was 460 large salmon and 698 small salmon, a 41% decline for large salmon and a 14% increase for small salmon from the previous five-year average. Removals of salmon (kept plus 6% hook and release mortality) from the angling fishery of the Matapédia in 1998 were 442 large salmon and 654 small salmon (Table 1).



Angling catch in Restigouche (NB) was 1,173 large salmon and 2,973 small salmon, a 48% decline for large salmon and a 11% increase for small salmon from the previous five-year average. A total of 86 large salmon and 2,305 small salmon were removed (Table 1). In Restigouche (NB) in 1998, 24% of the small salmon catch was released compared to 9% in 1997. This change was attributed to the 1998 management plan.



Status

Habitat

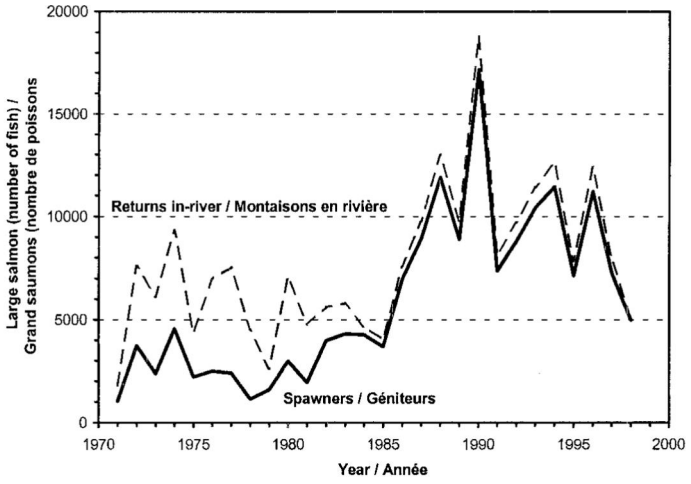
There are no major habitat constraints identified on the Restigouche River. Forest harvesting activities are widespread through the basin and localized erosion and siltation events are present. There is industry and municipal development in the estuary whose discharge of effluent may impact on salmon during the migration through the estuary as smolts or as returning adults.

Stock

Returns and escapements to the Matapédia River are based on visual counts at the end of July and in mid-October. Water conditions in the fall of 1998 prevented a visual count and the end-of-year estimate was derived from the proportion mid-season count to end-of-year count estimated in the previous three years. Estimates of returns and spawners to the Restigouche (NB) were derived from an association between angling catches and age-0^+ parr abundance. For 1998, returns and escapements were estimated from the angling catch and assuming catch rates in the angling fishery were similar to those estimated for the previous five years.

The end of year escapement to the Matapédia River was estimated at 1,643 large salmon and 823 small salmon. Returns in 1998 were estimated at 2,084 large salmon and 1,473 small salmon, a decline of 8% in the total returns from 1997 and declines of 38% and 18% for 1996 and 1995, respectively. The catch rates in 1998 were estimated at 47% on small salmon and 22% on large salmon with a combined catch rate of 33%, slightly higher than during 1994 to 1997 (27% to 29%) but well below the 37% to 54% catch rates of 1984 to 1993.

The escapement of large salmon to Restigouche (NB) was estimated at 5,000 fish, a 31% decline from 1997 and a 47% decline from the previous five-year average. This estimate assumed the catch rates calculated for 1993 to 1997 (about 20%) applied to the 1998 fishery. The catch rate in 1998 could have been lower as a result of the reduced daily hook-and-release limit. Losses of large salmon in the angling fishery were estimated at 86 fish. Spawning escapement in 1998 was the lowest since 1985 but remained above the spawning escapements estimated during 1971 to 1985.



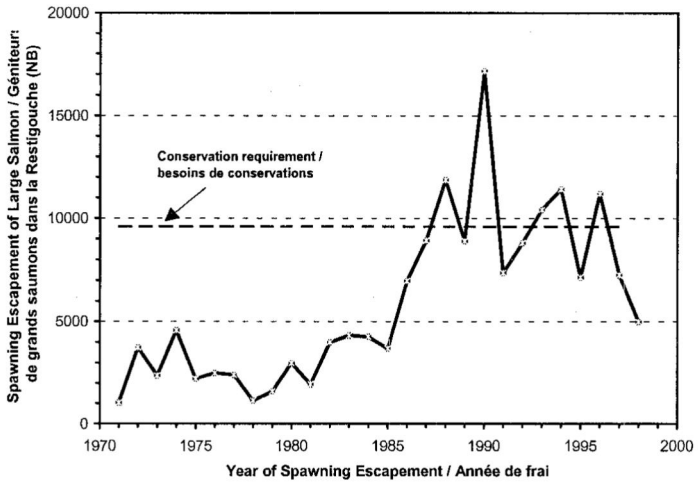
The count of large salmon at the Upsalquitch River protection barrier (10-mile) was up slightly (7%) from 1997 and down 20% from the previous five-year mean.

Small salmon returns were not estimated using the fry abundance model. Based on the ratio of small salmon to large salmon in the angling fishery and assuming catch rates for small salmon are higher than for large salmon (by 1.5 times based on estimates

from the Upsalquitch River), the small salmon returns in 1998 were unchanged from 1997 at about 9,000 fish. At the Upsalquitch protection barrier, the small salmon counts were down 19% and 18% from 1997 and the previous five-year mean, respectively.

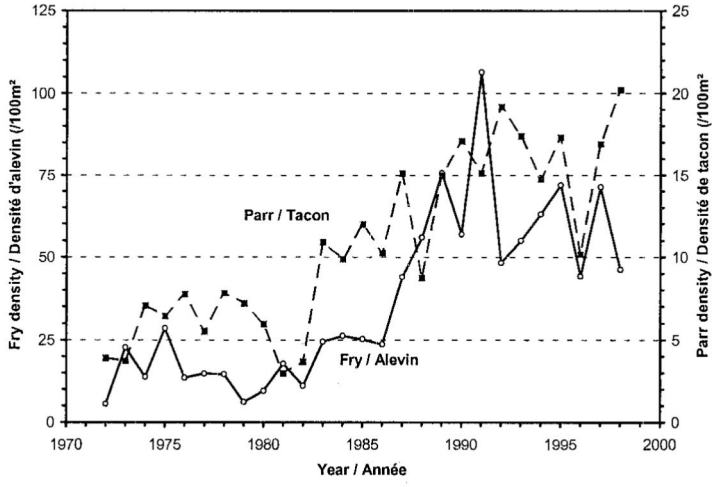
For the Matapédia River, conservation requirements are based on an egg deposition rate of 1.68 eggs per m^2. Spawning escapement in 1998 was estimated to have exceeded the conservation requirement for the fourth consecutive year. Conservation requirements were not achieved between 1984 and 1994. The recently improved performance of the Matapédia is believed to be partially the result of an improved spawner counting technique introduced in 1994 (snorkel-based counts versus canoe-based counts).

Conservation requirements for the Restigouche (NB) are defined on the basis of an estimated accessible salmon-producing habitat of 23 million m^2 and an assumed egg deposition requirement of 2.4 eggs per m^2. Based on average biological characteristics for wild small and large salmon between 1972 and 1980 (5,933 eggs per large salmon), the conservation egg requirement of 55.2 million eggs would be obtained from 9,300 large salmon spawners. The estimated escapement of 5,000 spawners in 1998 represents about 54% of the requirement with a 4% chance that the conservation requirement was achieved. Point estimates of the escapements since 1984 indicate conservation requirements were met in five of the last 15 years.



Applying the Matapédia egg deposition requirement to the Restigouche (NB) would indicate that the conservation requirement (6,500 large salmon) was met/exceeded every year since 1986, except for 1998. This discrepancy in the conservation egg deposition rate in the Restigouche River system must be resolved.

Densities of juvenile salmon have been estimated annually (with few exceptions) at 15 index sites in the Restigouche (NB) river. Densities of both fry (young-of-the-year) and small and large parr remain at greatly improved levels relative to the 1970's and early 1980's. Annual variations in densities represent both variations in egg depositions and survival rates.



Outlook

Expectations for the Restigouche (NB) are based on the mean values of small and large salmon returns in the previous five years. There is a 50% chance that returns of large salmon in 1998 will meet/exceed the conservation requirements in the Restigouche (NB) waters. The relatively high juvenile abundance levels observed since 1990 suggest that returns should be similar to those of the last five years. Small salmon returns should continue to exceed 8,000 fish with a high probability (68% chance).

For the Matapédia River, returns of small and large salmon have approximated or exceeded 4,000 fish annually since 1995. There is no reason to expect the total returns and the egg depositions to be less than the conservation requirements for the river.

Fisheries Management Considerations

The uncertainties in the estimates of returns and escapements in 1998 and previous years temper the positive outlook for the Restigouche River based on juvenile abundance and the performance of the Matapédia River. As such, a cautious approach to management on the Restigouche (NB) and the Matapédia River is warranted and mid-season assessments of the returns should be considered.

The loss to conservation expressed as percentage of anticipated eggs returning in 1999 and the probability of exceeding requirements was examined for several management scenarios. With the status quo, i.e., Aboriginal food fishery allocations for New Brunswick and angling fishery there is potential for loss of up to 8% of the egg potential returning to the Restigouche (NB) river in 1999. The probability that egg conservation requirements will be met increases from 40% with all fisheries in place to 50% in the absence of in-river and NB estuary fisheries.

Jacquet River

A barrier fence has been operated near the mouth of Jacquet River since 1994 (Locke *et al.* MS1998). Generally small salmon are released upstream throughout the season to provide angling opportunities. Allocations of small salmon have been made to the New Brunswick Aboriginal Peoples Council and Pabineau First Nation. Harvest data of Jacquet River salmon by these groups was not available in 1996, 1997 and 1998. Angling fisheries in 1998 were similar to 1997 except for the reduced daily limits of one small salmon and/or two hook-and-release fish. Angling season was April 15 to May 15 for black salmon and June 1 to October 15 for bright salmon. Angling catches for 1998 were not available at the time of writing.

Counts of small salmon in 1998 were improved (8%) from 1997 but large salmon counts (298 fish) were down 22% from 1997 and were the lowest since counting began in 1994. A fence washout in October may have resulted in an underestimation of the returns in 1998. Conservation requirements are based on 2.4 eggs per m^2 and a habitat area of 1.574 million m^2. The 3.778 million egg requirement would be obtained from 571 large salmon.

	Returns		Egg Depositions	
Year	Small salmon	Large salmon	% of conservation	by large salmon
1994	613	595	109	95%
1995	344	589	106	98%
1996	634	359	67	92%
1997	372	384	70	96%
1998	402	298	55	95%

Declining abundance of large salmon since 1994 suggests that the returns in 1999 could be below conservation requirements. The barrier fence operated on the river is intended to protect large salmon from illegal removals upstream prior to spawning. Small salmon make a minor contribution to egg depositions and the practice of releasing small salmon upstream throughout the season to provide angling opportunity has not compromised the egg depositions in the river.

Nepisiguit River

Salmon fisheries in the Nepisiguit River include Aboriginal fisheries by the Pabineau First Nation and recreational fisheries. Stock status for the Nepisiguit River in 1998 is at the preliminary stage but there is no expected improvement in status from recent years (Locke *et al.* MS1998). Water conditions in 1998 resulted in several washouts at the counting fence. Since 1982, the conservation requirements have only been met/exceeded in two years. Since 1994, egg depositions have remained at 50-60% of requirements. Juvenile abundance increased during the 1990's at a time when spawning escapement declined from the late 1980's. This contradiction suggests the

escapement of salmon may have been overestimated in the 1980's or underestimated in the 1990's. Improved juvenile levels provide a positive outlook for the Nepisiguit although like other rivers in the southern Gulf, these higher levels may not translate into improved adult returns. The contribution of hatchery-stocked fish is difficult to determine since the majority of the stocking occurs at early life stages which are not externally marked before release.

Miramichi and Southeast Gulf New Brunswick (SFA 16)

All rivers of SFA 16 along the Northumberland Strait shore (southeast of Miramichi Bay) were closed to salmon fishing in 1998.

Miramichi River

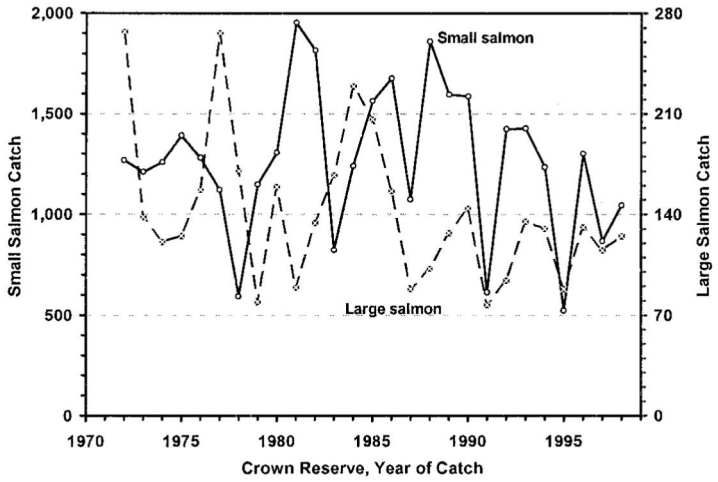
Fishery

Aboriginal fisheries and recreational fisheries exploited Atlantic salmon in the Miramichi River in 1998. Red Bank First Nation fished under communal agreement exclusively in the Northwest Miramichi. The Eel Ground First Nation fished in the Northwest and Southwest branches under communal agreement. The Burnt Church First Nation fished under communal license in Miramichi Bay. The New Brunswick Aboriginal Peoples Council also had access, by angling, to small salmon in the Miramichi River.

Aboriginal fisheries harvests in 1998 were 214 large salmon and 1,180 small salmon (Table 1). Relative to the previous five-year average, these harvests were 43% below for small salmon and 29% below for large salmon. The majority of the large salmon (195 fish, 91% of total) were harvested from the Northwest Miramichi, none were harvested in the Southwest Miramichi. Small salmon harvests were 782 fish from the Northwest branch, 378 fish from the Southwest branch and 20 fish from Miramichi Bay.

The recreational fishery was initially managed under reduced daily limits of one small salmon retained or a maximum of two hook-and-release salmon (of any size). The season retention limit was unchanged at eight small salmon. After an inseason assessment at the end of July, the daily hook-and-release limit was returned to its pre-1998 limit of four fish. Angling season closed on October 15, as in previous years.

The 1998 angling catch estimates are not available. Angling catches from the Crown Reserve stretches of the Northwest Miramichi were similar to the previous five-year mean catches (-2% for small salmon, +4% for large salmon). Effort (rod days) was up slightly (7%) from the average.



Status

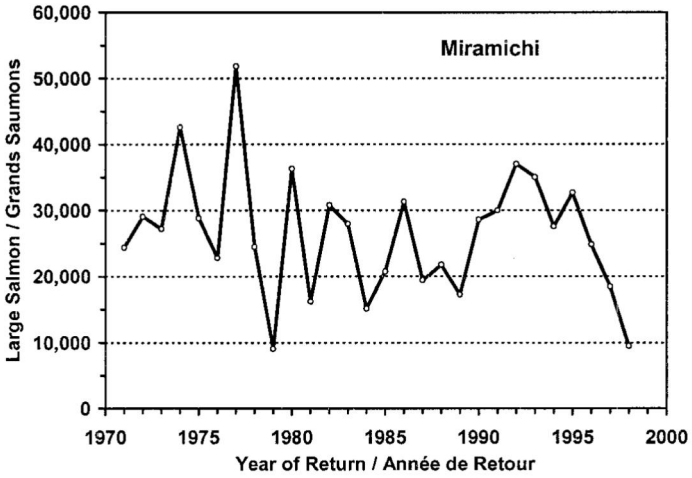
Habitat

There are no major habitat constraints on the Miramichi River. Forest harvesting activities and other land-use practices are widespread through the basin and localized erosion and siltation events are present. There is industry and municipal development in the estuary whose discharge of effluent may impact on salmon during the migration through the estuary as smolts or as returning adults.

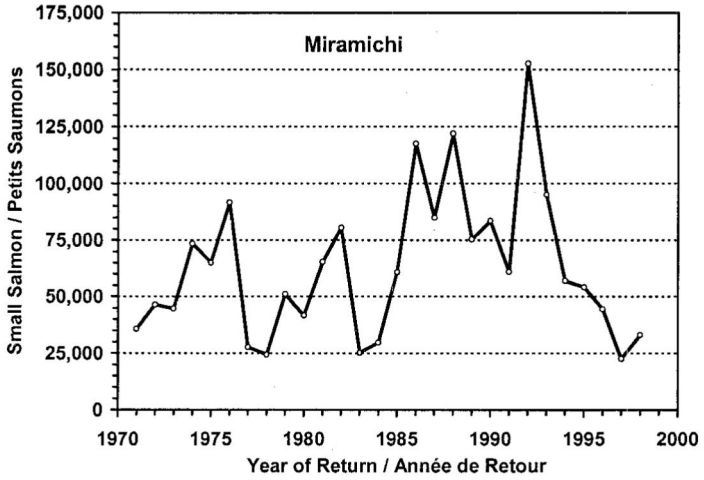
Stock

Returns and escapements to the Miramichi River and to each of the Northwest and Southwest branches are based on mark and recapture experiments using trapnets in the tidal waters (Chaput *et al.* MS1998, MS1999a).

Returns of large salmon to the Miramichi in 1998 were the second lowest of record (since 1971) at 9,500 fish (90% CL 7,500-12,500).

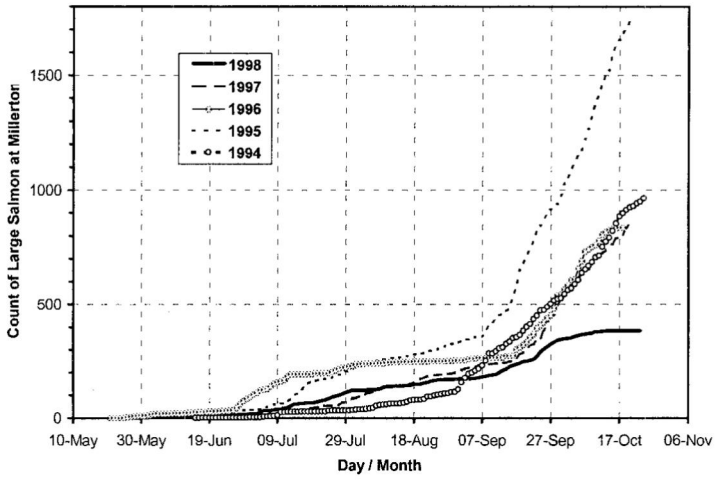


Small salmon returns in 1998 were 33,000 fish (90% CL 27,500-41,000), up 46% from the record low return of 1997.

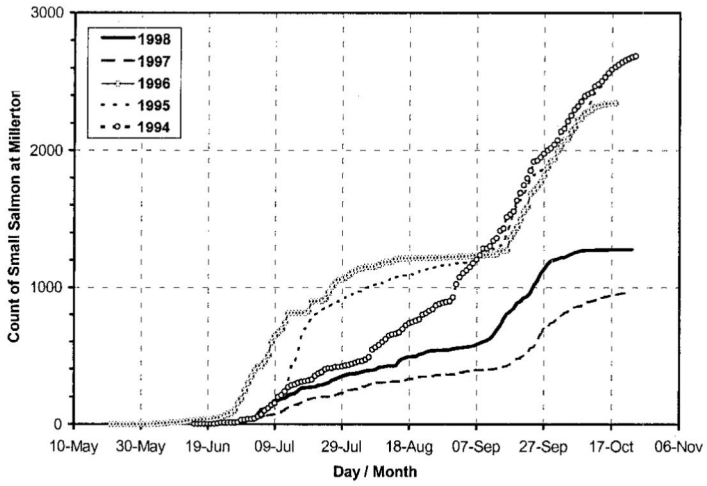


About 7,000 large salmon (90% CL 6,000-9,500) returned to the Southwest Miramichi and 2,200 (90% CL 2,100-3,100) returned to the Northwest Miramichi, declines relative to 1997 of 36% for the Southwest Miramichi and 70% for the Northwest Miramichi. A total of 24,000 small salmon (90% CL 19,000-32,000) returned to the Southwest Miramichi, up 78% from 1997, whereas 7,900 small salmon (90% CL 6,200-10,700) returned to the Northwest Miramichi, a decline of 19% from 1997.

The low abundance of large salmon in 1998 was not unexpected given the low returns of small salmon in 1997. Additionally, the low abundance in 1998 was the result of a very low return of fish during the fall. In the four previous years, catches of large salmon at the trapnet in the Southwest Miramichi were distributed about 25% early (May to August) and 75% late run (September and October). In 1998, the fall run represented 55% of the total fish sampled.



This contrasted with the small salmon run timing in 1998 which was identical to previous years when about 50% of the total run occurred early.



Small salmon returns were improved from 1997 at all the counting facilities in the Southwest Miramichi. The counts of large salmon were improved from 1997 at the two early-run facilities in the Southwest but decreased for the combined runs. Relative to the previous five years, counts of small salmon and large salmon were down. In the Northwest Miramichi, the count at the early-run protection barrier was greatly improved from 1997 for both small and large salmon but the fall-run Catamaran Brook count and the trapnet estimates were both down from 1997 and the previous five-year mean. Good water conditions through the summer may have facilitated the movement of salmon into the early-run headwater areas and contributed to improved counts from 1997.

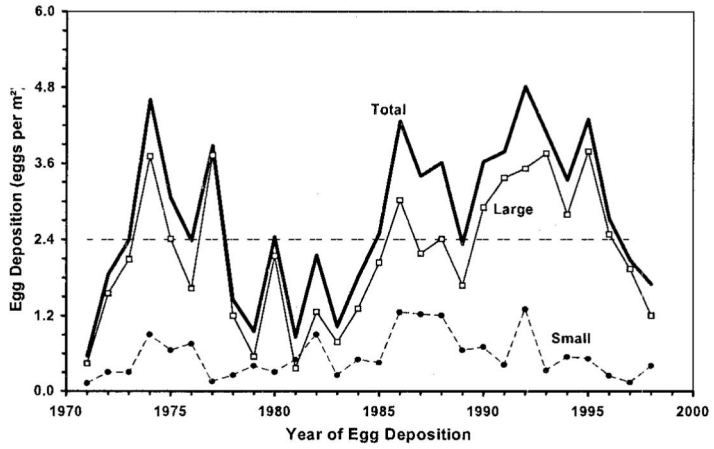
	Change in 1998 relative to:			
	Small salmon		Large salmon	
	1997	1993-1997	1997	1993-1997
Northwest Miramichi				
Northwest Barrier (early)	+107%	+55%	+90%	+36%
Catamaran Brook (late)	- 13%	- 51%	- 7%	- 35%
Trapnet estimate (early & late)	- 18%	- 66%	- 70%	- 80%
Southwest Miramichi				
Juniper Barrier (early)	+ 73%	- 8%	+34%	- 20%
Dungarvon Barrier (early)	+ 51%	+26%	+42%	+ 5%
Clearwater Brook (early & late)	+ 39%		- 34%	
Trapnet estimate (early & late)	+ 78%	- 21%	- 36%	- 56%

Conservation requirements for the Miramichi River and its two main branches are defined on the basis of an estimated accessible salmon-producing habitat of 55 million m^2 and an assumed egg deposition requirement of 2.4 eggs per m^2. Based on average biological characteristics for wild small and large salmon, the conservation egg requirement of 132 million eggs would be obtained from 23,600 large salmon spawners with 22,600 small salmon to ensure a 1:1 sex ratio.

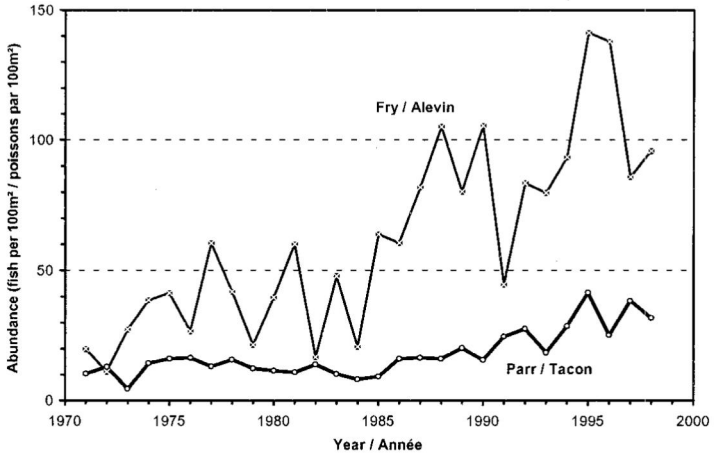
Egg depositions by all salmon returning to the Miramichi River (before any removals) would have equaled about 70% of the conservation requirements. Egg

depositions by large salmon alone would have equaled 50% of requirements. In the Southwest Miramichi, egg depositions at most would have equaled about 70% of conservation whereas in the Northwest Miramichi, egg depositions would have been 50% of conservation. Egg depositions after accounting for removals would be less than these values. Small salmon could potentially have contributed 36% of the total eggs in the Northwest Miramichi and 24% of the total in the Southwest Miramichi. The contribution to total egg depositions by small salmon will be less since most of the removals in 1998 were small salmon.

Egg depositions in 1998 were the lowest since the 1984 management plan. Lower egg depositions were estimated to have occurred between 1978 and 1983.



Densities of juvenile salmon have been estimated annually (with few exceptions) since 1971 at 13 index sites in the Miramichi River. Densities of both fry (young-of-the-year) and small and large parr remain at greatly improved levels relative to the 1970's and early 1980's. Annual variations in densities represent both variations in egg depositions and survival rates.



Outlook

Expectations for the Miramichi River were previously based on a model relating small salmon returns in the current year to large salmon returns the next year. The model has greatly overestimated the observed returns in the last three years. The sustained relatively high juvenile abundance levels observed since 1990 suggest that returns should be similar to those of the last five years. In the absence of a small salmon prediction model and the trends in small salmon and large salmon returns, the previous five-year mean was used for both size groups. Returns in 1999 could then be 22,600 (90% CL 7,900-37,300) large and 42,000 (90% CL 18,000-66,000) small salmon.

There is a 72% chance that eggs from returns of large and small salmon in 1999 will meet/exceed the conservation requirements for the Miramichi River. Correspondingly, the chance of meeting conservation in 1999 is 79% for the Northwest Miramichi and 62% for the Southwest Miramichi.

Fisheries Management Considerations

The uncertainties and the trends in the estimates of returns and escapements temper the positive outlook for the Miramichi River based on juvenile abundance. As such, a cautious approach to management on the Miramichi River and its branches is warranted. Mid-season assessments of the returns should be considered.

The loss to conservation expressed as percentage of anticipated eggs returning in 1999 and the probability of exceeding requirements was examined for several management scenarios. Under the status quo in 1999, i.e., Aboriginal food fishery harvests equivalent to the entire allocation in 1998 and angling fisheries with a 30% catch rate, then the loss of eggs would be about 17% for the Northwest Miramichi and 6% for the Southwest Miramichi. The probability of meeting conservation would decline from 79% to 68% for the Northwest and from 62% to about 50% for the Southwest Miramichi.

Tabusintac River

Fishery

Aboriginal fisheries and recreational fisheries exploited Atlantic salmon in the Tabusintac River in 1998. Burnt Church First Nation fished under communal agreement. Aboriginal fisheries harvests in 1998 were 18 large salmon and 18 small salmon (Table 1), large declines from harvests which occurred in 1995 and 1996. The recreational fishery was managed under reduced daily limits of one small salmon retained or a maximum of two hook-and-release salmon (of any size). The season retention limit was unchanged at eight small salmon. The 1998 angling catch estimates are not available. Angling catches between 1989 and 1993 averaged 200 small salmon and 200 large salmon annually.

Status

Habitat

There are no major habitat constraints on the Tabusintac River.

Stock

The Tabusintac River has been assessed intermittently: 1993, 1994, 1996 and 1998 (Atkinson and Hooper MS1995). The last two assessments were conducted by the Burnt Church First Nation (Douglas *et al.* MS1999). Returns and escapements to the Tabusintac River are based on mark-and-recapture experiments using trapnets in the tidal waters and recaptures at trapnets and in the angling fisheries. Conservation requirements are defined on the basis of an estimated accessible salmon-producing habitat of 824,000 m^2 and an assumed egg deposition requirement of 2.4 eggs per m^2. Based on average biological characteristics for wild small and large salmon, the conservation egg requirement of 2.0 million eggs would be obtained from 363 large salmon spawners with 236 small salmon to ensure a 1:1 sex ratio.

Estimated returns and escapements have been more than double the conservation requirements in every year assessed. Conservation requirements were in all likelihood exceeded during 1998.

Outlook

Conservation requirements have been exceeded for the four years the stock was assessed (1993, 1994, 1996, and 1998). The expectation is for this stock to continue meeting/exceeding its conservation requirements.

Fisheries Management Considerations

Since fish enter this small river mostly in the fall (October), the exploitation rate is mostly dependent on the gillnet effort of the aboriginal fisheries of the Burnt Church First Nation.

Buctouche River

Fishery

The Buctouche River was closed to all salmon fishing in 1998. Prior to 1998, Aboriginal fisheries and recreational fisheries exploited Atlantic salmon in this fall run river dominated by large salmon. Aboriginal fisheries harvests since 1993 have averaged less than 25 fish (small and large) annually (Table 1). Angling catches have been less than 100 fish combined.

Status

Habitat

There are no major habitat constraints on the Buctouche River. Forest harvesting activities and other land-use practices are widespread through the basin potentially creating extreme run-off events and localized erosion.

Stock

The Buctouche River has been assessed annually since 1993 (Atkinson *et al.* MS1998, MS1999). Returns and escapements estimates are based on mark and recapture experiments using trapnets in the tidal waters and recaptures at a fence in the Buctouche River. Conservation requirements are defined on the basis of an estimated accessible salmon-producing habitat of 661 thousand m^2 and an assumed egg deposition requirement of 2.4 eggs per m^2. Based on average biological characteristics for wild small and large salmon, the conservation egg requirement of 1.6 million eggs would be obtained from 281 large salmon spawners with 172 small salmon to ensure a 1:1 sex ratio.

Returns of large salmon have varied between 95 and 225 fish between 1993 and 1998. The 1998 estimated return is the lowest since 1993. Small salmon returns have generally been about 100 fish annually with the 1998 returns the second highest since 1993. Egg depositions relative to conservation have at best been 72% of requirements (in 1994) and were the lowest in 1998 at 33% of requirements.

Buctouche River						
	1993	1994	1995	1996	1997	1998
Returns (number of fish)						
Small	78	77	98	127	97	120
Large	95	225	154	134	200	102
Egg depositions (% of conservation requirement)						
	35%	72%	58%	46%	70%	33%
Juvenile abundance (catch rate [fish] per 15 minutes)						
Fry				5.0- 8.2	5.3- 8.0	19.8-20.5
Parr				7.2-10.9	8.2-12.3	12.3-16.6
Egg-to-fry survival				4.9%	7.3%	9.4%

Juveniles are generally found throughout the river with the highest concentrations in the South Branch. Derived densities from catch rates indicate abundance is low compared to levels in the Miramichi River. Egg-to-summer fry survival rates are low (5% to 9%) compared to published values suggesting there may be a habitat constraint at that life stage. Parr survival rates as inferred from stocking of fall fingerlings does not appear to be a constraint. Quality spawning and rearing habitat on the river appears limited.

Outlook

Conservation requirements were not met between 1993 and 1998. Based on the average returns of the last five years, there is a 1% chance of meeting the conservation requirements in 1999.

Fisheries Management Considerations

Salmon return to the river in the fall, mostly during October. Under a full aboriginal food fishery harvest and historical angling fisheries, probability analysis indicated an egg loss equivalent to 25% of the returns and that there would be a less than 0.1% chance of meeting conservation.

Prince Edward Island (PEI) (SFA 17)

Morell River

Fishery

Atlantic salmon are fished on the Morell River by both Aboriginal and recreational fishers. In 1998, the PEI Native Council took 28 small salmon of an allotted quota of 400 (Table 1). Recreational anglers are permitted to retain only small salmon (maximum seven per season). 1998 harvests are not yet available. Annual harvests, 1994-1997, were under 450 fish.

Status

Since the mid 1980's, the Morell River has been stocked with Atlantic salmon of hatchery origin that have been reared to smolt age in a semi-natural rearing pond. These fish comprise the majority of returning salmon runs (95% in 1998, Table 2). Because of the high proportion of hatchery fish in returns, runs are largely independent of egg deposition by wild and hatchery-origin fish. About 50 broodstock are required to produce eggs for the stocking program. Numbers at collection sites (Mooneys pool, 1998; Leards fishway, previous years) have not fallen below this requirement since semi-natural rearing was initiated.

<u>Habitat</u>

Although the Morell River is protected by a 60 m streamside buffer in which development and wood cutting is prohibited, the river receives siltation input from agricultural and road maintenance operations. Fine particles cover a substantial portion of the river bottom, and silt beds may move during the winter, smothering spawning areas which had been clear of silt during the previous fall's spawning period. The soils of Prince Edward Island are pH-buffered and acidity is not a problem to salmon. The major dam on the Morell system (Leards) has a fishway which provides adequate passage for salmon, which are also able to ascend the dam's main spillway. Numerous small impoundments on the river's headwaters are too far upstream to interfere with salmon

migration. However, water in these shallow impoundments often heats to levels beyond the thermal tolerance of salmon, and discharge of this water may negatively affect salmon habitat downstream.

Stock

Returns in 1998 are unavailable. Mean counts at Leards for 1994-1997 were 251 small salmon and 33 large salmon.

Year	Small wild	Small hatchery	Large wild	Large hatchery	Total
1994	8	28	2	27	65
1995	14	172	5	10	201
1996	78	470	10	65	623
1997	34	198	4	10	246
Mean	33.5	217.0	5.3	28.0	283.8

These counts reflect only fish ascending the river's West Branch, and may underestimate total ascents of that branch in 1994-1995 due to trap inefficiency, which was not measured in those years. Fish of hatchery origin comprised a mean of 88% of salmon examined on the system from 1994-1998. Calculated escapements of salmon above Leards met or exceeded conservation requirements in only one year from 1994 to 1997. Juvenile densities (mean 19 juveniles per 100 m^2 in 1998) (fry and parr combined) are lower than the Elson (1967) norm. Juvenile densities have been stable since 1995.

Outlook

Returns to the Morell above Leards have generally been below conservation requirements in the past several years. The Morell salmon run depends largely on stocking, and the stocking program has continued unchanged. Hence returns above Leards in 1999 will probably be below conservation requirements. Juvenile densities have little bearing on returns because most returns are of stocked fish.

Fisheries Management Considerations

Removals of small salmon by Aboriginal and recreational fishermen, and hook-and-release fisheries on small and large salmon, have little impact on future runs because most returning fish are of hatchery origin.

Other Rivers of SFA 17

Atlantic salmon are also fished recreationally on the Mill, Dunk, West, Valleyfield, and Montague rivers. There is no allocation to Aboriginal fisheries on these rivers, and recreational catches are much lower than those of the Morell. These rivers are stocked with hatchery smolts, and hatchery-origin fish comprise a high proportion of returning adults. Returns on these rivers are far below conservation requirements. These rivers are heavily impacted by siltation, primarily from agricultural sources.

Northumberland Strait Nova Scotia (part of SFA 18)

Fishery

Fisheries were conducted in 1998 by First Nations and recreational anglers. Trap nets were operated by Millbrook First Nation on River Philip (7 large salmon and 3 grilse harvested) and by Pictou Landing First Nation on East River (Pictou) (18 large salmon harvested). Members of Pictou Landing First Nation reported harvesting 40 large salmon with gill nets in Merigomish Harbour where 3 small river systems discharge: the Barney's, French (Pictou), and Sutherlands. Aboriginal peoples also reported harvesting fish on several other streams either as kelt salmon in the spring or as bright fish taken on their inward spawning migration in the autumn. Collectively these other harvests on six different rivers amounted to a few dozen fish.

The preliminary estimate of recreational catches for 1998 was 300 small salmon harvested, approximately 500 released, and about 800 large fish angled and released on the 13 rivers fished (Table 1). These catches were larger than those reported in 1997 but similar to the recent five-year average for both large and small salmon (O'Neil MS1998).

Status

Habitat

Atlantic salmon runs to the rivers in this area of Nova Scotia occur chiefly in the late autumn. Some fish do, however, enter River Philip in the summer, probably because of the past influence of stocking with summer-run fish from elsewhere. With high water conditions, small numbers of fish are also known to enter West River (Antigonish), in the late summer. Historical commercial catches occurred principally in June and July and in part, harvested fish from more northern Gulf of St. Lawrence rivers, such as the Miramichi (Claytor *et al.* MS1987). Consequently, river entry in late autumn is probably not a result of the former commercial fishery.

Middle River (Pictou) is impounded and although fish passage is present, production is known to be severely constrained.

Stock

Estimates of returns to several mainland Nova Scotia rivers of the Gulf of St. Lawrence in 1998 were based on catch data derived from the Nova Scotia license stub catch and effort reporting system and a catch rate determined for River Philip. Recreational catch estimates were extrapolated from the catch and effort cards completed and returned by anglers on a voluntary basis (about 35% of licensees). The catch rate for River Philip was determined by calculating the proportion of the adult returns that were angled. The returns or population estimate was based on a mark-and-recapture experiment, conducted after the angling fishery was over, where salmon captured by seining were marked and released and snorkel-divers surveyed the river to count marked and unmarked salmon. The resulting post-fishery "escapement" estimate was added to the estimate of removals to arrive at a total returns figure. The "escapement" estimate was

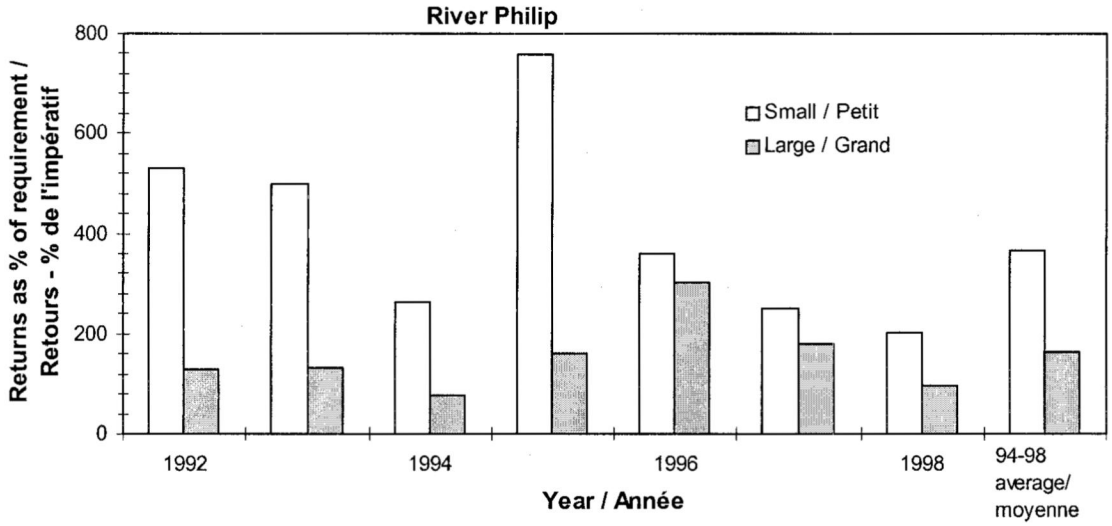
assumed to apply to the portion of River Philip above the junction of River Philip and Tillits Creek. The total river post-fishery population estimate was derived by expanding the mark-and-recapture estimate for the portion of the watershed surveyed to the entire watershed based on watershed area.

In summary, the catch rate was calculated as follows:

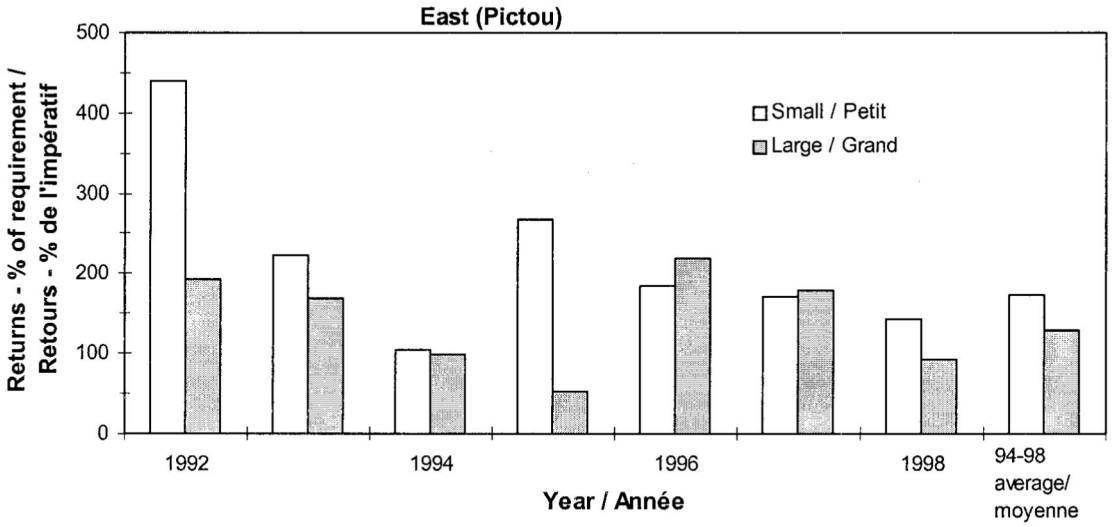
River Philip catch rate =	Recreational catch estimate / Returns estimate
Returns estimate =	Escapement estimate + removals
Removals =	Harvest of salmon in the recreational and aboriginal fisheries plus assumed 5% hook-and-release mortality on released fish
Escapement estimate =	Mark-and-recapture estimate for area above Tillits Creek * proportion watershed factor
Watershed factor =	1 / 0.633 = 1.58

River Philip, East River (Pictou) and West River (Antigonish)

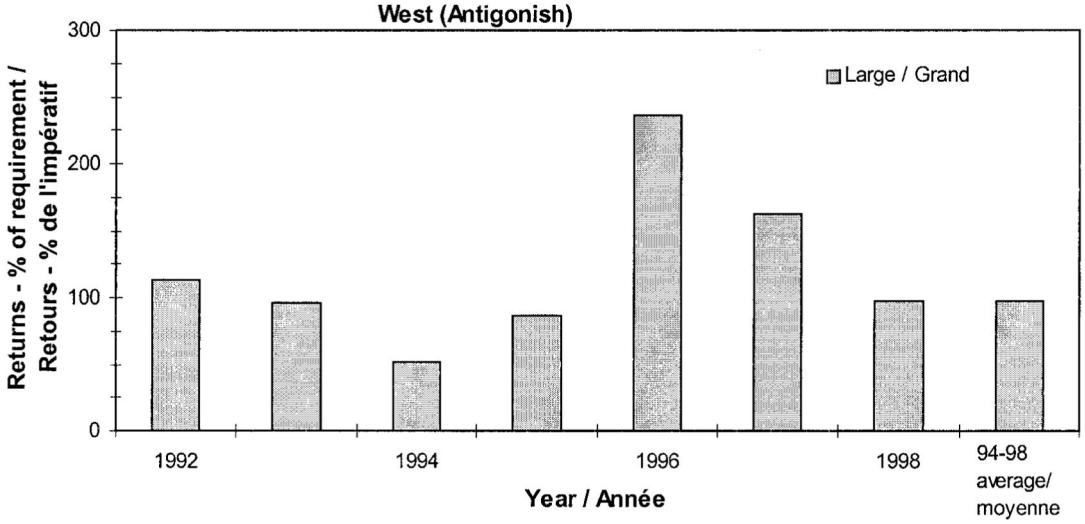
Returns to River Philip in 1998 were estimated at about 150 small and 350 large salmon. Escapements were about 70 small and 330 (90% CL 206-2,482) large salmon, 96% and 93% of the respective conservation requirement of 75 small and 358 large salmon (2.309 million eggs).



Escapement of large salmon to East River (Pictou) was 89% of the requirement of 271 fish (1.75 million eggs).



The estimated escapement of large salmon to West River (Antigonish) achieved 95% of the requirement of 353 fish (1.153 million eggs).



Other Rivers of SFA 18

Salmon about to spawn in the Sutherlands River were again counted by snorkel divers in 1998, for the fourth consecutive year.

Sutherlands River salmon escapements:

Year	No. small salmon	No. large salmon
1995	17	24
1996	19	59
1997	25	46
1998	20	26

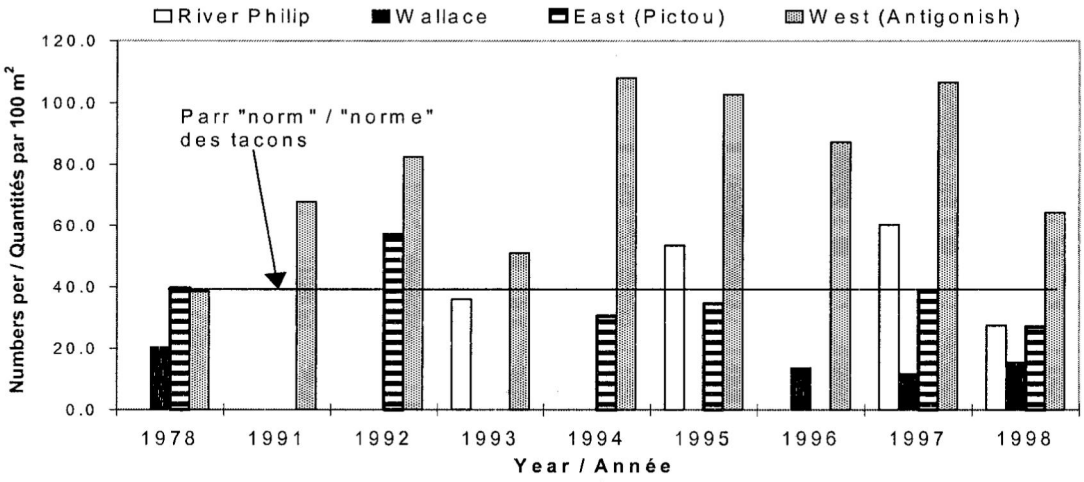
Only the lower 4 km of the river are accessible to salmon because of an impassable natural barrier. The spawning requirement is 25 large and five small salmon. The escapement to the river is used as an indicator of escapement to Barney's, French (Pictou), and Sutherlands rivers which discharge into Merigomish Harbour. The Aboriginal peoples harvest of salmon in the harbour is assumed to come from stocks of all three rivers. Escapements during the past four years have approximated or exceeded conservation requirements.

Estimates of large salmon returns to the other rivers of the area in 1998 are based on the recreational catch reported and the catch rate from River Philip. The data indicate that large salmon were short of the conservation requirement on the Wallace River (45%) and River John (50%) but were near the requirement on the Waugh River (80%). Estimated returns were 160% of the requirement for large salmon on West River (Pictou).

Outlook

Forecasts of returns to the three principal rivers of the area, East River (Pictou), River Philip; and West River (Antigonish), are based on five-year average returns for both large and small salmon. Average returns to East River (Pictou), were 170% (90% CL 116-231) and 130% (90% CL 62-193) of the requirement for small and large salmon, respectively. On River Philip, the mean number of returns during the past five years for small salmon was about 370% (90% CL 152-582) and for large salmon, about 160% (80-246) of the requirement. Large salmon returns averaged over the past five years for West River (Antigonish), were about 130% (90% CL 57-197) of the requirement of 353 fish. A 1:1 male:female ratio for large fish of the South river, 1984-1987 (Claytor MS1996) is assumed to be applicable to the West and other rivers of the immediate area. Consequently, conservation requirements are derived from large salmon and essentially all small salmon are surplus to requirements. If the small salmon returns to the West River (Antigonish) in 1999 are to equal the mean of the last five years there will be about 260 (90% CL 105-409) small fish returning.

Juvenile densities in the area rivers may indicate the level of adult recruits beyond 1999. On the West River (Antigonish), average densities of parr have been considerably above the Elson (1967) "norm" of 38 parr per 100 m^2 for the past several years. Densities on the East (Pictou) and River Philip have more closely approximated the "norm" whereas those on the Wallace River have been consistently below levels noted on neighboring rivers.



Forecasts of returns to the other rivers of Northumberland Shore, mainland Nova Scotia, are not provided because catches are small or highly variable, and catch data are unreliable on these small systems.

Fisheries Management Considerations

Based on indicator rivers, it is expected that large salmon returns to almost all rivers in 1999 will meet or exceed conservation levels. The level of directed fisheries exploitation in recent years generally has not been of concern to conservation requirements.

Small salmon returns to these rivers are predominately male (95% or more). Returns and spawning escapements in recent years have exceeded the conservation requirements. Returns of small salmon in excess of conservation requirements are anticipated in 1999.

Returns, as inferred from juvenile densities and angling catches, to Wallace River and River John appear inconsistent with returns to other rivers of the area and warrant precautionary measures to ensure conservation levels are met.

Cape Breton (SFA 19 and Part of SFA 18)

Salmon stocks of Cape Breton Island include those which typically exceed conservation requirements (Margaree and North), fluctuate about requirements (Grand River; with hatchery assistance) and fall short of requirements (Middle and Baddeck rivers). With minor exceptions, recent management strategies for SFA 18 (Cape Breton) have permitted a recreational fishery with retention of 1SW (small) salmon and hook-and-release of MSW fish (large salmon). An aboriginal food fishery for 130 small and 650 large salmon is permitted on the Margaree. In SFA 19, recreational fisheries have generally been limited to hook-and-release grilse (occasional closure) and in 1998 a modest Aboriginal food fishery for 50 small and 50 large salmon from the North River.

Margaree River

Fishery

In 1998, 130 small and 650 large salmon were allocated to five First Nations. A total of 30 small and 150 large fish were allocated to the period June 1- August 31, the remainder were to be taken September 1- October 31, except where extensions were granted for seining in November and December. Harvest records have not yet been submitted in entirety but it is unlikely that the total removal exceeded about 30 small and 120 large salmon (Table 1) taken mostly by seining in the fall.

Regulations for the recreational fishery in 1998 were identical to those of 1997, retention of small salmon and hook-and-release of large salmon, June 1-October 31. Interim estimates of catch from voluntary returns of the Nova Scotia Salmon License stubs (data resulting from reminder letters yet to come) suggest a retention of 211 small salmon and release of 146 small and 1,467 large salmon. Removals (Table 1) include an assumed 5% hook-and-release induced mortality. Forty-two summer-run fish were collected for broodstock by the Aquatic Development Association of Margaree (ADAM) and yielded 187,000 eggs for incubation and release back to the river as age-0^+ fry.

Status

Habitat

The Margaree River, like the Middle, Baddeck and North rivers which originate in the Cape Breton Highlands of Inverness and Victoria counties, is unobstructed, unimpacted by acid precipitation and only modestly exposed to agricultural practices in the lower valley. Flow regimes have changed within the Margaree drainage. Pol (MS1975) indicated that for the period 1967-1973, there had been an increase in the frequency and magnitude of peak flows and, lower and more frequent low flows than in preceding years. Causative agents were not fully identified by Pol (*op. cit.*; there had been a 10% increase in rainfall over the period) but flood frequency and magnitude could have been enhanced by the mortality and harvesting of much of the Highland's forests as a result of a spruce budworm infestation.

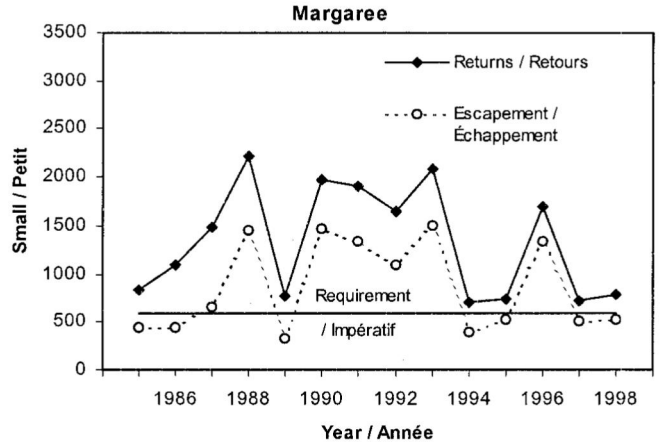
The Margaree River is not affected by the aquaculture industry. ADAM released about 100,000 (35% marked) age 0^+ juveniles back to the river in 1998. A private hatchery rearing trout for private catch-out is believed to be the source of the occasional large adult rainbow trout (*Oncorhynchus mykiss*) observed in the recreational catch and past assessment operations. Bacterial kidney disease (*Renibacterium salmonarium*) is ubiquitous within the drainage (Paterson *et al.* 1979) and although known to cause post-winter mortality in the hatchery located on the Northeast Margaree, the disease has not been demonstrated to cause mortalities among juvenile salmon in the wild.

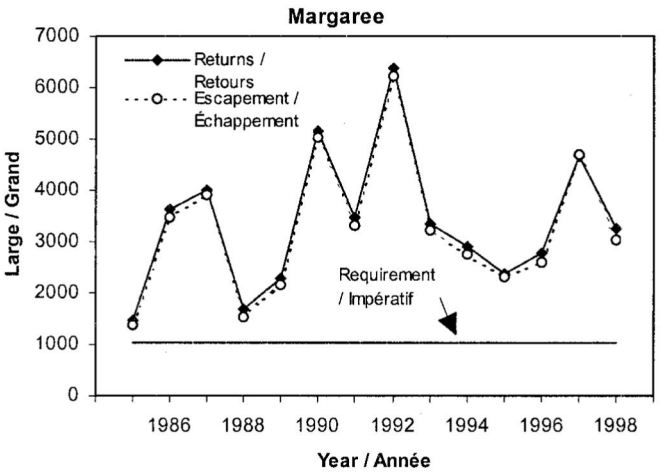
Stock

Returns of large salmon to the Margaree were estimated from preliminary estimates of recreational catch (Nova Scotia License stub returns) and catch rates 1991-1996 (Marshall *et al.* MS1998a). Catch rates are the product of catch from NS License

stub returns and the reciprocal of mark-and-recapture based estimates of adult returns when DFO operated Levi's trapnet in the Margaree estuary. For small salmon, the estimate is based on a significant regression between catch and estimated returns, 1991-1996 (Marshall *et al.* MS1998a)

Interim catch estimates of 357 small and 1,467 large salmon on the Margaree in 1998 contribute to interim estimates of 774 small and 3,260 (90% CL 2,300-5,700) large salmon returning to the Margaree. Small salmon returns are similar to those of 1994, 1995 and 1997 but only 65% of the mean value, 1993-1997. Large salmon were down 30% from 1997 but equal the mean of the previous five years. After deduction of removals and losses to hook-and-release mortality, interim escapements number about 500 small and 3,000 large salmon.

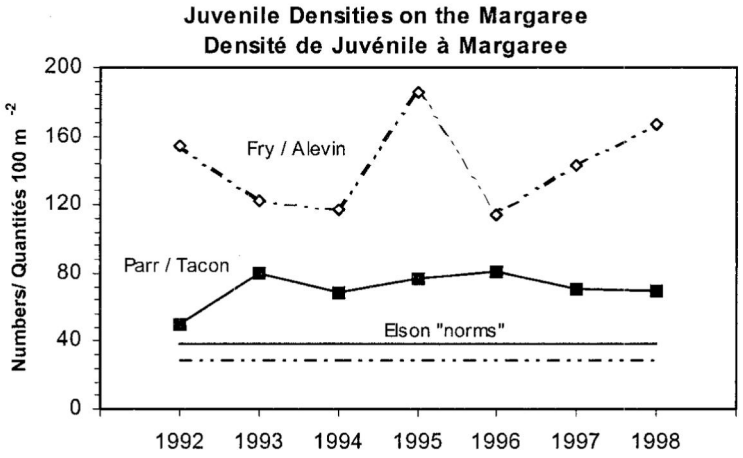




The conservation requirements for the Margaree River is based on an egg deposition of 2.4 eggs per m^2, historical biological characteristics and 2.798 million m^2 of habitat. Required fish to provide those eggs are 1,036 large salmon and for sufficient males, 582 small salmon. In 1998, small salmon escapement was about 85% of requirement, large salmon were about 290% of requirement. Total egg requirements have been exceeded in every year since 1985.

Mean juvenile densities for a site on each of Forest Glen, MacFarlanes and Big brooks in 1998 were 167 age-0^+ per 100 m^2 and 75 age-1^+ and -2^+ parr per 100 m^2 and are

5.8 and 1.8 times the Elson (1967) norm of 29 fry and 38 parr per 100 m^2. Monitoring at the same sites since 1992 (below), and also at a large mainstem site reveals densities consistently above the norms and consistent with escapements of two to six times the conservation requirements since 1991.



Outlook

Past forecasts of large returns to the Margaree have been derived from stock-recruit relationships, 1947- to present, using tabular, Ricker, Beverton-Holt and "mean" models (Marshall *et al.* MS1998a). Never in the 40 years of data have recruits been estimated to be less than conservation requirements. In 1997, a prognosis for 1998 using the mean recruit value for the entire data set (3,265) equaled the current estimate of returns in 1998. An interim prognoses for returns in 1999 using the mean of the last five-years is 3,200 (90% CL 1,760-4,617) MSW fish. Based on the mean, there is a greater than 99% probability (Bayes procedures) that conservation requirements will be met. Prognoses of small salmon returns have typically been presented as the mean of the previous five years. On this basis, returns would be about 940 (90% CL 280-1,630) fish and the probability of meeting the 582 fish conservation requirements is about 80%.

Fisheries Management Considerations

Conservation requirements continued to have been met and are expected to be exceeded in 1999 on the Margaree and probably other east coast Cape Breton rivers (see 'Other Rivers of SFA 18 and 19). Small salmon are predominantly male, usually are less abundant than large salmon, and generally are not constraining to stock conservation.

Exploitation levels, both realized (harvests by Aboriginal peoples have rarely exceeded 25% of allocation) and potential on the Margaree River have not been a conservation concern. Directed fisheries on small and large salmon could remove 22% of the potential egg depositions with relatively little reduction in the probability of meeting conservation.

Estimated losses from potential fisheries to the 1999 egg depositions[a] and probabilities of meeting conservation requirements for the Margaree River, are:

	Losses	Prob.
Aboriginal (both small and large salmon) plus recreational retention (small salmon) fisheries[b] -	22%	95%
Aboriginal fisheries (both small and large salmon) -	20%	95%
Aboriginal (both small and large salmon) plus recreational small and large hook-and-release fisheries -	22%	95%
Recreational hook-and-release fishery only -	2%	99%

[a] based on biological characteristics of wild returns in 1992-1996 (Marshall *et al.* MS1997a) and the five-year mean prognoses of returns in 1999.

[b] harvest of 650 large and 130 small salmon allocation by First Nations and a recreational fishery in which anglers hook-and-release large salmon (5% hook-and-release mortality) and retain all captured small salmon (catch/exploitation rate of 0.45).

Middle River

Fishery

In 1998, there was a total allocation of 100 small salmon from Middle River, Nyanza Bay and Bras d'Or Lakes to Wagmatcook First Nation. Fishing was to commence once conservation requirements had been met on the Middle River, i.e., following mid-/late fall assessment of returns. No harvests have been reported and gillnetting was actively discouraged by Aboriginal guardians prior to the fall assessment of returns (Table 1).

The hook-and-release (small and large salmon) recreational fishery for the Middle and other rivers of SFA 19 was reduced from the June 1-October 31 season in 1997, to that of June 1- July 15 and September 1- October 31 in 1998. The split season was implemented after consultation with Cape Breton First Nations who sought to reduce the risk of hook-and-release mortality on returns which, with few exceptions, were forecast pre-season to be less than conservation requirements. The reduced season should have had little impact on the overall recreational effort and therefore hook-and-release mortality on the Middle River. Estimates of catch from voluntary returns of the Nova Scotia Salmon License stub were 39 small (9 illegally retained) and 124 large salmon, both values being similar to those of 1997. Removals (Table 1) include an assumed 5% hook-and-release induced mortality prior to 1998 and 3% in 1998.

Status

Habitat

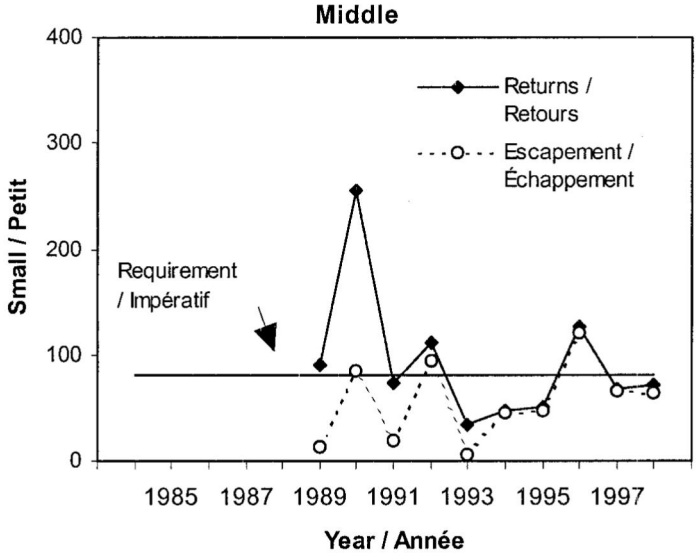
The Middle River, like the Margaree, Baddeck and North rivers which originate in the Cape Breton Highlands of Inverness and Victoria counties, is unobstructed, unimpacted by acid precipitation but exposed to agricultural practices in the lower valley. Possible changes in flow regimes from the Highlands were mentioned for the Margaree River. The course of the lower Middle River appears to have shifted more dramatically than other assessed rivers of Cape Breton.

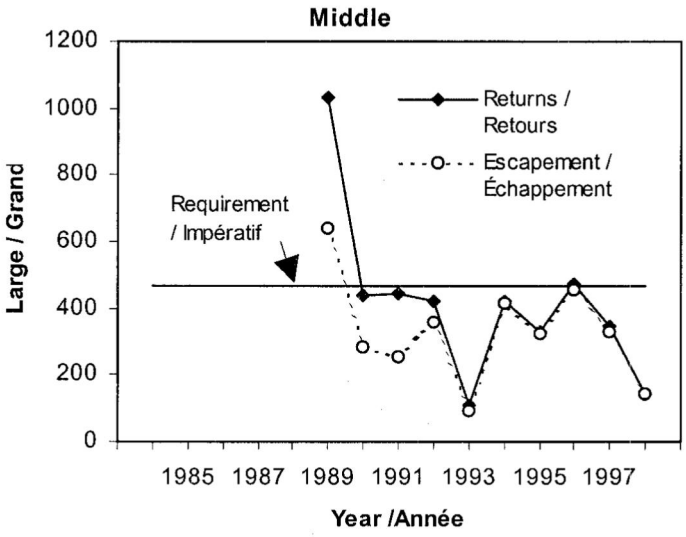
The Middle River has on occasion had small numbers of farmed escapees coincident with reported escapes from industry grow-out sites in Bras d'Or Lakes, i.e., from Whycocomagh Bay to Seal Island. Occasional adult rainbow trout are observed and sometimes reported. Juvenile rainbow trout are rare among juvenile salmon when assessed by electrofishing. Bacterial kidney disease has also been reported from Middle River (Paterson *et al.* 1979). There is currently no stocking of hatchery-reared salmon.

Stock

Returns of salmon to the Middle River were derived using mark-and-recapture methods and Bayes estimation procedures (Marshall *et al.* MS1998a). Marks were applied to adult fish seined on October 17 and 18; counts of marked (recaptures) and unmarked fish were obtained by divers floating virtually all of the river's salmon holding areas on October 19 and 20. Small and large salmon were apportioned on the basis of the small:large composition of the count.

The count of marked and unmarked fish in 1998 numbered 148 fish, the modal estimate was 222 salmon (90% CL 157-421) comprised of 70 small, 143 large and 9 farmed salmon escapes. Estimated returns of small and large salmon (combined) have been decreasing (p=0.036) and were fewer than in any year since 1993. Total returns of 222 fish (including 9 farm escapees) are 54% of those in 1997 and the previous five-year mean (Table 2). Without reported harvests, escapement is assumed to be equal to the estimate of late-season returns.





Conservation requirements for the Middle River are 2.07 million eggs from 470 large and 80 small salmon (Marshall *et al.* MS1998a). Assuming that late-season estimates of returns equal escapement, small salmon were about 85% of requirement, large salmon were 30% of requirement. In total, the probability that returns equaled conservation requirements was less than 1%.

Mean juvenile densities of 29 age-0^+ per 100 m^2 and 52 age-1^+ and -2^+ parr per 100 m^2 for two mainstem sites on Middle River in 1998 were 1.0 and 1.4 times the Elson (1967) norm. Monitoring since 1995 indicates densities to be consistently at or slightly above the norms even though escapement for egg requirements are not estimated to have been met.

Outlook

For the Middle River, prognoses of returns were based on the previous five-year returns. The mean of combined small and large returns in the past five years is 429 fish (90% CL 192-663 fish). Based on this mean and standard deviation, the Bayes derived probability of the 1999 return exceeding the 550 fish requirement is about 20% (6% based on recent biological characteristics and egg carrying capacity). It is uncertain if normal or above-normal parr densities on the Middle River will contribute to the near-future attainment of conservation requirements.

Fisheries Management Considerations

Conservation requirements have generally not been achieved in the Middle River and there is only a 20% expectation that returns and 6% expectation that eggs will meet requirements in 1999.

Estimated losses from potential fisheries to the 1999 egg depositions[a] and probabilities of meeting conservation requirements for the Middle River are:

	Losses	Prob.
Aboriginal fisheries (small and bycatch of large salmon)[b] -	16%	3%
Aboriginal (small and bycatch of large salmon) plus recreational hook-and-release fisheries[c] -	17%	2%
Recreational hook-and-release fishery only -	2%	6%

[a] Egg calculations are based on a length-fecundity relationship for salmon of the St. Mary's River (Marshall MS1986) and Middle River small:large ratios and mean length of females sampled 1996-1998.

[b] Assumes that an allocation of 100 small salmon to a gillnet fishery in Nyanza Bay yields a harvest comprised of 70% Middle River origins and 30% Baddeck River origins. It is also assumed that the 70 fish of Middle River origin will be comprised of small and a bycatch of large salmon in the same ratio as they return to the river (mean ratio of 0.17 grilse:0.83 salmon over the last five-years), i.e., a harvest of 12 small and 58 large Middle River salmon.

[c] Hook-and-release recreational fishery with catch rate of 52% as in 1998 and assumed hook-and-release mortality of 3%.

Baddeck River

Fishery

There has been no specific allocation of Baddeck River fish to Aboriginal peoples. However, it is assumed that a gillnet fishery for 100 small salmon from Middle River outflow, Nyanza Bay and Bras d'Or Lakes to Wagmatcook First Nation would impact 30 fish of Baddeck River origins. The impact would only have been after conservation requirements had been met on the Middle River, i.e., following mid-/late fall assessment of returns. No harvests have been reported although gillnetting was actively discouraged by Aboriginal guardians prior to the fall assessment of returns to Middle River (Table 1).

The hook-and-release (small and large salmon) recreational fishery for the Baddeck and other rivers of SFA 19 was reduced from June 1-October 31 in 1997, to that of June 1- July 15 and September 1-October 31 in 1998 . The reduced season should have had little impact on the overall recreational effort on the Baddeck River, given that returns rarely enter the river before fall. Estimates of catch from voluntary returns of the Nova Scotia Salmon Licence stub were 76 small and 105 large salmon. The values exceed those of 1997 and the previous five-year mean. Removals (Table 1) include an assumed 5% hook-and-release induced mortality prior to 1998 and 3% in 1998.

Status

Habitat

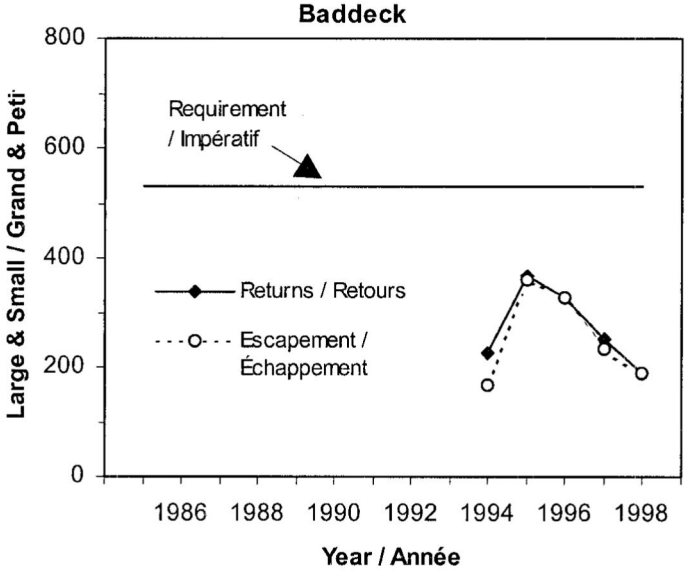
The Baddeck River, like the Margaree, Middle and North rivers which originate in the Cape Breton Highlands of Inverness and Victoria counties, is unobstructed, unimpacted by acid precipitation and only modestly exposed to agricultural practices in the lower valley. Possible changes in flow regimes from the Highlands were mentioned previously.

The Baddeck River has on occasion had small numbers of farmed escapes coincident with reported escapees from industry grow-out sites in Bras d'Or Lakes, i.e., from Whycocomagh Bay to Seal Island. Occasional adult rainbow trout are observed/reported; juvenile rainbows have not been observed among juvenile salmon assessed by electrofishing. Bacterial kidney disease has also been reported from Baddeck River (Paterson *et al.* 1979). There is currently no stocking of hatchery-reared salmon.

Stock

Returns of salmon to the Baddeck River were derived using mark-and-recapture methods and Bayes estimation procedures (Marshall *et al.* MS1998a). Marks were applied to adult fish seined on October 18; counts of marked (recaptures) and unmarked fish were obtained by divers floating virtually all of the river's salmon holding areas on October 21. Small and large salmon were apportioned on the basis of the small:large composition of the count.

The count of marked and unmarked fish in 1998 numbered only 104 fish, the modal estimate of returns was 195 (95% CL 127-503) salmon comprised of 51 small, 139 large and 5 farmed escapes. Estimated returns of small and large salmon are fewer than any year since 1994. Total returns of 195 fish (including 5 escapees) are 78% of those of 1997 and 66% of the previous four-year mean (Table 2). Without reported harvests, escapement is assumed to be equal to estimates of late-season returns.



Conservation requirements for the Baddeck River are 2.0 million eggs from 450 large and 80 small salmon (Marshall *et al.* MS1998a). Assuming that late-season estimates of returns equal escapement, small and large salmon met about 35% of requirement and the probability that returns equaled conservation requirements was 4%.

Mean juvenile densities of 64.7 age-0^+ per 100 m^2 and 30.1 age-1^+ and -2^+ parr per 100 m^2 for three mainstem sites on Baddeck River in 1998 were 2.2 and 0.8 times the Elson (1967) norm. Monitoring since 1996 indicates that densities of age-0^+ fluctuate

above while densities of age-1^+ and -2^+ parr fluctuate around the Elson norms even though escapement requirements are not estimated to have been met.

Outlook

For the Baddeck River, prognoses of returns were based on recent returns. The mean return in the past five years is 274 fish (90% CL 156-391 fish). The Bayes derived probability of the 1999 return exceeding the 530 fish requirement is less than 1%. Near normal parr densities do not, in the case of the Baddeck River, necessarily indicate increases in returns beyond 1999.

Fisheries Management Considerations

Conservation requirements have not been achieved in the Baddeck River and there is <1% expectation that returns will meet requirements in 1999.

Estimated losses from potential fisheries to the 1999 egg depositions[a] and probabilities of meeting conservation requirements for the Baddeck River are:

	Losses	Prob.
Aboriginal fisheries (small and bycatch of large salmon)[b] -	11%	<1%
Aboriginal (small and bycatch of large salmon) plus recreational hook-and-release fisheries[c] -	13%	0%
Recreational hook-and-release fishery only -	3%	<1%

[a] Egg calculations are based on a length-fecundity relationship for salmon of the St. Mary's River (Marshall MS1986) and Baddeck River small:large ratios and mean length of females sampled 1996-1998.

[b] Assumes that an allocation of 100 small salmon to a gillnet fishery in Nyanza Bay yields a harvest comprised of 70% Middle River origins and 30% Baddeck River origins. It is also assumed that the 30 fish of Baddeck River origin will be comprised of small and a bycatch of large salmon in the same ratio as they return to the river (mean ratio of 0.22 grilse:0.78 salmon over the last five-years), i.e., a harvest of 7 small and 23 large Baddeck River salmon.

[c] Hook-and-release recreational fishery with catch rate of 95%(!) as in 1998 and assumed hook-and-release mortality of 3%.

North River

Fishery

Ten large and 10 small salmon from the North River were allocated (nets not permitted) to each of the five First Nations on Cape Breton (100 fish total). This was down from the 20 large and 15 small salmon allocated in 1997. No harvests have been reported in 1998 or in the recent past (Table 1).

The hook-and-release (small and large salmon) recreational fishery for the North River, unlike other rivers of SFA 19 remained June 1-October 31. Estimates of catch from voluntary returns of the Nova Scotia Salmon License stub were 133 small and 124

large salmon. The catch of small salmon in 1998 was 193% of that in 1997 while the catch of large salmon was 92% of 1997. The respective small and large salmon catches are 117% and 85% of the previous five-year means. Removals (Table 1) include an assumed 5% hook-and-release induced mortality prior to 1998 and 3% in 1998.

Status

Habitat

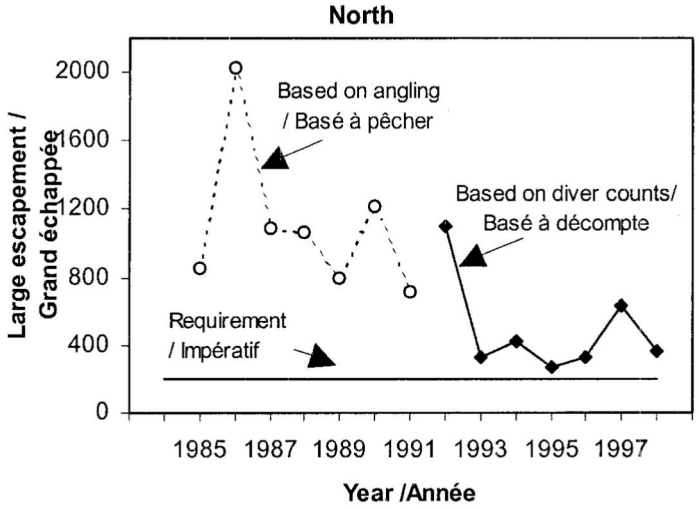
The North River, like the Margaree, Middle and Baddeck rivers which originate in the Cape Breton Highlands of Inverness and Victoria counties, is unobstructed, and unimpacted by either acid precipitation or agricultural practices in the lower valley. Possible changes in flow regimes from the Highlands were mentioned previously.

The North River has on occasion had small numbers of farmed escapees coincident with reported escapees from industry grow-out sites in Bras d'Or Lakes, esp. Seal Island. Occasional adult rainbow trout are observed/reported; juvenile fish have not been observed among juvenile salmon assessed by electrofishing. Bacterial kidney disease has also been reported from North River (Paterson *et al.* 1979). There is currently no stocking of hatchery-reared salmon.

Stock

Returns of salmon to the North River were derived using mark-and-recapture methods and Bayes estimation procedures (Marshall *et al.* MS1998a). Marks were applied to 13 adult fish seined in a single pool on October 20; counts of marked (recaptures) and unmarked fish were obtained by divers floating most of the river's salmon holding areas, exclusive of the gorge (12 unmarked salmon counted from shore by volunteers) on October 22. Small and large salmon were apportioned on the basis of the small:large composition of the count.

The count of marked and unmarked fish in 1998 numbered 224 fish (equal to the small and large salmon conservation requirement), the modal estimate was 488 (90% CL 311-1,438) salmon comprised of 74 small, 359 large and 55 escapees. In the absence of harvests, estimated returns/escapement of large salmon exceeded those of three of the past five years.



Conservation requirements for the North River are 0.85 million eggs from 200 large and 30 small salmon (Marshall *et al.* MS1998a). Assuming that late-season returns equal escapement, small and large salmon (excluding aquaculture escapees) were about 190% of requirements. There is a greater than 99% probability that the estimated returns met conservation requirements.

Mean juvenile densities of 79.4 age-0^+ per 100 m^2 and 21.6 age-1^+ and -2^+ parr per 100 m^2 for four mainstem sites on North River in 1998 were 2.7 and 0.6 times the Elson (1967) norm. Monitoring, mostly at different sites, 1996-1997, yielded annual mean densities of 29.4 age-0^+ and 27.2 age-1^+ and -2^+ parr per 100 m^2. Age-0^+ parr approximate the norm, while older parr are less than the 39 parr per 100 m^2 norm. The inconsistency between less-than-normal parr densities resultant of escapements in excess of current conservation reqirements warrants investigation.

Outlook

Stock-and-recruit data have been developed for the North River but recent prognoses relative to the attainment of conservation requirements could just as easily have been based on the mean of recent years. The mean of native salmon returns in the past five years is 547 (90% CL 300-783 fish). The Bayes derived probability of the estimate exceeding the 230 fish requirement in 1999 is greater than 98%, the probability based on eggs is 93%.

Fisheries Management Considerations

Conservation requirements of North River were exceeded again in 1998 and there is a 93% chance that conservation egg requirements will be met in 1999. Estimated losses from potential fisheries to the 1999 egg depositions[a] and probabilities of meeting conservation requirements for the North River are:

	Losses	Prob.
Aboriginal fisheries (50 small and 50 large salmon) -	13%	87%
Aboriginal fisheries plus recreational hook-and-release[b] fisheries -	15%	86%
Recreational hook-and-release fishery only -	2%	93%

[a] Egg calculations are based on a length-fecundity relationship for salmon of the St. Mary's River (Marshall MS1986) and North River small:large ratios and mean length of females, 1996-1998.

[b] Hook-and-release recreational fishery with catch rate of 53% as in 1998 and assumed hook-and-release mortality of 3%.

Grand River

Fishery

There has been no recent allocation of Grand River salmon to First Nations and to-date, no reported removals (Table 1). The hook-and-release (all salmon) recreational fishery for the Grand River was also reduced from June 1-October 31 in 1997, to that of June 1-July 15 and September 1- October 31 in 1998. The split season did not reduce recreational effort from that of 1997. Estimates of catch from voluntary returns of the Nova Scotia Salmon Licence stub were 48 small and 28 large salmon. The catch of small and large salmon is 165% and 560% of respective catches in 1997, and the respective small and large salmon catches are 72% and 161% of the previous five-year means. Removals (Table 1) include an assumed 7% hook-and-release induced mortality prior to 1998 (including 1995 when the season was closed) and an assumed 4% without a summer season in 1998.

Status

Habitat

Grand River, Richmond County, is a low gradient river in which the mainstem flow and temperature is moderated by headwater lakes, including Monroe, Uist and Loch Lomond. Grand River Falls is an obstruction to salmon at low discharge and located 10.2 km above head-of-tide. A fishway at the Falls is estimated to pass an average 60% of small and 43% of large salmon that approach it (Amiro and Longard MS1990 and MS1995). It is estimated that 45% of the juvenile production area is above the falls (Amiro and Longard *op. cit.*).

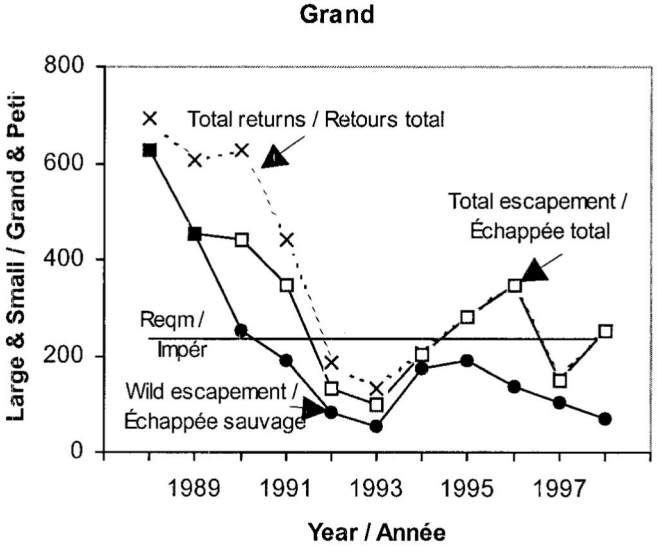
The Grand River fishway is not known to have passed farmed escapees but the river does support a small population of resident brown trout (*Salmo trutta*). Atlantic salmon stocked in 1995 (21,617 age 0^+ parr) and 1997 (15,463 smolts) contributed to 72% of small salmon returns in 1998.

Stock

Unlike most other Cape Breton stocks, salmon of the Grand River are principally small (1SW) and of June/July (80%) run timing. The few large salmon are almost all repeat-spawning 1SW fish. Returns have declined in recent years despite significant hatchery

supplementation with Grand River stock (Marshall *et al.* MS1998a) and the elimination of south coast Newfoundland commercial fisheries. Partial counts of salmon were made at a trap in a fishway at Grand Falls through July 31, total returns were estimated as [[Count/[1- by-pass rate (0.4)]/0.8 the counted component]].

The count of wild and hatchery-origin salmon in 1998 was 112 small and 8 large fish, the estimate of returns is about 250 salmon of which 72% were of hatchery origin. Since 1994, escapements have approximated returns. Wild escapements (returns) in 1998 numbered approximately 70 fish, and are the fewest since 1993.



Conservation requirements for the entire Grand River are 1.1 million eggs from 545 salmon (mostly small). Required above the fishway are 234 salmon (475,000 eggs). In 1998, escapement of wild and hatchery salmon above the fishway was 107% of requirement, the third highest of the previous seven years.

Juvenile densities at four sites on the main stem (two above and two below the falls) averaged 31 age-0^+ and 8.0 age-1^+ and -2^+ parr per 100 m^2, 107% and 21% of respective norms and the highest of any mean annual values, 1995-1997. In 1997, age-0^+ densities were the same (30 fry), age-1^+ and -2^+ parr were only slightly fewer (6 parr).

Outlook

There is no precedent for forecasting returns to the Grand River. A forecast based on the mean of wild returns, 1994-1998, (there may also be some hatchery returns from 23,500 age-0^+ parr stocked in 1996) is 135 fish (90% CL 54-218) comprised mostly of small salmon. The data indicate only about a 2% probability that the conservation requirements of 234 fish could be met by wild fish in 1999. Recent low parr densities are not suggestive of future increases in adult returns.

Fisheries Management Considerations

In the absence of any fishery, returns to the Grand River fishway met the conservation requirement for the area upriver of the fishway. Requirements were met only as a result of significant returns of hatchery fish (72% of total). Returns to the area above the falls in 1999 will be largely dependent on wild production and the probability of meeting egg conservation requirements is 0%.

Estimated losses from potential fisheries to the 1999 egg depositions[a] and probabilities of meeting conservation requirements for the Grand River are:

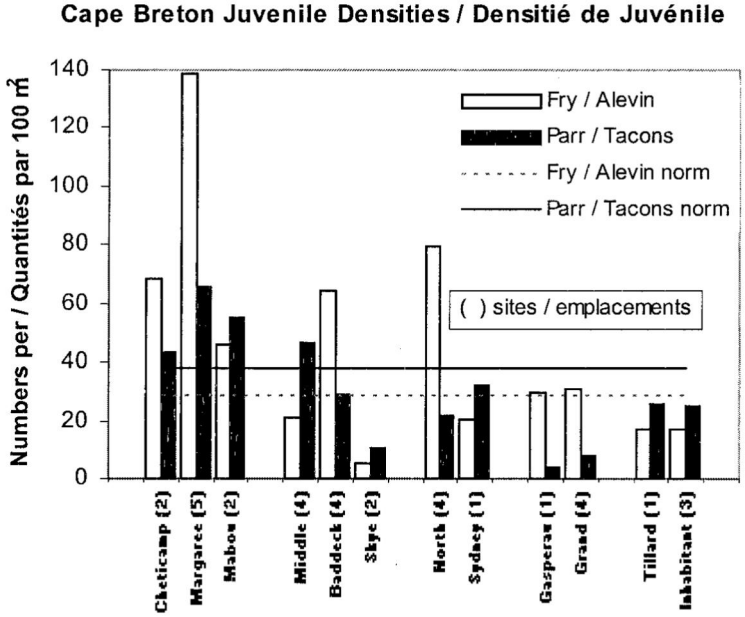
	Losses	Prob.
Closure of directed fisheries -	0%	0%
Recreational hook-and-release fishery only -	2%	0%

[a] Egg calculations are based on data for the Grand River (Amiro and Longard MS1990) and small:large salmon ratios for wild fish projected to return (5-year mean) in 1999.

[b] Hook-and-release recreational fishery with an assumed catch rate of 40% assumed hook-and-release mortality of 4%.

Other Rivers of SFA 18 and SFA 19

In 1998, juvenile salmon surveys were also conducted on the Cheticamp and Mabou rivers in SFA 18 and Skye, Sydney, Gaspereaux, Tillard and Inhabitants rivers in SFA 19. Mean river densities (number of sites in brackets) of fry (age -0^+)and parr (age -1^+ and 2^+) for sites surveyed in 1998 relative to Elson (1967) norms are shown below. The paucity of sites on some rivers and the potential for fry to remain concentrated in areas proximate to egg deposition renders fry data less valuable than the usually more spatially distributed parr.



In general, estimated parr densities relative to norms and estimates of numbers of returning salmon and escapements among fully assessed stocks contribute to the following generalized *fishery management considerations*: (1) Stocks of SFA 18 Gulf Cape Breton may all be meeting and, with a high degree of probability, be expected to meet conservation requirements in 1999. (2) Stocks of the Bras d'Or Lakes have in general terms not met conservation requirements and should not be expected to do so in 1999. Of special note is the Skye River where in 1998, 100 grilse-sized salmon were reported harvested by Aboriginal fishers at sites proximate to the river. Fishing mortality on this stock in particular, should as a precaution be minimized. (3) Stocks of Atlantic coast rivers exhibit, on average, lower parr densities than Gulf and Bras d'Or rivers (excl. Skye River). These parr densities indicate a need for caution and river specific assessments before more liberalized fishing is permitted.

Eastern and Southern Shores of Nova Scotia (SFAs 20 and 21)

Rivers of the geological area known as the Southern Uplands of Nova Scotia (SFAs 20 and 21) generally drain lowland areas of shallow soils and peat bogs underlain by granites and metamorphic rocks lacking in basic minerals. Water is generally organic-acid stained of lower productivity and when combined with acid precipitation these conditions can result in toxic conditions for salmon. Interspersed are areas of limestone rich soils (drumlins) that provide local areas of less acidified water. Difficulties in identifying the locations and quantifying the degree of impact has impeded the derivation of standard conservation requirements for acidified rivers in these areas.

According to the last pH (a measure of the acidity) inventory (Watt 1986), there were eight low- or non-acidified salmon rivers in SFA 21 with a history of Atlantic salmon angling catch (Gold, LaHave, Medway, Martins, Meteghan, Mushamush and Petite Riviere) and fourteen in SFA 20 (Gaspereau Brook, West Sheet Harbour, East Sheet Harbour, Port Dufferin, Halfway Brook, Ecum Secum, Quoddy, Moser, Ship Harbour Lake Charlotte, Country Harbour, Saint Mary's, Salmon Guysborough, Musquodoboit and Guysborough rivers) that had pH's greater than 5.1. At pH's below 5.1 salmon production is considered unstable and only remnant populations may persist. Two of these rivers, LaHave River above Morgans Falls and St. Mary's River, were used as indices of the 1998 status of Atlantic salmon in SFA 21 and SFA 20. The count at Morgans Falls continues from 1972 and is used to provide inseason forecasts for SFA 20 and 21 (Amiro *et al.* MS1996; Harvie and Amiro MS1998;and O'Neil *et al.* MS1998).

There are twenty partially impacted rivers on the Southern Upland of Nova Scotia where the main stem pH is 4.7-5.0 and remnant populations of Atlantic salmon may remain.

Fourteen rivers of the Southern Uplands of Nova Scotia have lost their population of Atlantic salmon (Watt 1986 and MS1997). Four of these rivers, East River Sheet Harbour, Mersey River, Clyde River and Jordan River, receive hatchery-reared Atlantic salmon smolts to support public fisheries.

Three other rivers, Liscomb and Tusket River (partially impacted) and East River Sheet Harbour (lost salmon stock) had operational counting facilities in 1998. The Liscomb River fishway count extends back to 1979 and the East River count periodically back to the 1967. Tusket River counts are complete for the entire salmon run in 1998 and historically provided counts up to July back to 1979. Observations made at these facilities are used to corroborate the counts and forecasts made at Morgans Falls, LaHave River, and to validate the index approach.

There is evidence that water quality in rivers of the Southern Uplands of Nova Scotia has deteriorated since 1986 (Watt MS1997). Some of these rivers are also impacted by hydroelectric or impoundment for domestic water use.

Egg depositions in these rivers are contributed equally by 1SW and 2SW salmon. 1SW salmon comprise about 70% of the numbers of fish and are about 60% female.

Low- or Non-Acidified Rivers (Index Rivers: St. Mary's River (SFA 20) and LaHave River (SFA 21))

For assessments purposes, operational conservation requirements have been assigned for two low acidified rivers, LaHave River and St. Mary's River (Amiro *et al.* MS1996; O'Neil *et al.* MS1998). These requirements are equivalent to 1,320 fish for the LaHave River above Morgans Falls and 3,155 fish for the St. Mary's River.

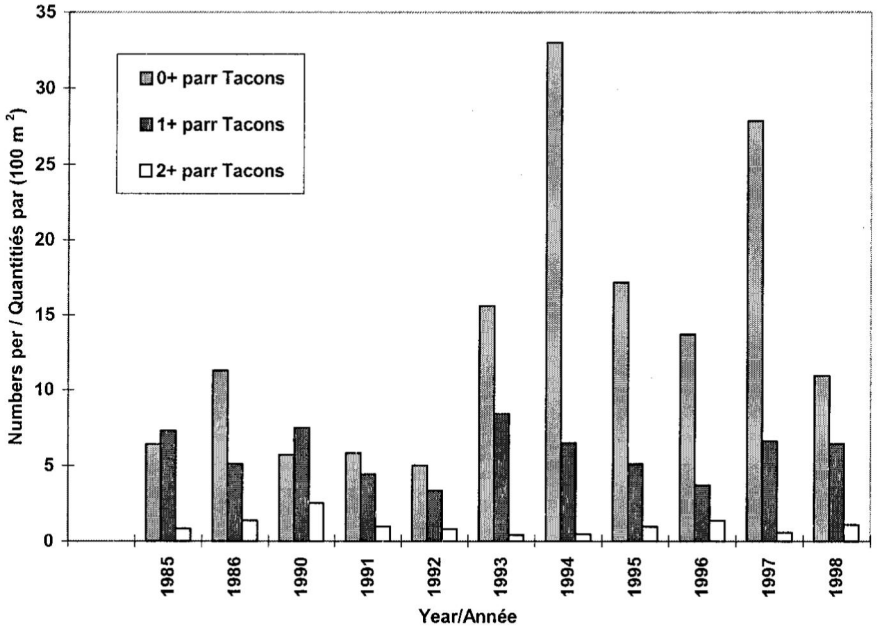
Fishery

In 1998 no licensed commercial, recreational or food fishery agreements permitted the harvest of Atlantic salmon in the less acidified rivers of SFA 20 or 21. Two pre-season and four in-season assessments indicated a low probability that returns would be in excess of operational conservation requirements. Based on these assessments no change in exploitation was recommended or occurred in 1998.

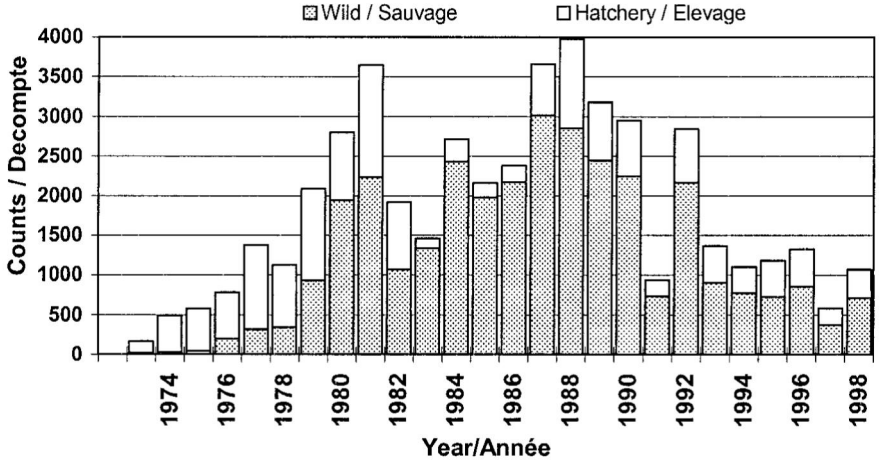
Status

Status for all low-acidified rivers in SFA's 20 and 21, which are still capable of producing wild Atlantic salmon, is expected to be similar or worse than the index rivers. Dissimilarities in the status of salmon stocks among rivers of these SFA's may be attributed to the levels of acidification and hatchery supplementation.

Total escapement to St. Mary's River was estimated by in-river mark-and-recapture in 1997 (O'Neil *et al.* MS1998) and 1998. In 1998, the estimate doubled to 2,000 fish (90% CL 1,618-2,709) or 63% of the number of fish required. However, an unusually high percent (95%) were 1SW fish which resulted in an estimated egg deposition of only 55% of the egg requirement. Age-1^+ and age-2^+ parr densities remain low while age-0^+ parr have increased periodically since 1985.

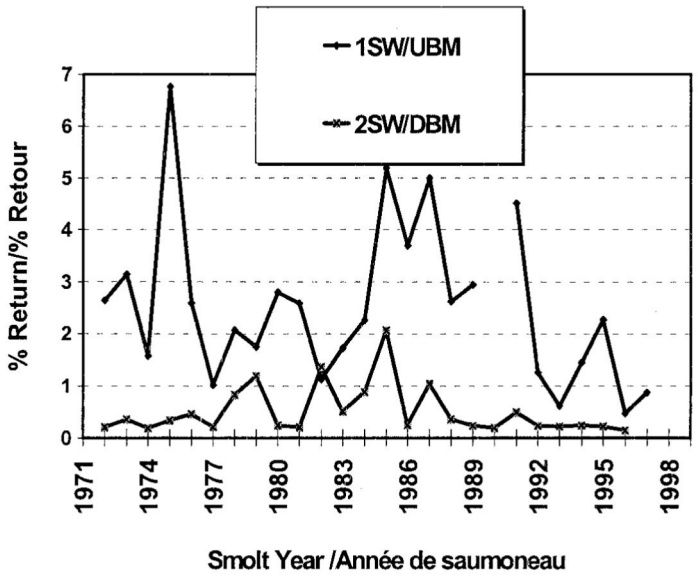


Counts at Morgans Falls fishway on the LaHave River indicated a return of 80% of the requirement of 1,320 fish and 84% of the egg requirement above the falls. Because of the scarcity of 2SW salmon and their preferential selection for broodstock, the 1998 potential egg deposition in the river was estimated at 68% of requirement. No adjustment for non-return fall back was made in deriving these numbers.



This was the fifth consecutive year that escapement of salmon above Morgans Falls on the LaHave River before adjustment for non-return fall back was at or below the operational conservation requirement.

Return rate of hatchery smolts to Morgans Falls, LaHave River has declined ($p=0.001$) since 1984. Return rate of 1997 hatchery smolts as 1SW fish in 1998 increased to 0.87% from 0.47% experienced in 1997. Returns of 2SW hatchery salmon in 1998 (1996 smolt class) declined to 0.14% from the 0.22% value in 1997 (1995 smolt class).

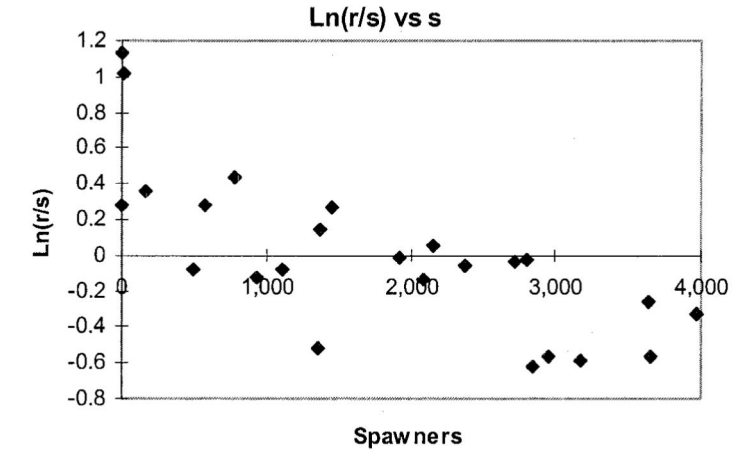


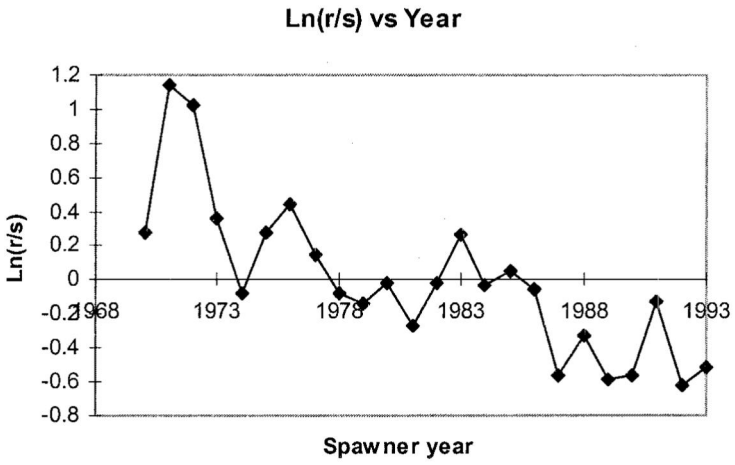
Outlook

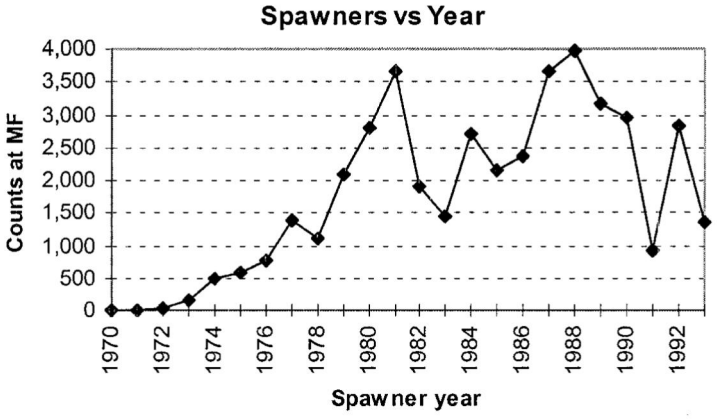
The average estimated return to St. Mary's River from 1994 to 1998 was 1,504 ± 829 SD grilse and 511 ± 446 SD salmon. Using this mean return as an estimate for 1999 there is less than a 25% chance that numbers of fish will be greater than the operational conservation requirement.

Forecasts of 1999 returns to Morgans Falls, LaHave River, based on long-term models, indicate more than a 75% chance that the returns in 1999 will be greater than operational conservation requirements. However, 42% of the forecast return would be derived from about 44,000 hatchery smolts migrating from above Morgans Falls in 1998. In comparison, there was an estimated 15,600 (90% CL 14,700-16,625) wild smolts emigrating from above Morgans Falls. There is less than a 10% chance that returns in 1999 of wild grilse and wild salmon to Morgans Falls will be greater than operational conservation requirements.

Returns of salmon to LaHave River above Morgans Falls, an area minimally impacted by acidification, have been below replacement since 1986. The natural log of the number of recruits for each spawner Ln(r/s), a measure of generation-to-generation survival, has declined and did not recover in 1991 or 1993 when escapements were low (Amiro *et al.* MS1998). This analysis indicated that factors outside the freshwater environment may account for the decline in recruitment to the river.

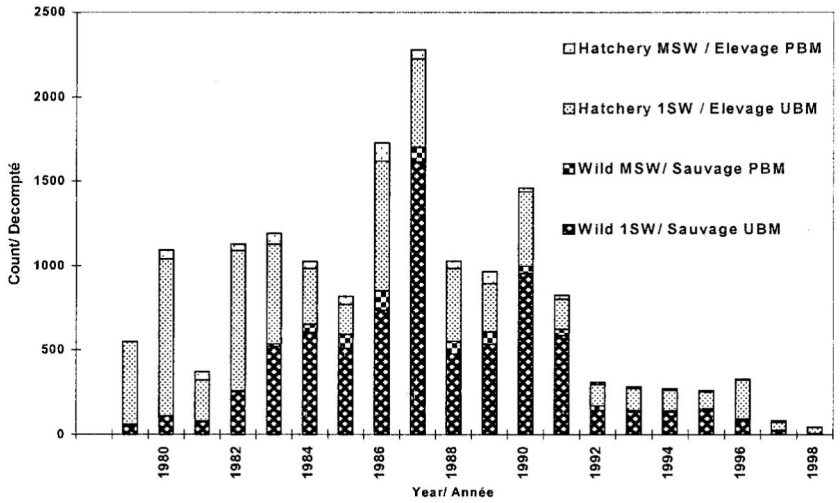






Partially-Acidified Rivers of SFA 20 and SFA 21

Returns to the Liscomb River fishway numbered only 46 fish in 1998. Wild salmon have virtually disappeared and survival of hatchery-origin salmon has declined severely.



Delayed mortality of stocked smolts is suspected and falling pH (i.e., increased acidity) may be the primary cause. Therefore, hatchery supplementation as a mitigation technique for acidification is less effective in these rivers than when the stocking programs originally began. This can be seen in the comparison of 1SW return rates for hatchery smolts stocked in LaHave River, a low acid-impacted river, and the Liscomb River.

Acid-Impacted Rivers with Fisheries Dependent on Stocking

Some rivers can no longer support the production of salmon because of inadequate fish passage, flooding of habitat and acidification. The East River Sheet Harbour, Mersey River, Clyde River and Jordan River receive hatchery smolts placed below barriers and sometimes directly into salt or brackish water to provide adult returns for harvest. Because there is nearly no natural production possible in these rivers, there are no present-day operational conservation requirements. All fish in excess of the broodstock requirements for these stocks may be exploited.

Juvenile salmon surveys conducted on the West River, Sheet Harbour, 1991-1998, indicate no significant increase in the population of age-1^{+} parr above or below a 500 m section of the river overlain with limestone rubble placed to buffer low pH episodes. Therefore, no increase in adult returns resultant of increased juvenile salmon production may be anticipated in 1999.

Management Considerations

Reduced performance of the stocks in low or non-acidified rivers has resulted in management actions in SFAs 20 and 21 to decrease in-river exploitation through reductions in daily catch limits, early closure of Aboriginal peoples fisheries and recreational fisheries. Based on the status and recent performance of the wild salmon stock above Morgans Falls on the LaHave River and estimates of returns to St. Mary's River, non- or low-acidified rivers that have not received substantial hatchery

supplementation are not expected to achieve operational conservation requirements in 1999.

Sixteen rivers were stocked with hatchery smolts or parr in 1998.

River	pH Category	Origin of stock	Number of smolt	Percent of SFA	Number of parr
SFA 21					
Clyde	1	LaHave	9,920	4	
Jordan	1	LaHave	3,852	1	
Jordan	1	Medway	1,000	0	
Mersey	2	LaHave	10,704	4	
Sackville	2	LaHave		0	
Sackville	2	Sackville	24,137	9	5,580
Tusket	2	Tusket	55,660	21	69,439
Gold	3	Gold	20,592	8	
LaHave	3	LaHave	49,691	18	20,526
Medway	3	Medway	28,482	11	59,632
Salmon River - Digby	3	Salmon River	30,150	11	4,616
Meteghan	4	Tusket			29,754
Mushamush	4	LaHave	11,612	4	6,844
Petite	4	LaHave	11,224	4	17,110
Bear River		Tusket	15,040	6	
SFA 21 Total			271,064		213,501
SFA 20					
East R. Sheet Hbr.	2	East River	33,756	38	
Liscomb	2	Liscomb	45,036	50	31,670
Musquodobit	4	Musquodobit	10,704	12	19,956
SFA 20 Total			89,496		51,626

Both the St. Mary's and LaHave rivers are representative of low acid-impacted rivers. Returns to the St. Mary's River in 1998 were again insufficient to achieve the conservation requirement, and are unlikely to be sufficient in 1999 (25% chance). The conservation requirement was also not met on the LaHave River (above Morgans Falls) for the second year in a row but is expected to be achieved in 1999 (83% chance). More than 40% of the returns in 1999 will originate from hatchery stocking, which without would reduce the chance of meeting the conservation requirement to less than 10%. Because hatchery stocking is extensive and acidification low, the LaHave River may be the only river in SFAs 20 and 21 where salmon returns in 1999 may be expected to exceed the conservation requirement.

Estimated losses from potential fisheries to the 1999 egg depositions and probabilities of meeting conservation requirements for the St. Mary's and LaHave rivers, are:

St. Mary's River	Losses	Prob.
All directed salmon fisheries closed -	0%	33%
Aboriginal fisheries (small salmon only) -	6%	28%
Aboriginal (small salmon only) plus recreational hook-and-release fisheries -	8%	27%
Recreational hook-and-release fishery only -	2%	31%
Aboriginal (small salmon only) plus recreational retention (small salmon only) fisheries -	20%	18%
LaHave River		
All directed salmon fisheries closed -	0%	83%
Aboriginal fisheries (small salmon only) -	7%	77%
Aboriginal (small salmon only) plus recreational hook-and-release fisheries -	9%	77%
Recreational hook-and-release fishery only -	2%	82%
Aboriginal (small salmon only) plus recreational retention (small salmon only) fisheries -	22%	68%

The Liscomb River is representative of the partially acidified rivers. Returns to the Liscomb have shown an almost total loss of wild salmon and severe decline in the survival of stocked hatchery salmon. Hatchery supplementation as a mitigation technique for acidification is less effective in these rivers than when the stocking programs originally began. For this reason, despite substantial hatchery smolt stocking in 1998, conservation requirements may not be met in 1999 in the Liscomb or other partially acidified rivers (e.g., Medway, Gold).

The acid-impacted rivers dependent on stocking include the East River (Sheet Harbour), Mersey, Clyde and Jordan rivers. Because these rivers are no longer able to support wild salmon production, they have no conservation requirements. They do however offer the potential to supply hatchery broodstock, an opportunity currently being considered.

Inner Bay of Fundy (SFA 22 and part of SFA 23)

Salmon of the inner Bay of Fundy occupy about twenty-six rivers of SFA 22 in Nova Scotia and about ten rivers in SFA 23, New Brunswick. Rivers in these areas generally drain the Cobequid Mountain Range and have a variety of high gradient and low gradient habitats. In general, habitat is minimally impacted by forest harvesting and agriculture practices and is not susceptible to acidification. Some rivers have lost their to salmon production because of impassable barriers placed across their estuaries to facilitate transportation, agriculture, power generation or domestic water use. Some have fish passage facilities of undetermined and possibly low efficiencies. Moderate-to-high production of salmon has been documented in these rivers as recent as 1985 and no pervasive degradation of freshwater habitat has been documented. Salmon usually enter these rivers in the fall of the year, have a high proportion that return to spawn after one

winter at sea, are not generally known to migrate to the North Atlantic Ocean, and have a high survival between consecutive spawnings. Two rivers, the Big Salmon River, New Brunswick, and Stewiacke River, Nova Scotia, account for more than half of the production. Historic catches averaged 1,061 in the commercial fishery 1970-1984, and 1,462 small and 597 large for 1970 - 1990, in the recreational fishery.

Stewiacke and Big Salmon Rivers

Fishery

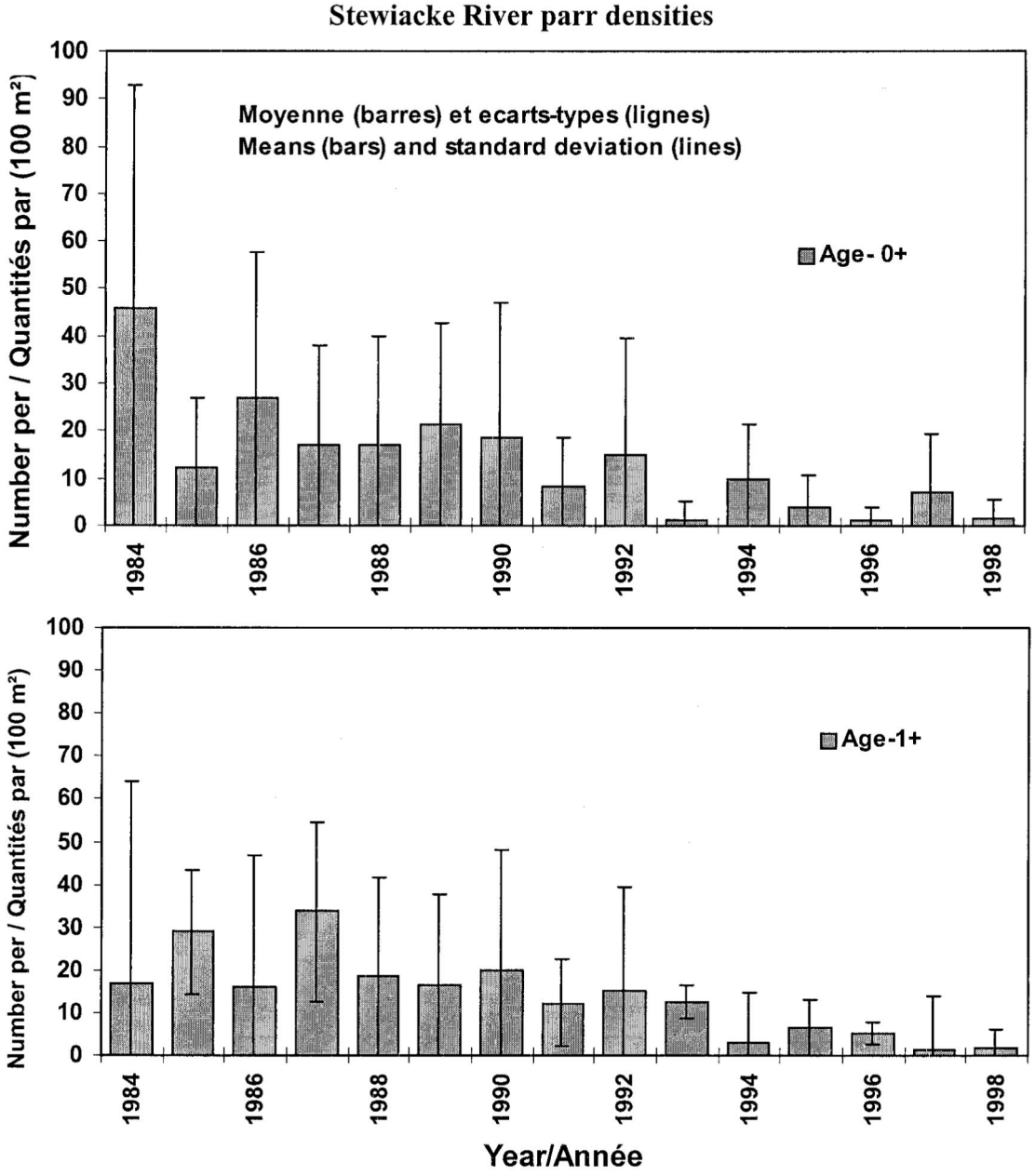
There has been no licensed salmon fishery for inner Bay of Fundy salmon since 1989.

Status

Increased effort to document and/or sample salmon in inner Bay of Fundy Rivers, provided no quantitative or qualitative observations that indicated salmon stocks increased in 1998. While an index of redd counts in the Big Salmon River increased to 36 from 22 redds in 1998[1], counts of adult salmon in the Big Salmon River indicated only 25 to 50 salmon in the river. The Big Salmon River salmon count for 1998 is low relative to recent years when estimates were 100 to 250 salmon and very low compared to the high counts of greater than 4,000 salmon observed at fixed counting facilities in the 1960's.

Attempts to count, observe and/or sample adult salmon using stream-side observation (clear water rivers only), snorkel diving or an electrofishing boat in five other rivers (Salmon River Truro, Folly River, Debert River, Maccan River, and Stewiacke River) of the inner Bay of Fundy located only two adult salmon. These observations indicated that no improvement in marine survival occurred in 1998. Electrofishing for juvenile salmon at 37 sites in the Stewiacke River and at a total of ten locations in six other rivers (Maccan, Portapique, Economy, Great Village, Debert, Folly and North rivers) of the inner Bay of Fundy, indicates that there are few Atlantic salmon of any age in rivers of the inner Bay of Fundy in 1998.

[1] T. Pettigrew NBDNRE, PO Box 150, Hampton NB E0G 1Z0



Outlook

Smolt-to-adult survival of the inner Bay of Fundy salmon stock continues to be low. Spawning escapements, parr densities and therefore populations of salmon, have been critically low since 1993. Smolt production is very low and therefore all recruitment to spawning is required for conservation, or indeed preservation of the stock. If in the near future marine survival were to increase to previously documented levels, recovery of the inner Bay of Fundy salmon stock would take at least three generations or twelve years. No salmon surplus to conservation will be available until three generations of recovery have been documented.

Management Considerations

Inner Bay of Fundy salmon (e.g. Stewiacke River and Big Salmon River) are unique among Atlantic salmon stocks. Marine distribution of these salmon has for the most part only been observed in the Bay of Fundy and Gulf of Maine areas. Inner Bay of Fundy salmon populations are critically low and cannot tolerate any exploitation. Measures to prevent their extirpation are required if the stock is to persist. While a cause and remedial action plan is formulated, measures to defer their extirpation began in 1998. Wild parr from two rivers, Stewiacke River and Big Salmon River, have been collected and are available for grow-out to mature salmon. Upon maturity these salmon will provide broodstock to extend the population.

Gaspereau and Annapolis Rivers

Salmon of the Gaspereau River and Annapolis River, unlike salmon inhabiting other rivers in the inner Bay of Fundy, migrate to the northwest Atlantic and possess a recruitment and life history pattern similar to stocks of other Atlantic coast rivers. Salmon counted at the White Rock dam fishway in 1998 totaled 95 fish (74 hatchery and 21 wild) or a potential 56% of the required spawning escapement upstream of the dam. A total of 32 fish was removed for enhancement through a fish culture program. There is no information to suggest that returns will improve or that conservation requirements will be attained in 1999.

The status of salmon in Annapolis River is inferred from broodstock collections in 1998. In 12.5 hours of beach- and drift-net seinings in traditional collection sites on two dates in October 1998, only10 fish were captured. All were hatchery origin and 90% were grilse. Only 20% were female. A fishway at Martyn's Mills on the Nictaux River, a tributary of the Annapolis, became operational late in the season of 1998. Data collected at this fishway may provide additional assessment information in future years. There is no information to suggest that returns will improve or that conservation requirements will be attained in 1999.

Outer Bay of Fundy (Western Part of SFA 23)

Stocks in this area have generally not been meeting conservation requirements during the last decade and have been closed to recreational retention fisheries for 1SW salmon (grilse) since September 15, 1993. Aboriginal food fisheries (main Saint John River and Tobique River tributary) and hook-and-release fisheries for grilse (various season lengths) were permitted in 1994, 1996 and 1997 but virtually closed in 1995 and closed in 1998. Inseason assessments at Mactaquac have been used as an index of stock status throughout Southwest New Brunswick.

Saint John, Upriver of Mactaquac

Fishery

In 1998 the fishery for salmon on the entire Saint John River was closed to both aboriginal and recreational anglers (Table 1). This followed an early closure in 1997 (August 12) of the aboriginal food and recreational hook-and-release fisheries and a preseason forecast for 1998 that conservation requirements were again unlikely to be met. An assessment on July 30, 1998, when about one-half or more of the run would have been counted at Mactaquac, indicated a near zero probability that conservation egg requirements would be met.

Status

Habitat

Salmon returning to Mactaquac Dam and Hydroelectric Station are trapped at the Mactaquac collection facilities, transported to the sorting facilities, sampled and trucked upriver of Mactaquac dam. Fish are taken to either the Woodstock release site on the mainstem upriver of Mactaquac or upriver of the Beechwood and Tobique Narrows dams to the Arthurette release site on the Tobique River. A few salmon are transported upriver of the Beechwood and Tinker dams to the Aroostook river release site. About 150 of each of male and female salmon are held at Mactaquac for spawning and production of approximately 1.2 million juveniles to mitigate the impact of hydroelectric development. Upstream fish passage facilities are provided at each of the Beechwood, Tobique and Tinker dams. None of these dams have downstream passage facilities and thus adults (those misplaced by trucking and kelts) and smolts must descend through spill gates during spate conditions or through turbines during generation of power.

Juvenile salmon production area on the mainstem Tobique (largest salmon producing tributary above Mactaquac) is subject to highly variable flows released from three storage reservoirs to meet peak power generation at the Tobique Narrows hydroelectric station. Peak power generation by the five major stations (inc. Grand Falls on the mainstem which is a complete barrier to salmon migration) contributes to a highly erratic, especially during annual spring floods, and largely disrupted mainstem environment.

Since construction, the Mactaquac, Tobique and Beechwood headponds have become home to mature communities of non indigenous smallmouth bass, *Micropterus dolomieui.* More recently, muskellunge, *Esox masquinongy* have been increasing in numbers in the mainstem downriver of Mactaquac and in Glazier Lake (New Brunswick-Maine boundary waters) upriver of Grand Falls. Chain pickerel, *Esox niger* may also be expanding into more lacustrine environments. These species are potential predators of overwintering presmolts and spring migrating smolts. Downstream migrating smolts from the Tobique River descend through three headponds and dams. In general about half as many smolts from the Tobique return as adults as compared to adult returns from smolts

released downstream from Mactaquac dam. Non indigenous populations of brown trout persist in the Meduxnekeag and Presquile rivers.

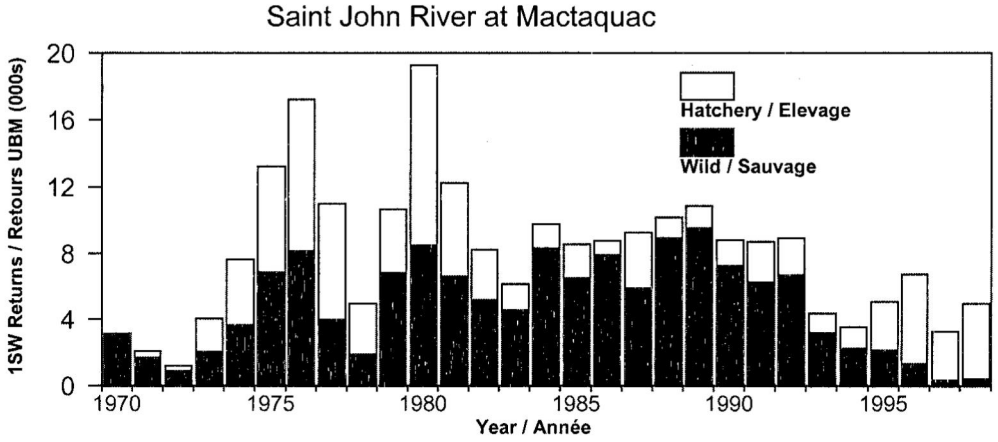
Water quality, with the exception of high turbidity caused by ice scouring during the annual spring floods is generally improved over the last four decades. This is a result of new and improved industrial and community sewage treatment facilities both above and below Mactaquac.

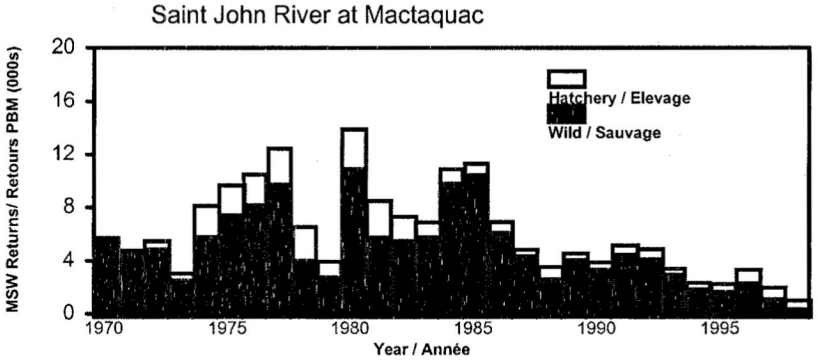
Stock

Returns to Mactaquac in 1998 are the sum of salmon captured at the dam and in the hatchery migration channel, and assumed to have been lost (1% of 1SW and 2.5% of MSW returns to the river) to bycatch in the downriver shad and gaspereau fishery or poached in the area between Fredericton and Mactaquac. While the total count of fish is fixed, the proportions of hatchery and wild 1SW and MSW salmon are dependent on as yet incomplete interpretation of ages from scale samples.

The total count at Mactaquac in 1998 was 5,880 fish and based on size was comprised of 4,892 1SW and 988 MSW salmon. Four fish had fin deformities and body shape consistent with escaped farm salmon. Total returns (including assumed losses downriver of Mactaquac) with partial adjustment for some aging were about 4,950 1SW and 1,000 MSW salmon (Table 2). Preliminary assessment suggests that of the total 1SW fish, ninety percent were of hatchery origin. Of the total MSW fish, sixty-five percent were of hatchery origin.

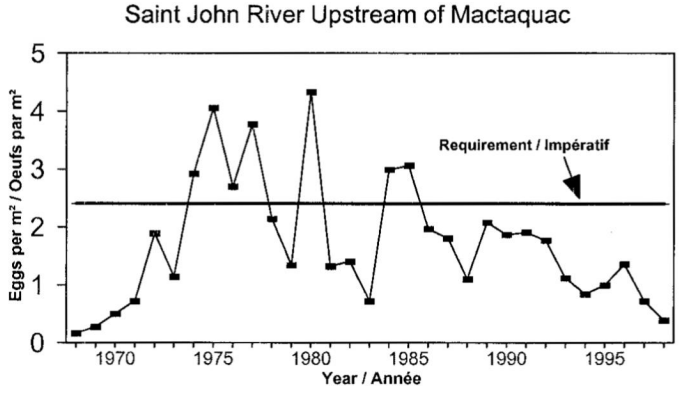
Current estimates of wild 1SW returns exceed returns in 1997 (by <100 fish), and are the second lowest of a 29-year record; wild MSW returns are less than half those of 1997 and are the lowest of the 29-year record. Hatchery 1SW returns are, with the exception of returns in 1996, the highest in 17 years. Hatchery MSW returns were about 75% of those in 1997 and 65% of those in 1996 but equal to the mean of the last five years.





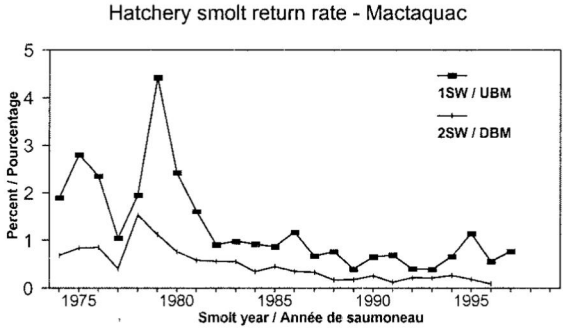
Escapements are those fish returning to the dam minus approximately 300 MSW and 25 1SW fish retained at Mactaquac as broodstock, 76 1SW and 4 MSW fish transported above Tinker dam on the Aroostook River and 212 1SW and 12 MSW accidentally entrapped in the Tobique and Beechwood fishways. Thus, escapements numbered slightly fewer than 700 MSW and 4,600 1SW salmon. More than 80% of escaping MSW fish were female, more than 90% of escaping 1SW fish were male. Fish held for broodstock were predominantly June/July arrivals which yielded 1.7 million eggs, about 20% of the eggs arriving at Mactaquac.

Conservation requirements above Mactaquac are based on an accessible salmon-producing substrate of 13,472,200 m^2, an assumed requirement of 2.4 eggs per m^2, a length-fecundity relationship for Saint John River salmon (Marshall *et al.* MS1998b) and biological characteristics for wild 1SW and MSW salmon, 1988-1995. Requirements are 32.33 million eggs to be provided by 4,900 MSW and 4,900 1SW fish. The biological characteristics and preliminary estimates of numbers of salmon escaping in 1998 indicate that only 16% of the conservation egg requirement (68% of the total derived from hatchery-origin fish) was met. This is the lowest value in 30 years.



Aged returns of hatchery 1SW and 2SW fish released from Mactaquac Hatchery via the migration channel as 1-year smolts have been used as an index of marine survival. Preliminary assessment indicates a 1SW return rate of 0.77% from smolts released in 1997, up from the 0.56% value in 1997 and similar to the 0.7% mean value since the

complete conversion to a 1-year smolt program in 1985. Hatchery MSW returns decreased to 0.088% and are the lowest of the entire record.



Densities of juvenile salmon are currently estimated for 38 sites electrofished by aboriginal communities upriver of Mactaquac. Sites on the Tobique (3), Shikatehawk (4), Meduxnekeag (4) rivers have a continuous record since 1993. Average densities 100 m^{-2}, for the 13.5 million m^2 of suitable juvenile production habitat upriver of Mactaquac, weighted by the estimated proportion that each tributary comprises of the total (Marshall *et al.* MS1998b) are:

Stage	1993	1994	1995	1996	1997	1998
Age 0^+	13.2	1.9	38.9	5.5	7.9	2.3
Age 1^+ and 2^+	9.1	7.8	6.7	7.5	6.5	9.5

Average age-0^+ densities of 11.6 fry per 100 m^2 are only 40% of an Elson (1967) normal abundance of 29 fry and are not significantly different from the 50% average attainment of egg conservation requirements, 1992-1997. The average density of 8.5 parr per 100m^2, 1993-1997, and the 1998 value of 9.5 parr per 100m^2 are about 25% of the norm of 38 parr per 100m^2. There are no trends in the fry or parr data sets even though the contributing egg depositions, trend downwards from 1991 to 1997 (Table 2). When identified, hatchery-stocked juveniles (300,000 to 900,000 fry and 300,000 to 500,000 fall fingerlings per year but usually < 5% of any site population), have been excluded.

Outlook

Numerous models have been explored to forecast separate returns of wild and hatchery (inc. smolts released below and juveniles released above Mactaquac) 1SW and MSW fish (Marshall *et al.* MS1998b). Summed point estimates of the various population components derived from elaborate (and failing) forecast models were in 1997 replaced by summed components of forecasts based for the most part on mean and modal values of returns, proportions of hatchery fish at age and return rates in recent years. Without age-adjusted estimates of the hatchery and wild composition among 1SW and MSW fish in 1998, prognoses were simplified to Bayes derived probability of attaining the conservation requirement from the mean and standard deviation of 1SW and MSW returns and egg depositions in the previous five years. The method provided forecasts relative to returns, 1996-1998 as follows:

	1996		1997		1998	
	1SW	MSW	1SW	MSW	1SW	MSW
Mean prev 5-yr	6100	3600	5700	3200	4600	2000
Returns	6700	3300	3300	2000	4900	1000

None of the 1SW forecasts were significantly less than returns, each of the forecasts for MSW salmon exceeded returns. Prognoses for returns in 1999 are 4,700 (90% CL 2,420-6,970) 1SW and, optimistically, 2,200 (90% CL 845-3,3530) MSW salmon. Bayes derived probabilities of attaining conservation requirements of 4,900 of each of 1SW and MSW fish (ignores the requirement for 300 MSW broodstock) are 56% and < 1%, respectively. Conversion of total returns to eggs (using eggs per fish for spawners in 1998) suggests a probability of <1% that 1SW and MSW returns in 1999 will meet conservation egg requirements. Recent densities of "wild" juveniles (Table 2) and a consistent supplementation with juveniles surplus to the 1-year smolt program at Mactaquac suggest that future returns will not increase.

Fisheries Management Considerations

For the Saint John River stock upriver of Mactaquac, egg depositions have been trending downwards, reaching a low in 1998 with only 16% of the conservation requirement being met. There is essentially a zero probability that returns of large salmon in 1999 will be sufficient to meet the conservation requirement. There is a 56% chance of attaining the 4,900 small salmon requirement.

Generally, 80% of the large salmon returns to Mactaquac are female. Although males comprise a high proportion of the small salmon (90% in 1998), the egg contribution from the small salmon can be important when large salmon returns are as low as they are currently. In 1998, the small salmon contributed one quarter of the eggs deposition upriver of Mactaquac.

Wild salmon returns were the lowest since the construction of Mactaquac Dam in 1968. Only 10% of the 4,950 small salmon and 35% of the 1,000 large salmon returning in 1998 were identified as wild. This low return of wild salmon, while at least in part attributed to low marine survival, may also be caused by in-river influences (e.g., losses to downstream passage at hydroelectric dams, increased predators), and warrant an immediate and thorough investigation.

Considering the projected low returns of salmon to Mactaquac Dam, and in particular the low production of wild salmon, fishing mortality should be minimized. An in-season assessment will be conducted in late-July.

Estimated losses from potential fisheries to the 1999 egg deposition and probabilities of meeting conservation requirements for the Saint John River upriver of Mactaquac are:

	Losses	Prob.
All directed salmon fisheries closed[a] -	0%	0%
Aboriginal fisheries (small salmon[b]) -	7%	0%
Aboriginal (small plus recreational hook-and-release fisheries[c])-	8%	0%
Recreational hook-and-release fishery only -	1%	0%

[a] Does not account for removals of hatchery broodstock (approx. 150 MSW females or 1.7 million eggs), losses of MSW fish coincident with food fisheries for 1SW fish (note Table 1) and usual minor losses to the Aroostook River and mortalities in handling or entrapment at fishways.

[b] Aboriginal fisheries have in the recent past been allocated 3,700 grilse of which it is estimated that 3,485 would originate upriver of Mactaquac, 155 would originate from the Nashwaak and the remainder would originate in other tributaries.

[c] Assumed that recreational anglers have a 15% catch rate on 1SW and MSW fish and 5% hook-and-release mortality in the presence of an aboriginal food fishery and a 20% catch rate and 5% hook-and-release mortality in the absence of a food fishery.

Nashwaak River

Fishery

The recreational fishery on the Nashwaak River was also closed in 1998 (Table 1). There was no fishery by Aboriginal peoples in 1998 and there has never been a food fishery allocation specifically for the Nashwaak River. However, it is estimated that a fishery by Aboriginal peoples in the main Saint John downstream of the Nashwaak confluence (Oromocto First Nation and members of the New Brunswick Aboriginal Peoples Council) would intercept fish of Nashwaak River origin. The closures affecting the Nashwaak were consistent with recent failures of the river to approach conservation requirements and prognoses that returns in 1998, like those upriver of Mactaquac, would be well below 50% of adult requirements.

Status

Habitat

Numerous forestry operations in the upper part of the watershed may contribute to increased stream temperatures and increasingly variable water discharge patterns. Coincidentally, chain pickerel and smallmouth bass have now been observed in salmon holding pools as far as 50 km upstream of the confluence with the mainstem Saint John River. The return by an angler of a Carlin tag from the stomach of a chain pickerel in the same season that it had been applied to a hatchery released smolt is consistent with observations in Mactaquac Headpond where pickerel may be effective predators on migrating smolts and possibly overwintering presmolts.

Aeromonas salmonicida, the causative agent of furunculosis, is ubiquitous to the Saint John drainage and can inflict mortality among physically or environmentally stressed fish. Of 19 dead adults recovered from the upstream side of the Nashwaak River fence during warm water periods and submitted for disease analyses in 1998, nine were

found to be positive for furunculosis. Of a dozen mortalities submitted in 1997, one-half tested positive.

A commercial salmon hatchery producing smolts for the Fundy-Isles aquaculture industry has been in operation for most of the 1990s on the Tay River tributary. A portable smolt fence operated in May-June, 1998, revealed 134 escapees among 532 wild smolts. The likely stock origin of escapees is Saint John River (Mactaquac), but the most immediate lineage is several generations of cage-grown adults. Stocking of the Nashwaak with progeny of "wild" fish returning to Mactaquac ceased in 1995 and minimal stocking since that time has been progeny of adult returns to the Nashwaak River.

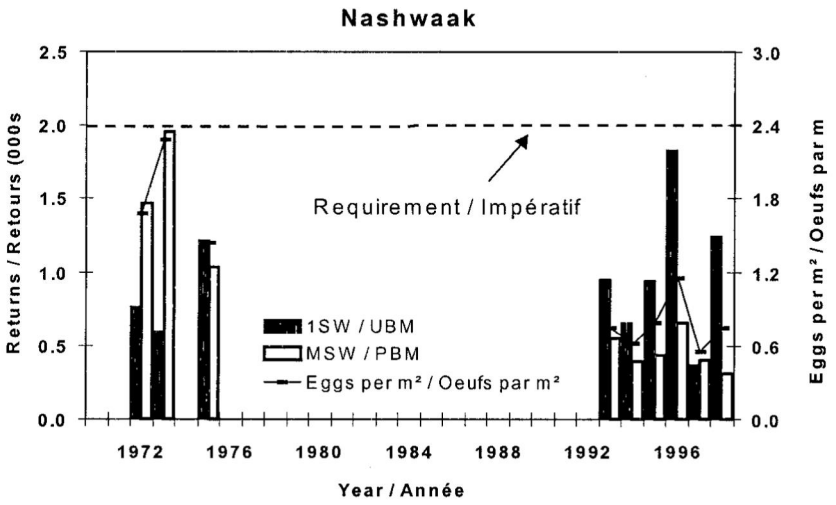
Stock

Returns of salmon to the Nashwaak River in 1998 were largely derived using mark-and-recapture methods and Bayes estimation procedures. Marks were applied at the Nashwaak River fence to all fish ascending except for those migrating during 3- and 5-day washouts in August and October. Counts of marked and unmarked fish were obtained by seining above the fence on October 14 and 15. The few fish that were captured at the fence between seining dates and the October 28 fence closure date were added to the mark-and-recapture estimate.

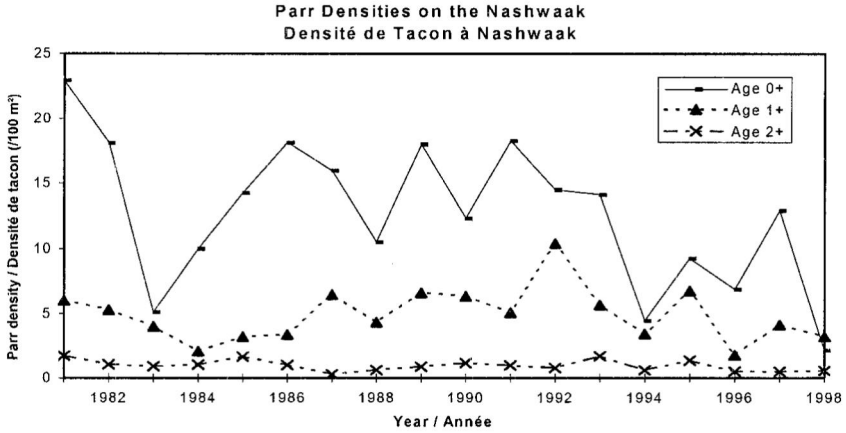
Counts of small and large salmon at the Nashwaak fence suggested passage of 464 1SW and 152 MSW salmon. Seining and capture of 24 marked and 39 unmarked fish above the fence in October resulted in separate mark-recapture estimates of 1,250 1SW and 315 MSW salmon (Table 2). Based on external characteristics, hatchery returns from minimal distributions of juveniles to the river contributed to less than 5% of the total returns. No farmed fish were identified on the basis of gross external fin deformation noted among Tay River escaped smolts.

Preliminary estimates (unadjusted by interpretation of sea age from scales) indicate that the 1SW returns were the second highest since resumption of the fence operations in 1993, and three times the total 1SW return of 1997. MSW returns were the lowest on record but consistent with the low 1SW returns observed in 1997 from the same smolt class.

Conservation egg requirements for an estimated 5.35 million m^2 of substrate (> 0.12% gradient) above the fence are 12.8 million eggs. This egg requirement is on average obtainable from 2,040 MSW salmon, an equal number of 1SW salmon are needed to provide males. Estimated returns minus known removals (mortalities and broodstock to supply 5,000 juveniles for two satellite rearing units) suggest an escapement of 1,230 1SW and 310 MSW salmon. A length-fecundity relationship for Saint John origin salmon (Marshall *et al.* MS1998b) and biological characteristics of fish captured at the fence, indicates egg deposition in 1998 to have been 31% of requirement. Females among 1SW salmon (51%) contributed to 54% of the estimated egg deposition.



Juvenile densities have been monitored since 1981 at 2 tributary and 5 mainstem sites located above the Nashwaak River counting fence. The 1998 density for age-0^+ parr was the lowest in the 18-year time series. Age-0^+ densities at these sites trend downwards ($p= 0.03$) and the most recent five-year average of 9.5 age-0^+ fish per $100m^2$ represents only 33% of an Elson (1967) normal abundance (Table 2). The 1998 combined parr density was with the exception of 1984 and 1996, the lowest on record. The five-year average density of 8.5 age-1^+ and -2^+ parr per 100 m^2 is about 22% of the Elson norm. Historically the parr data show no significant trend. Low fry and parr densities relative to the Elson (1967) norm are consistent with the low percentages (25-50%) of egg conservation requirements met since 1993.



In 1998, a mark-and-recapture estimate was initiated between late-April and early-June to estimate smolt output from the area above the fence. This was accomplished by capturing and marking smolts at a portable fence on the Tay River tributary and sampling for marked fish among unmarked fish with a smolt "wheel" (financed by NB Wildlife Trust Fund and entrusted to the Atlantic Salmon Federation) moored in the main Nashwaak just above the Nashwaak Fence site. Recovery at the wheel of 30 smolts marked in the Tay River and an additional 1,203 unmarked smolts contributed to a mark-and-recapture estimate of about 23,000 (90% CL 17,000-34,500) migrating smolts (0.4 smolts per $100m^2$ of production area).

Outlook

Use of parr abundances to forecast 1SW returns in 1998 (Marshall *et al.* MS 1998b) was not particularly instructive. An expectation for 1999, based on the mean of 1SW returns over the last five years (1,030 1SW fish [90% CL 230-1,940]), suggests a 3% probability that 1SW requirements will be met. That return from the estimated 23,000 smolts would yield a 4.5% survival rate, six to seven times that of the current rate for hatchery smolts released from and returning to Mactaquac. The five-year mean of MSW returns to the fence is 410 fish (90% CL 215-650), a near-zero probability of meeting MSW conservation requirements. The product of the mean ratio 2SW/1SW returns for the smolt years, 1992-1996, and 1998 1SW returns suggests that 2SW returns will number 475 fish.

Fisheries Management Considerations

The Nashwaak River stock, failed in 1998 to achieve its conservation requirement. Only 31% of the requirement was met and expectation is a near zero probability for achieving conservation in 1999. The stock of this river is also assumed to be representative of stocks of the Saint John River downriver of Mactaquac

Considering the high female component (30-50%) in the stocks downriver of Mactaquac, losses of small salmon to exploitation would directly and significantly affect egg depositions and achievement of conservation requirements, particularly now when large salmon returns are inadequate to meet requirements. As well, on the Nashwaak River, juvenile salmon of non-Nashwaak River origin fish should be prevented from escaping the Tay River hatchery.

Estimated losses from potential fisheries to the 1999 egg deposition[a] and probabilities of meeting conservation requirements for the Nashwaak River are:

	Losses	Prob.
All directed salmon fisheries closed -	0%	3%
Aboriginal fisheries[b] (situated on main Saint John River, small salmon) -	8%	2%
Aboriginal (situated on main Saint John River, small salmon) plus recreational hook-and-release fisheries[c] -	7%	2%
Recreational hook-and-release fishery only -	1%	2%

[a] Assumed biological composition the same as those fish spawning in 1996-1998.
[b] Aboriginal food fisheries are opened and harvest 155 grilse of Nashwaak origins.
[c] Assumed include a 20% catch rate on 1SW and MSW fish and 5% hook-and-release mortality.

Consistency between stock levels at the Nashwaak Fence and Mactaquac indicate the additional utility of an in-season assessment at Mactaquac.

Kennebecasis River

Unlike the previous two years (Marshall *et al.* MS1998b) there is no assessment in 1998 of salmon ascending the low-barrier fence operated by the NB Co-operative Fish and Wildlife Unit on the Kennebecasis River headwaters. Counts, exclusive of high water events in much of October and early November (when the majority of fish may have ascended), numbered 36 1SW and 16 MSW but the late-season high water precluded sampling of downstream migrating post spawners for counts of marked and unmarked fish and the attainment of a mark-and-recapture population estimate. Incomplete counts under somewhat lower flow conditions in 1996 and 1997, when it was estimated that less than 50% of conservation requirements were achieved, were 82 1SW and 47 MSW fish, and 74 1SW and 44 MSW fish, respectively.

Hammond River

There is at present no complete assessment of returns to the Hammond River in 1998. A redd count (Pettigrew[1] pers. comm.) of 97 large redds (visibility somewhat less than other years) on the 11.75 km of spawning habitat on the upper mainstem was 62% of the previous five-year mean, and 59% of the value for 1997. Based on previous assessments (Marshall *et al.* MS1997b) redd counts suggest that egg depositions in the section were 84% of a 2.4 eggs m^{-2} conservation requirement. As noted in previous assessments, depositions in this section are likely to be higher than the average depositions for the entire system. New in 1998 was a mark-and-recapture estimate of salmon returning to the river by Hammond River Angling Association (with funding from NB Wildlife Trust). Preliminary results suggest lower overall egg depositions than indicated by the redd count data.

Magaguadavic River

Fishery

In 1998 the fishery for salmon on the Magaguadavic River, as with all rivers tributary to the outer Bay of Fundy, was closed. There has been no allocation of salmon from the Magaguadavic River to Aboriginal peoples.

Status

Habitat

A 13.4 m-high dam and 3.7 megawatt hydroelectric station is located at the head-of-tide and is a complete obstruction to migrating fish. Upstream passage is by means of a pool-and-weir fishway; assessment of the anadromous resource(s) is afforded by a trap in the third pool from the top of the fishway. Downstream passage is through a sluiceway adjacent to the penstock. There are more than 55 lakes within the drainage, three of which

[1] T. Pettigrew, NBDNRE, PO Box 150, Hampton, NB E0G 1Z0

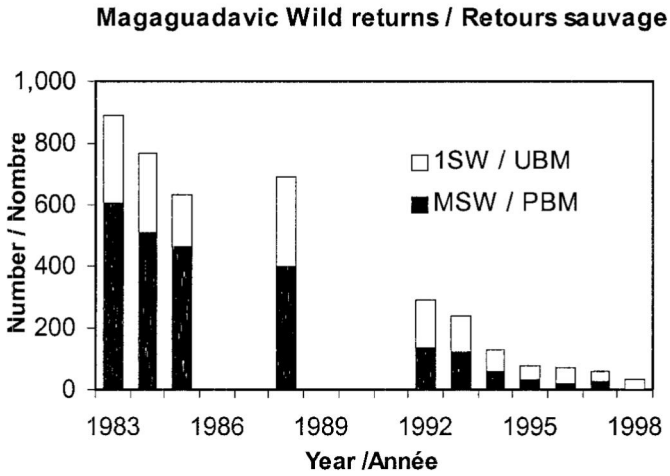
have controlled outlets and serve as reservoirs for power production (Whoriskey *et al.* MS1998). Smallmouth bass were introduced to the drainage in the 1930's or 1940's and with landlocked salmon (*Salmo salar*) provide popular recreational fisheries.

The Magaguadavic River is the most proximate large river to the centre of the "Fundy-Isle" salmon aquaculture industry (approx. current production of 20,000 t) and as such has attracted more salmon escapees than any other monitored river in eastern North America. Three commercial salmon hatcheries which produce more than two million smolts of cage parentage (originally Saint John River) for the industry are located within the drainage and escapees have been noted among riverine samples of juvenile salmon (Whoriskey *et al.* MS1998).

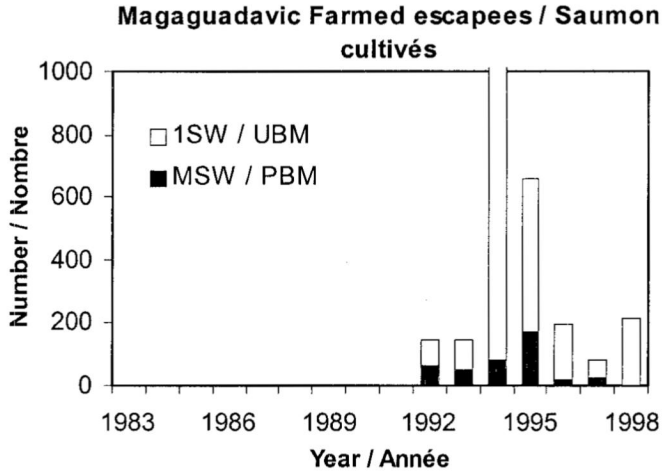
Stock

In 1998, as in recent years, the Atlantic Salmon Federation, with funding from NB Wildlife Trust, monitored the trap in the St. George fishway, late-June through November, and provided summary data and analyses (Whoriskey *et al.* MS 1998). In 1998, as in the past two years no fish of aquaculture origin captured at the trap were released to the river. Rather, they were released to various points in the Bay (as part of a homing experiment) or sacrificed for sampling of pathogens. Intentional stocking of "hatchery" fish (those fish reared and released with the intent of stock enhancement) have, with exception of a small satellite rearing project (releases are marked by removing the adipose fin), been absent on the Magaguadavic River over the recent record.

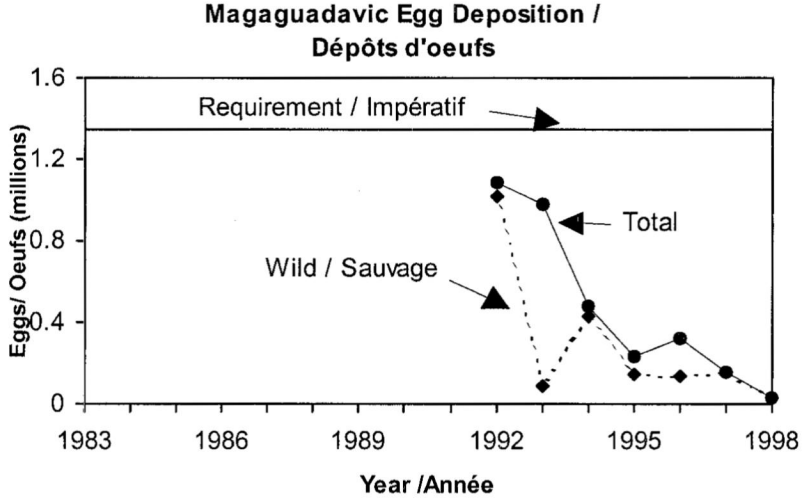
Wild returns in 1998 numbered only 28 1SW and 3 MSW salmon, the fewest of record and in total, only 27% of total wild returns in the previous five years.



Farm-origin fish ascending the fishway in 1998 numbered 211 1SW, 8 MSW (and 8 post smolts) and represent the third highest count since 1992.



Interim conservation requirements are 1.35 million eggs (Marshall *et al.* MS1998b). Spawners necessary to obtain those eggs are estimated at 230 MSW and 140 1SW salmon, an objective which in all likelihood was met in the 1980s (see wild returns graph). Biological characteristics of the few fish released to the river in 1998 indicate a potential deposition of 30,400 eggs (Whoriskey *et al.* MS1998) i.e., 2.3% of requirement and the lowest of record.



Densities of juvenile salmon are available for five sites in 1995 and four sites in 1997 (Carr and Whoriskey MS1997). The only repeated site indicated an increase in fry and parr densities but this site is proximate to a commercial hatchery. Fry densities were low (0-8.6 per 100 m^2), parr densities ranged from 0.1-55.0 per 100 m^2 and juvenile smallmouth bass were present (up to 12.0 fish per 100 m^2; mostly age-0^+) in all sites (Carr and Whoriskey *op. cit.*).

Outlook

Prospects for wild MSW returns in 1999 (and beyond) are poor, wild 1SW fish have diminished annually and the equation MSW=2.09(1SW)-121.19 (n=6; R^2_{adj}=0.83; p=0.019) from count data through 1997 suggests that wild MSW returns in 1999 will not exceed current levels. 1SW recruitment has been weak and estimated egg depositions 1994-1995 (above) supports the contention that recruitment in 1999 (and beyond) is unlikely to exceed

the two to three dozen returns in each of 1997 and 1998. Mean estimated egg deposition, 1994-1998, is 0.24 million or 21% of conservation requirements. If these depositions are indicative of those of the next few years, there is a zero probability (Bayes probabilities from the mean and standard deviation) of egg depositions being equal to or greater than the 1.35 million egg requirement.

Fisheries Management Considerations

Returns of wild salmon to the Magaguadavic River in 1998 continued a downward trend and numbered only 3 large and 28 small salmon. There is no chance that conservation requirements will be met on these rivers in 1999.

Introgression of the existing wild stock should be reduced by the continued removal of aquaculture fish from the escapement and by ensuring containment of juveniles within industry hatcheries in the drainage. Action plans to prevent extirpation of salmon stocks of these and other outer Bay of Fundy rivers are urgently required.

Estimated losses from potential fisheries to the 1999 egg deposition and probabilities of meeting conservation requirements for the Magaguadavic River are:

	Losses	Prob.
Directed salmon fisheries closed -	0%	0%
Recreational hook-and-release fishery only[a] -	1%	0%

[a] assumed catch rates of 0.2 and hook-and-release mortality of 5%.

St. Croix River

Fishery

In 1998 the fishery for salmon on the St. Croix River, as with all rivers tributary to the outer Bay of Fundy, was closed. There has not been an allocation of salmon from the St. Croix to Aboriginal peoples.

Status

Habitat

The St. Croix River is a USA/Canada international river bordering the State of Maine and Province of New Brunswick which drains southeasterly into Passamaquoddy Bay of the Bay of Fundy. Approximately 1,619 km^2 of the drainage basin is in New Brunswick and 2,616 km^2 is in Maine. Once a significant producer of Atlantic salmon, the river and stocks succumbed to industrial development - initially cotton mills and tanneries, then pulp mills, and now hydroelectric dams and headponds at Milltown, Woodland (inc. paper mill), Grand Falls, and water control structures at Canoose in New Brunswick and East Grand Lake and other sites in Maine, and at St. Croix and Forest City on the mainstem boundary waters.

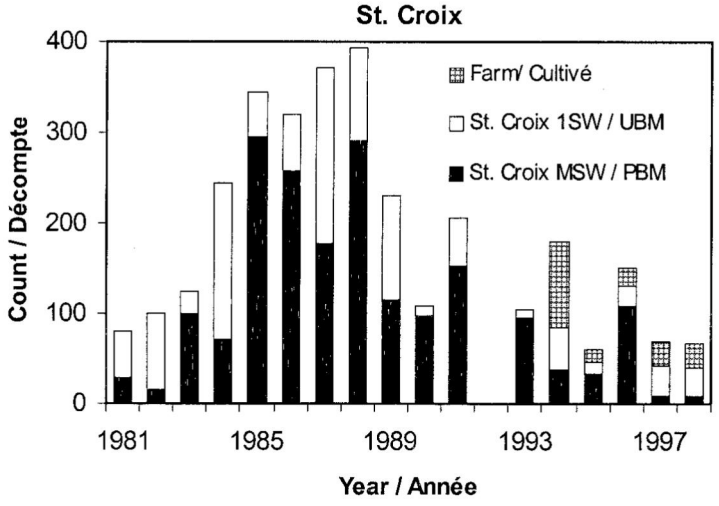
All dams have upstream fish passage facilities which allow access to the major salmon producing area of the East Branch, (Grand Falls to St. Croix) and Monument Brook boundary waters. Downstream passage facilities have been improvised but their effectiveness is largely unknown. Water quality is monitored by the International Joint Commission and has improved such that juvenile salmon have on occasion been found in the mainstem downstream of Woodland.

The St. Croix River is also proximate to the Canadian Fundy-Isles and US Cobscook Bay region salmon aquaculture industries (total production of about 32,000 t) and as such has attracted farm escapees, but in fewer numbers than the Magaguadavic River. Within the drainage there are State of Maine hatcheries rearing landlocked salmon but none rearing fish for the aquaculture industry. The river and lakes are home to significant populations of smallmouth bass and important associated fisheries.

Stock

The original St. Croix stock was extirpated and present-day wild and hatchery returning salmon are the result of rehabilitation efforts using fish of Penobscot and Saint John river origins (Anon MS1988). Conservation requirements for the habitat suitable for salmon production is currently 1,710 MSW and 680 1SW fish. Based on present stocking schedules, returns and escapements, salmon will not approach conservation requirements in the foreseeable future.

Counts of salmon at the Milltown fishway, just above head-of-tide, between May 1 and October 31, 1998 numbered 67 fish comprised of 9 wild and hatchery MSWs and 33 wild and hatchery 1SWs (L. Sochasky[2] pers. comm.), the lowest of recent record. External characteristics indicated that there were also 11 MSW and 14 1SW fish of aquaculture origins which were removed from the trap and submitted to disease analysis by the US Fish and Wildlife Service. Intentionally stocked fish contributed to 56% of non-aquaculture origin returns.



[2]L. Sochasky, St. Croix International Waterway Commission, #8-#1 Highway, St Stephen, NB E3L 2Y7.

Thirteen fish, mostly MSW and wild in appearance, were taken as broodstock but yielded only 39,000 eggs for hatchery incubation. Twenty-nine fish, mostly grilse (one-third females) may have spawned in the wild and yielded another 46,000 eggs. A total egg deposition of about 46,000 eggs is < 1.0% of requirements, the lowest in recent years.

Outlook

Mean numbers of wild and hatchery MSW and 1SW returns, 1994-1998, have been 40 and 30 fish, respectively. Neither recent levels of stocking nor natural spawning indicate that returns of each of 1SW and MSW fish in 1999 or for that matter 2,000, will number more than three or four dozen fish.

Fisheries Management Considerations

Unlike the Magaguadavic River, the St. Croix has probably never attained conservation requirements in the 20th century. To do so will require significantly more support than is currently available. The downward trend in returns since 1984 may in part reflect changing enhancement initiatives but is also consistent with the downward trend in wild stocks in Southwest New Brunswick. Hence, fishing mortality on returns needs to be minimized and fish of aquaculture origin removed. Action plans to prevent extirpation of salmon stocks of this, and based on limited surveys of smaller and near-by other outer Bay of Fundy rivers (Whoriskey[3] pers. comm.) are urgently required.

Estimated losses from potential fisheries to the 1999 egg deposition and probabilities of meeting conservation requirements for the St. Croix River are:

	Losses	Prob.
Directed salmon fisheries closed -	0%	0%
Recreational hook-and-release fishery only[a] -	1%	0%

[a] assumed catch rates of 0.2 and hook-and-release mortality of 5%.

Maritimes Overview

There is a clear geographic distinction in stock status of Atlantic salmon in the Maritime provinces. Trends in returns, escapements relative to conservation requirements, juvenile abundance, and measured sea survivals of hatchery-released smolts indicate that the stocks of the Bay of Fundy and Atlantic coast of Nova Scotia have declined to low levels with reduced recovery potential. Hatchery-origin fish have increased proportionally to wild salmon as the wild salmon abundance declines. The Atlantic coast of Nova Scotia has a diverse status. In the mainland rivers of this area, hatchery-origin salmon are expected to have important contributions to the returns. The rivers characterized by very low abundance have major habitat constraints mostly

[3] Dr. Fred Whoriskey, Atlantic Salmon Federation, PO Box 429, St. Andrews NB E0G 2X0.

resulting from low pH. The stocks in the rivers of the Bay of Fundy are all at low to very low abundance.

Many of the stocks of the southern Gulf of St. Lawrence have also declined in recent years but juvenile abundances are at medium to high levels and most of the rivers are near or above conservation. The rivers along the Northumberland Strait shore of New Brunswick are presently at low abundance. This latter group of rivers may in some instances have been overfished, or have a productive capacity lower than assumed for the general conservation criterion.

Chaleur Bay, northern New Brunswick (SFA 15). Small salmon in these rivers are predominantly male and contribute minimally to egg depositions. Returns in recent years have exceeded the requirements based on a 1:1 sex ratio in the escapement. Returns of large salmon in 1999 may equal the conservation requirement. Loss of eggs in the Restigouche River fisheries harvesting only small salmon would represent 2% or less of the potential egg depositions. Losses from large and small salmon directed fisheries would potentially be less than 10% but the probability of achieving conservation falls to 40%.

Miramichi and Southeast New Brunswick (SFA 16). With the exception of the Miramichi, small salmon are predominantly male (>90%) and contribute minimally to egg depositions. In the Miramichi, early-run small salmon have a higher female proportion than fall-run fish (<10%). Except for the Buctouche River, the small salmon requirement has generally been exceeded annually. Small salmon directed fisheries have not in previous years been a conservation concern because of the sufficient escapement levels of large salmon which contribute the majority of the egg depostions. But in 1998, the relative contribution to egg depositions by small salmon (before removals) in the Miramichi could have exceeded 25% because of the low abundance of large salmon. With the exception of the rivers of the Northumberland Strait of New Brunswick (Buctouche is the index river), egg depositions from returns are expected to equal or exceed conservation. In 1999, loss of eggs in the Miramichi River fisheries harvesting only small salmon could represent up to 8% of the potential egg depositions. Losses from large and small salmon directed fisheries would potentially be as high as 17% with the probability of achieving conservation falling to or just above 50%.

Prince Edward Island (SFA 17). Since the mid 1980s, the majority of returning salmon (95% in 1998, Table 2) have been of hatchery origin. Because of the high proportion of hatchery fish in returns, runs are largely independent of egg deposition in the river. Removals of small salmon by Aboriginal and recreational fishermen, and hook-and-release fisheries on small and large salmon, have little impact on future runs provided the stocking levels of recent years remain unchanged. The low numbers of natural spawned salmon returning to the Morell River continue to be exploited in the directed fisheries even though these could be distinguished from the stocked salmon on the basis of the presence of an adipose fin.

Northumberland Strait, mainland Nova Scotia (part of SFA 18). Small salmon in these rivers are predominantly male (95% or more). Returns and escapements in recent years have exceeded the requirements based on a 1:1 sex ratio in the escapement. Returns of small salmon in excess of conservation requirements are anticipated in 1999. Conservation requirements for large salmon are also expected to be achieved in 1999. The level of directed fisheries exploitation in recent years has not been of concern to conservation but estimated removals of salmon in illegal fisheries (480 fish in 1998) are high relative to the removals in the directed fisheries.

Cape Breton Island (part of SFA 18, SFA 19). Stocks of SFA 18 Cape Breton may all be surpassing conservation requirements. Exploitation levels both realized and potential have not been a conservation concern. Small salmon are predominantly male and generally are less abundant than large salmon. Returns in 1999 to the Margaree River are expected to be above conservation (99% chance). Directed fisheries on small and large salmon could remove 22% of the potential egg depositions with relatively little reduction in the probability of meeting conservation.

The status of stocks tributaries of the Bras d'Or Lakes (SFA 19) are generally not meeting conservation requirements. Small salmon are predominantly male and are less abundant than large salmon. Conservation requirements have generally not been met and expectations for 1999 are that returns will be below conservation. The Skye River is of particular concern because in 1998, 100 "grilse-sized" food fish were reported harvested proximate to the river and where in previous years a gillnet food fishery had been promulgated for "grilse" escapees from a former near-by salmon aquaculture site. Fishing mortality should probably not be increased on these stocks and in the case of the Skye River, should as a precaution be minimized.

Stocks of Atlantic coast rivers (SFA 19) exhibit, on average, lower parr densities than Gulf and Bras d'Or, even though North River has been exceeding conservation requirements. Juvenile densities for Sydney, Tillard and Inhabitants rivers suggests a group of Atlantic coast rivers whose status is no worse than those of Bras d'Or. With the exception of the Grand River, large salmon are dominant and small salmon are predominantly male. The returns to North River in 1999 should exceed conservation (99% chance) but full directed fisheries on small and large salmon could remove up to 15% of the potential eggs and reduce the probability of meeting conservation to 86%. Salmon from the Grand River are comprised primarily of small salmon with essentially all the large salmon being repeat-spawning 1SW fish. As a precaution it would be unwise to increase fishing mortality on Atlantic coast rivers without additional river-specific assessments.

Atlantic Coast of Nova Scotia (SFA 20 and 21). Egg depositions in these rivers are contributed equally by 1SW and 2SW salmon. 1SW salmon comprise about 70% of the numbers of fish and are about 60% female. Rivers of the southern uplands of Nova Scotia are generally susceptible to low pH events causing toxic conditions for salmon. Some of these rivers are also impacted by hydroelectric or impoundment for domestic water use. Status for all non-acidified rivers in SFAs 20 and 21, which are still capable of producing wild Atlantic salmon, is expected to be similar or worse than the index rivers.

Low acid-impacted rivers: Based on the average estimated return to St. Mary's River from 1994 to 1998, there is less than a 25% chance that returns in 1999 will exceed the operational conservation requirement. For the LaHave River, above Morgans Falls, there is a 75% chance that the returns in 1999 will exceed the operational conservation requirements. However, 42% of the forecast return would be derived from about 44,000 hatchery smolts migrating from above Morgans Falls in 1998. There is less than a 10% chance that returns in 1999 of wild grilse and wild salmon to Morgans Falls will be greater than operational conservation requirements. Returns of salmon to LaHave River above Morgans Falls have been below replacement since 1986. Based on the status and recent performance of the wild salmon stock above Morgans Falls on the LaHave River and estimates of returns to St. Mary's River, non- or low-acidified rivers that have not received substantial hatchery supplementation are not expected to achieve operational conservation requirements in 1999.

Partially Acidified Rivers: Returns to the Liscomb have shown an almost total loss of wild salmon and severe decline in the survival of stocked hatchery salmon. Hatchery supplementation as a mitigation technique for acidification is less effective in these rivers than when the stocking programs originally began. Conservation requirements are not expected to be met in 1999.

Acid-Impacted Rivers Dependent On Stocking: Some rivers can no longer support the production of salmon because of inadequate fish passage, flooding of habitat and acidification. The East River Sheet Harbour, Mersey River, Clyde River and Jordan River receive hatchery smolts placed below barriers and sometimes directly into salt or brackish water to provide adult returns for harvest. Because there is nearly no natural production possible in these rivers, there are currently no operational conservation requirements. All fish in excess of the broodstock requirements for these rivers may be exploited.

Inner Bay of Fundy (SFA 22 and part of SFA 23). Inner Bay of Fundy salmon are unique among Atlantic salmon. Marine distribution of these salmon has for the most part been observed in the Bay of Fundy and Gulf of Maine areas. No quantitative or qualitative observations indicate that theses stocks increased in 1998. Electrofishing for juvenile salmon at 37 sites in the Stewiacke River and at a total of ten locations in six other rivers of the inner Bay of Fundy, indicates that there are few Atlantic salmon of any age in rivers of the inner Bay of Fundy in 1998. Inner Bay of Fundy salmon populations are critically low and measures to defer their extirpation began in 1998 with the collection of wild parr from the Stewiacke and Big Salmon rivers for rearing through to maturity.

Salmon of the Gaspereau River, unlike other inner Bay of Fundy rivers, migrate to the Northwest Atlantic and have followed a recruitment and life history pattern similar to other Atlantic coast rivers. Only 56% of the required spawning escapement was attained in 1998.

Outer Bay of Fundy (western part of SFA 23) Stocks in this area have generally not been meeting conservation requirements during the last decade and have

been closed to recreational retention fisheries for 1SW salmon since September 15, 1993. There were virtually no salmon fisheries in 1995 and none in 1998. Inseason assessments at Mactaquac have been used as and largely observed to be an index of stock status throughout Southwest New Brunswick.

In the Saint John River upriver of Mactaquac, generally 80% of MSW salmon are female while in the 1SW fish, a high proportion are male (90% in 1998). Since 1985, egg depositions have been trending downwards and there is essentially a zero probability that total returns in 1999 will meet egg conservation requirements. There is a 56% chance of attaining the 4,900 1SW salmon requirement. Stable but "low" densities of "wild" juveniles and a consistent supplementation with juveniles surplus to the 1-year smolt program at Mactaquac are not suggestive of increases in future returns unless there is an increase in survival in the smolt, post-smolt or maturing adult stages. Hence, fishing mortality should be minimized prior to in-season assessments in late-July of 1999.

In tributaries of the Saint John downriver of Mactaquac, there is an important female component in the small salmon size group. In the Nashwaak River, small salmon contributed 54% of the estimated egg deposition as a result of the low large salmon abundance and the high percentage females (about 51%) among small salmon. In the Hammond and Kennebecasis rivers, the proportion female in the small salmon component has been greater than 25% in the recent years' sampling. For the Nashwaak, River, there is a near-zero probability that small or large returns will meet conservation requirements in 1999. Recent consistency between low stock levels at Mactaquac and the Nashwaak suggest that the in-season assessment at Mactaquac in late-July could also be an index of status for the Nashwaak River.

Other outer Bay of Fundy rivers which have been assessed include the Magaguadavic River in which wild stocks have made dramatic declines in the last decade, and St. Croix River in which salmon have been introduced in modest numbers following extirpation nearly a century ago. Both rivers are proximate to and heavily impacted by the Fundy-Isles (Canada) and Cobscook Bay (USA) salmon aquaculture industries which together have an annual production of about 30,000 t. Prospects for wild MSW returns to both rivers in 1999 (and beyond) are poor and will not exceed the few dozen fish now returning to each. 1SW recruitment has also been poor and returns in 1999 and beyond are also unlikely to exceed the two to three dozen fish observed in each of 1997 and 1998. There is a near-zero probability of meeting the conservation requirements in the Magaguadavic River and at the present level of development, a zero probability of ever meeting requirements on the St. Croix River. Thus fishing mortality on wild (both rivers) and hatchery (St. Croix only) returns should be minimized. The potential for introgression of the existing "wild" stocks on each river should be reduced by the continuation of removals of aquaculture fish from the escapement. On the Magaguadavic River, the potential for introgression can further be reduced by ensuring "containment" of non-Magaguadavic River juveniles within industry hatcheries located in the drainage.

Acknowledgments

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Table 1. Fisheries removals of Atlantic salmon from rivers of the Maritimes, 1994 to 1998. Removals refers to losses to spawning resulting from the fishing activity. For the recreational fisheries, the removals include losses estimated to have occurred as a result of hook and release induced mortality. 1998 data are provisional.

			Aboriginal Fisheries Removals[1]										Recreational Fisheries Removals[2]									
			Small Salmon					Large Salmon					Small Salmon					Large Salmon				
River	SFA	Index	'94	'95	'96	'97	'98	'94	'95	'96	'97	'98	'94	'95	'96	'97	'98	'94	'95	'96	'97	'98
Restigouche System[3]	15	1&2	58	21	77	26	26	380	202	213	166	234	4869	1620	3475	3125	2959	1308	1164	1361	953	528
Matapédia	15	1	0	0	0	0	0	0	0	0	0	0	822	337	721	450	654	917	829	922	691	442
Restigouche-NB	15	2	29	21	77	26	26	32	24	37	11	37	4047	1283	2754	2675	2305	391	333	439	262	86
Jacquet	15	3	na	na	na	na	na	na	na	na	na	na	33	61	67	67	-	3	0	2	2	-
Nepisiguit	15	4	120	131	84	85		0	44	28	0		380	350	450	200	-	8	9	13	9	-
Tabusintac	16	5	30	106	171	-	18	44	42	187	-	18	197	33	-	74	-	9	1	-	2	-
Miramichi	16	6&7	2977	3004	2583	1197	1180	124	185	372	548	214	11203	5533	-	8311	-	154	94	-	152	-
NW Miramichi	16	6	2921	1795	1504	871	782	81	172	317	548	195	4131	1705	-	3153	-	56	19	-	46	-
SW Miramichi	16	7	0	1170	1074	326	378	0	13	0	0	0	7072	3828	-	5158	-	98	76	-	106	-
Buctouche	16	8	11	15	25	25	Closed	12	0	4	5	Closed	7	33	21	5	Closed	1	0	1	0	Closed
Morell	17	9	0	19	17	1	28	0	1	0	0	0	89	449	397	230	-	0	0	0	0	0
River Philip	18	10	9	29	2	0	0	15	37	45	21	7	61	105	165	43	80	9	12	33	5	10
Wallace	18	11		2					6				11	16	20	13	33	3	1	4	5	3
French, (Col.)	18	12												1	1		2			1		
Waugh	18	13											7	14	24	8	25	2	2	7	1	3
River John	18	14	0	3			0	17	5			18	12	10	22	25	29	2	1	6	3	2
West (Pictou)	18	15	0	0			0	8	3			12	4	26	57	5	35	1	2	10	1	6
East (Pictou)	18	16	5	2	11	0	3	141	28	49	40	15	14	22	34	23	27	4	2	14	3	7
Sutherlands	18	17	2			0	0	10			14	14		1								
French (Pictou)	18	18	2			0	0	10			13	13			1	3						

[1] - na means no allocation to aboriginal fisheries for this river, - means no agreement was signed but removals occurred.

[2] - for recreational fisheries, - means no data were available

[3] - for Restigouche System, Aboriginal fisheries removals exclude removals by the Listiguij First Nation in the estuary because these data are not available

Table 1 (continued). Fisheries removals of Atlantic salmon from rivers of the Maritimes, 1994 to 1998. Removals refers to losses to spawning resulting from the fishing activity. For the recreational fisheries, the removals include losses estimated to have occurred as a result of hook and release induced mortality. 1998 data are provisional.

			Aboriginal Fisheries Removals[1]										Recreational Fisheries Removals[2]									
			Small Salmon					Large Salmon					Small Salmon					Large Salmon				
River	SFA	Index	'94	'95	'96	'97	'98	'94	'95	'96	'97	'98	'94	'95	'96	'97	'98	'94	'95	'96	'97	'98
Barney's	18	19	2			0	0	10			13	13		1	10							
West (Ant.)	18	20											29	50	109	21	67	6	7	24	5	10
South	18	21											4	1	10	1	2	1		1		
Margaree	18	22	14	2	7	20	30	50	4	89	124	120	298	206	306	204	218	95	70	139	121	73
Middle	19	23	7	1	4	3	na	67	7	16	15	na	1	2	5	4	10	8	3	7	4	4
Baddeck	19	24	9	2	2	5	na	50	5	7	13	na	2	10	2	1	2	3	4	8	3	3
North	19	25	na	0	1	0	0	na	0	2	0	0	4	9	9	4	4	5	10	6	7	4
Grand	19	26	na	na	na	na	na	na	na	na	na	na	4	-	5	4	2	1	1	1	1	1
St. Mary's	20	27											21	421	60	8	Closed	3	13	18	3	Closed
Liscomb	20	28	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed
West Sheet Har.	20	29	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed
LaHave	21	30	0	81	220	58	0	0	0	0	0	0	138	565	1131	377	Closed	12	24	33	17	Closed
Mersey	21	31																				
Jordan	21	32																				
Clyde	21	33																				
Stewiacke	22	34	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed
Gaspereau	22	35	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed
Big Salmon	23	36	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed
Mactaquac	23	37	250	50	675	361	Closed	90	25	285	265	Closed	27	Closed	50	24	Closed	18	Closed	25	15	Closed
Nashwaak	23	38	40					30		-	-	Closed	3	Closed	14	5	Closed	3	Closed	5	3	Closed
Magaguadavic	23	39	na	na	na	na	na	na	na	na	na	na	<1	Closed	<1	<1	Closed	<1	Closed	1	<1	Closed
St. Croix	23	40	na	na	na	na	na	na	na	na	na	na	<1	Closed	<1	<1	Closed	<1	Closed	<1	<1	Closed

[1] na means no allocation to aboriginal fisheries for this river, - means no agreement was signed but removals occurred.

[2] for recreational fisheries, - means no data were available

Table 2. Summary of stock status of Atlantic salmon in the Maritimes Region.

River	SFA	Method	Map Index	Returns in 1998 Small	Returns in 1998 Large	% hatchery origin	Conservation met 1998	Conservation met 84 to 98	Abundance Juveniles	Abundance Adults Wild	Abundance Adults Hatchery	Status in 1998 rel. to 1997	Status in 1998 1984 to 1997	Constraints
Restigouche System	15	Ang	1&2	10,500	7,100	< 1%	No	5 of 15 ⇧		⇔		🡻	🡻	
Matapédia	15	Vi	1	1,473	2,084	0%	Yes	4 of 15 ⇧		⇧				
RestigoucheNB	15	Ang	2	9,000	5,000	< 1%	No	5 of 15 ⇧	Med ⇧	Med ⇔		🡻	🡻	
Jacquet	15	Fe	3	402	298	0%	No	2 of 5 🡻		🡻		🡻	🡻	
Nepisiguit	15	Ang	4				No	2 of 15 🡻	Med ⇧	Med	Low 🡻			
Tabusintac	16	MR	5	1,740	1,260	0%	Yes	4 of 4						
Miramichi	16	MR	6&7	33,000	9,500	< 1%	No	11 of 15 ⇔	High ⇧	Med ⇔	Low ⇔	🡻	🡻	
NW Miramichi	16	MR	6	7,900	2,200	< 1%	No	6 of 7 ⇔	High ⇧	Med 🡻	Low ⇔	🡻	🡻	
SW Miramichi	16	MR	7	24,000	7,000	< 1%	No	5 of 7 🡻	High ⇧	Med. 🡻	Low ⇔	🡻	🡻	
Buctouche	16	MR	8	120	102	0%	No	0 of 6 ⇔	Low	Low		🡻	🡻	
Morell	17		9			95%	?	9 of 14	Low ⇔					LU
River Philip	18	ViM	10	153	350	0%	No	5 of 7 ⇔	Med ⇔	High ⇔		🡻	🡻	
Wallace River	18	CR	11	58	103	0%	No					🡻		
Waugh	18	CR	13	61	93	0%	No					⇧		
River John	18	CR	14	87	74	0%	No					🡻		

Assessment methods: Ang = angling catches and assumed exploitation rates; CR = catch rate index; Fe = counting fence; Fw = fishway; MR = mark and recapture experiment; Sh = shore count; Vi = snorkel count; ViM = snorkel count and mark/recapture calibration

Map index numbers refer to text Figure in Introduction.

Trend symbols (over recent ten years maximum): 🡻 = decline; ⇔ = no change; ⇧ = increase

Constraints: Ac = acid impacted rivers; AQ = aquaculutre escapees; Fp = fish passage constraints; LU = land use practices; WU = water use practices

Table 2 (continued). Summary of stock status of Atlantic salmon in the Maritimes Region.

River	SFA	Method	Map Index	Returns in 1998 Small	Returns in 1998 Large	% hatchery origin	Conservation met 1998	Conservation met 84 to 98	Abundance Juveniles	Abundance Adults Wild	Abundance Adults Hatchery	Status in 1998 rel. to 1997	Status in 1998 1984 to 1997	Constraints
West (Pictou)	18	CR	15	61	201	0%	Yes					⇧		
East (Pictou)	18	CR	16	84	263	0%	No	4 of 7⇔	Med⇔	High⇔		🡻	🡻	
Sutherlands	18	Vi	17	20	40	0%	Yes	4 of 4		High⇔		🡻		
West (Ant.)	18	CR	20	206	344	0%	No	3 of 7⇔	High ⇧	High⇔		🡻	⇔	
Margaree	18	Ang	22	774	3260	5%?	Yes	14 of 14	High ⇔	High ⇔	Low ⇔	🡻	⇔	
Middle	19	ViM	23	70	143	0%	No	2 of 10	High ⇔	Low 🡻	na	🡻	🡻	
Baddeck	19	ViM	24	51	139	0%	No	0 of 5	High ⇔	Low ⇔	na	🡻	🡻	
North	19	ViM	25	74	359	0%	Yes	14 of 14	Med ⇔	Low 🡻	na	🡻	🡻	
Grand	19	Fw	26	233	17	72%	Yes	7 of 11	Low ⇔	Low 🡻	Med 🡻	⇧	🡻	Fp,
St. Mary's	20	MR	27	1,990	100	0%	No	9 of 15(Ang)	Med ⇔	Low 🡻	Low 🡻	⇧	🡻	
Liscomb	20	Fw	28	45	1	80%	?	?	Low ⇔	Low 🡻	Low 🡻	🡻	🡻	Ac, Fp
LaHave	21	Fw	30	1,669	211	26 %	No	10 of 15 🡻	Med ⇧	Med 🡻		⇧	🡻	
Mersey	21		31											
Jordan	21		32											
Clyde	21		33											

Assessment methods: Ang = angling catches and assumed exploitation rates; CR = catch rate index; Fe = counting fence; Fw = fishway; MR = mark and recapture experiment; Sh = shore count; Vi = snorkel count; ViM = snorkel count and mark/recapture calibration

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Table 2 (continued). Summary of stock status of Atlantic salmon in the Maritimes Region.

River	SFA	Method	Map Index	Returns in 1998 Small	Returns in 1998 Large	% hatchery origin	Conservation met 1998	Conservation met 84 to 98	Abundance Juveniles	Abundance Adults Wild	Abundance Adults Hatchery	Status in 1998 rel. to 1997	Status in 1998 1984 to 1997	Constraints
Stewiacke	22	Electro	34	?	?	?	No	?	Low ⬇	Low ⬇	Low ⬇	⬇	⬇	
Gaspereau	22	Fw	35	74	21	75%	No	?	?	Low?	Low?	?	?	WU
Big Salmon	23	Sh+Vi	36	?	?	?	No		Low?	Low?		⬇	⬇	
Mactaquac	23	Fw	37	4950	1000	87%	No	2 of 15 ⬇	Low ⇔	Low ⬇	High ⇧	⬇	⬇	Fp, AQ, LU, WU
Nashwaak	23	Fe/MR	38	1250	315	< 5%	No	0 of 6 ⇔	Low ⇔	Low ⇔	Low ⇔	⇧	⇔	AQ, LU, WU
Magaguadavic	23	Fw	39	28	3	0%	No	3 of 10 ⬇	na	Low ⬇	na	⬇	⬇	Fp, AQ, WU
St. Croix	23	Fw	40	29	10	58%	No	0 of 14 ⬇	na	Low ⬇	Med ⇔	⇔	⬇	Fp, AQ, WU

Assessment methods: Ang = angling catches and assumed exploitation rates; CR = catch rate index; Fe = counting fence; Fw = fishway; MR = mark and recapture experiment; Sh = shore count; Vi = snorkel count; ViM = snorkel count and mark/recapture calibration

Map index numbers refer to textFigure in "Introduction".

Trend symbols (over recent ten years maximum): ⬇ = decline; ⇔ = no change; ⇧ = increase

Constraints: Ac = acid impacted rivers; AQ = aquaculutre escapees; Fp = fish passage constraints; LU = land use practices; WU = water use practices