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Stock Status of Atlantic Salmon (*Salmo salar* L.) on the Eastern Shore of Nova Scotia, Salmon Fishing Area 20, in 1997

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Abstract

Atlantic salmon returns, fishing activity and general stock status for rivers located on the Eastern Shore of Nova Scotia, Salmon Fishing Area (SFA) 20, are described. Anglers were not permitted to harvest fish in any river except for East River, Sheet Harbour. The other rivers were limited to hook-and-release angling. Angling catches were the lowest reported since detailed record keeping began in 1951. No First Nation catches were reported in the area in 1997. Estimated effort by anglers was also only a fraction of recent year values.

Rivers on the Eastern Shore of Nova Scotia can generally be divided into two categories, acid-stressed and non-acid-stressed. Water chemistry indicated that several streams have limited capacity to support Atlantic salmon populations. Only six of the twenty-six rivers in the area which were known to support runs of salmon are not seriously affected by the acidic precipitation. Salmon returns to the acid-stressed rivers have been declining. Returns of wild fish to the acidic Liscomb River in 1997 were the lowest since the fishway began operating in 1979. Juvenile salmon were found to be absent from most sites visited on the river in 1997. Similarly, young salmon were absent or numbers were very low on most sites on the acidified West River, Sheet Harbour. Greater numbers of parr were found on sites which had been treated with limestone gravel by the local river association.

The three principle non-acid rivers in the area, the Musquodoboit; St. Mary's; and Salmon River, Guysborough; account for the majority of the angler effort and catch. Juvenile salmon densities on those streams in 1997 were comparable to densities observed in the 1980s.

Estimates of spawning escapement to the St.Mary's River were 1,000 fish; returns to the Salmon River, Guysborough, were either 215 or 545 fish depending on the data sets used. All estimates were below requirements.

The number of large and small salmon returns to the non-acid impacted rivers of SFA 20 did not meet conservation levels in 1997 and are not expected to in 1998. Returns to the acid-stressed rivers were below requirements in 1997 and are expected to remain low for the foreseeable future. Some stocks in the area are in serious danger of extirpation.

Résumé

Les remontées du saumon de l'Atlantique, l'activité de pêche et l'état général des stocks de saumon de l'Atlantique de rivières de la côte est de la Nouvelle-Écosse situées dans la zone de pêche du saumon 20 sont décrites. Les pêcheurs à la ligne n'étaient autorisés à récolter des poissons que dans la rivière East, Sheet Harbour. La pêche dans les autres rivières était limitée à celle par capture et remise à l'eau. Les captures ont été les plus faibles signalées depuis que l'on tient des registres détaillés, en 1951. Aucune prise par les Premières nations n'a été signalée pour cette zone en 1997. L'effort de pêche estimé des pêcheurs à la ligne ne correspondait qu'à une fraction de celui des années antérieures.

Les rivières de la côte est de la Nouvelle-Écosse peuvent être généralement réparties en deux grandes catégories : celles qui subissent un stress acide et celles qui n'en subissent pas. La chimie de l'eau a montré que la capacité de plusieurs cours d'eau à permettre la vie de populations de saumon était limitée. Seulement six des vingt-six rivières de la zone où il y a des remontées de saumon ne sont pas sérieusement affectées par les précipitations acides. Les remontées des rivières subissant un stress par l'acidité étaient à la baisse. Les remontées de poissons sauvages en 1997 dans la rivière acidifiée Liscomb ont été les plus faibles notées depuis le début du fonctionnement de la passe à poissons, en 1979. Les saumons juvéniles étaient absents de la plupart des sites de la rivière visités en 1997. De façon semblable, les jeunes saumons étaient absents ou en nombres très faibles dans la plupart des sites de la rivière acidifiée West, Sheet Harbour. Des quantités plus élevées de tacons ont été décelées aux sites qui avaient fait l'objet d'un traitement au gravier calcaire par l'association riveraine locale.

La plus grande partie de l'effort de pêche et des captures des pêcheurs à la ligne est concentrée dans les trois principales rivières non acidifiées de la zone : la Musquodoboit, la St. Mary's et la Salmon, Guysborough. Les densités de juvéniles dans ces cours d'eau en 1997 étaient semblables à celles notées au cours des années 1980.

L'échappée de géniteurs de la St. Mary's a été estimée à 1 000 poissons et les remontées dans la Salmon, Guysborough, à 215 ou 545, tout dépendant des ensembles de données utilisés. Toutes les valeurs estimées étaient en deçà des besoins.

Le nombre de grands et de petits saumons qui sont revenus aux rivières non affectées par l'acidité de la zone de pêche du saumon 20 en 1997 était inférieur aux besoins de conservation et la situation devrait s'être maintenue en 1998. Les remontées des rivières acidifiées étaient aussi inférieures aux besoins en 1997 et devraient demeurer faibles dans un avenir prévisible. Il existe un sérieux danger de disparition pour certains stocks de la zone.

Introduction

Atlantic salmon stocks in the Maritimes Region have been generally divided into areas which contain stocks which are believed to be similar or are at least subject to similar marine and freshwater environments during their life cycle. Salmon Fishing Area 20 (SFA 20) is located on the eastern shore of Nova Scotia and includes the rivers which discharge into the Atlantic Ocean between Halifax Harbour and the Strait of Canso (Fig. 1). Although the area includes 29 rivers which have been fished by angling for Atlantic salmon, fewer than 20 have been fished in recent years.

Atlantic salmon stock status is provided for several rivers on the Eastern Shore, SFA 20, in this document, with special emphasis on the St. Mary's River.

Many of the rivers in SFA 20 are acid-stressed (Table 1). Watt (1986) classified the rivers of the southern uplands of Nova Scotia, which includes rivers of SFA 20, according to their acidity (Table 1). LaCroix (1989) and Watt (1986), among others, have related the capability of streams to support Atlantic salmon to the acidity of the water as measured by pH. In SFA 20, seven rivers have levels of pH in the range of 4.7 to 5.0 during the autumn to spring period of the year when Atlantic salmon juveniles are most vulnerable to the acidity (Daye and Garside 1977; Daye and Garside 1979). Four rivers in the area, Cole Harbour; Larry's; Lawrencetown Lake; and Salmon, Halifax County, have pH levels which render them unsuitable for Atlantic salmon production (Table 1). Only five rivers on the Eastern Shore of Nova Scotia have sufficient buffering capacity to protect them from the impact of acid rain and the pHs of those rivers remain above pH 5.5. Those rivers are Country Harbour; Guysborough (Milford Haven); Moser; Musquodoboit; Salmon, Guysborough; and St. Mary's (Table 1).

Description of fisheries and fisheries data

First Nation and recreational fisheries have been the only fisheries for salmon in Salmon Fishing Area 20 since the commercial fishery was closed after the 1984 season. Recent changes in regulations have limited what was once a relatively unlimited recreational fishery to one where individual anglers must release all salmon $\geq$ 63 cm. in length and have season and daily catch limits of 8 and 2 fish, respectively. In SFA 20 in 1997, rivers were open for hook-and-release angling only with the exception of East River, Sheet Harbour, where a grilse harvest was permitted. The Native Council of Nova Scotia is signatory to a fishing plan which permits the band to issue grilse harvest tags; Millbrook First Nation has a 50-grilse quota in its fishing plan for East River, Sheet Harbour, and Indian Brook First Nation, a 100-grilse quota for the Musquodoboit River.

Sport catch in 1997 for SFA 20 was the lowest since detailed record keeping began in 1951 (Table 2; O'Neil and Swetnam 1991). The 1997 catch of 262 grilse released, 2 grilse retained, and 107 large salmon released for a total of 371 fish was 25% of the 1996 catch of 1,479 salmon and grilse and 25% of the 1992-96 mean catch for SFA 20 of 1,513 fish (Table 2).

First Nations did not harvest any fish in SFA 20 in 1997.

Angler effort in 1997, approximately 2,100 rod-days, was a fraction of the time spent fishing by anglers during the previous five years; 1992-96 mean annual effort was 10,699 rod-days. In 1996 the effort estimate (2,684 rod-days) was low relative to any previous year in recent time but the effort value was considerably higher than that noted in 1997 (Table 2). Low angler effort was caused in part by the mandatory hook-and-release regulation in effect in 1997, but the general low abundance of fish was perhaps more responsible than any other single factor for anglers staying home. Fisheries and Oceans fisheries officers noted in 1995 and 1996 (B. Gillis and J. Julian[1], pers. comm) that in areas open only for

[1] B. Gillis and Jerry Julian, Fisheries and Oceans, Sherbrooke, Nova Scotia.

hook-and-releasing some anglers were fishing salmon, while not licensed, under the guise of fishing for trout. Although effort levels were extremely low in 1997, those same officers did not note the same degree of delinquency among anglers with regards to fishing without a salmon license.

East River, Sheet Harbour

East River, Sheet Harbour, has been largely inaccessible to anadromous fishes since the early 1920s because of a series of water storage and hydroelectric dams (Fig. 2). Ninety-five percent of the habitat in the system is above an impassable hydroelectric dam located at Malay Falls.

A five-year management plan for anadromous fisheries resources of the river was implemented in 1994 and is described in O'Neil *et al.* (1997a). Components of the plan include treating (by the addition of limestone to a headwater lake) the acidic water in the system which is near pH 4.9 in much of the watershed (Table 3), trapping and trucking returning adult salmon above the uppermost impassable dam in the system at Marshall Falls, and stocking juvenile salmon as parr and smolts (Table 4). The resource management plan involved Millbrook First Nation, Eastern Shore Wildlife Association, Nova Scotia Power Inc., and Fisheries and Oceans (DFO). The plan objective is to maintain and if possible enhance the anadromous resources until 1998 after which Nova Scotia Power Inc. will consider construction of fish passage around the Malay Falls and Marshall Falls dams.

In 1996 and 1997 anglers could harvest fish in the lower 4 km of river prior to removals for broodstock or food. Fish could also be harvested from elsewhere within the watershed as a result of the release of fish trucked upriver from the trap at the Ruth Falls Dam. This was a departure from 1994 and 1995 when harvest was not allowed on the system. The destiny of fish captured at the Ruth Falls trap was either (1) removed for broodstock; (2) taken for food; (3) trucked to Fifteen Mile Stream and released; or (4) released above Ruth Falls to ascend the river to Grant River or Malay Falls (free swim; Table 4). Millbrook First Nation operated the trap under DFO supervision and with financial support from Nova Scotia Power Inc.

In 1997, only 20 fish were captured at the trap and 2 fish were angled downstream of the structure. In 1996, 163 fish were counted at Ruth Falls with an additional 33 fish removed by anglers. This extremely low return rate is consistent with the low rates noted on other Atlantic coast rivers of the Maritime Provinces in 1997. Only 14 hatchery fish returned in 1997 from 18,700 smolts stocked in 1996 (Table 4),

No conservation requirement has been prepared for East River, Sheet Harbour, because the salmon resource in the river was destroyed by the construction of dams for hydroelectric power production over 70 years ago. The Fisheries and Oceans management plan in place for the river was unique among eastern shore rivers and a harvest of grilse was allowed throughout the system in 1996 and 1997. A total of 25,740 hatchery smolts was released into the river in 1997 (Tables 4 and 5). The current management regime recognizes that the river has been 100% dependent on stocking from the federal fish hatcheries. The five-year plan committed to by DFO in 1993 (to begin in 1994) included the stocking of approximately 20,000 to 25,000 smolts per year by DFO for at least a five-year period.

Liscomb River

The Liscomb River drains an area of 400 km^2 and has been the site of an Atlantic salmon development project since 1977. Since 1979, a fish trap has been operated in the fishway at Liscomb Falls. The river is acid-stressed (Tables 1 and 3) and contains some tributaries which can not support Atlantic salmon (pH<4.7).

Conservation requirements

The egg and adult requirements for the Liscomb River have been described by O'Neil *et al.* (1997b; Table 6). Liscomb River is acid-stressed (Tables 2 and 3) and is unlikely to produce sufficient spawners to meet the conservation requirement at a level equivalent to the orthophoto area (1,685,600 m^2) seeded at 2.4 eggs/ m^2. Options for management were presented in O'Neil *et al.* (1997b) but no decision has been made specific to the harvesting of fish in acidic waters or for revisions to conservation requirements.

Research data

Prior to 1997, juvenile salmon numbers had not been monitored in the Liscomb River since before the fishway was constructed in the late 1970s. At that time, salmon juveniles were reported present below Liscomb Falls, but densities were relatively low; juvenile densities based on electrofishing at two sites in 1997 were also very low:

Source (main river sites)	Fry (0+ parr) per 100 m^2	Total parr (1+ and 2+) per 100 m^2
Gray (1976): below falls	0.44	2.23
1997 survey results: above falls	0.0	hatchery: 9.3; wild: 0.5
below falls	0.1	0.8

Several other sites were spot checked (5 minutes of electrofishing or more) for juveniles in 1997 and none were found on Little Liscomb River, on the main river at Slate Brook Road at a site just above the fishway, or on Big Brook.

Estimation of stock parameters

The number of fish (84) which returned to the Liscomb River in 1997 was the lowest since the fishway trap began operating in 1979 (Table 7a). The return rate for hatchery one-sea-winter fish, 0.17%, was also the lowest of the time series (Table 7b). Large salmon returns have become so few that calculating a return rate is almost meaningless. Nevertheless, the 1997 return rate of 0.03% was above the 1996 rate of 0.02% and approximated the 1992-96 (return years) mean return rate of 0.038% (Fig. 3).

Counts of hatchery and wild fish at the Liscomb Falls fishway were reconstructed to returns by adding the number of fish removed by anglers which were proportioned into hatchery and wild according to proportions at the fishway (Table 7a). Hook-and-release mortality was assumed to be 5%. The Liscomb River wild large salmon returns were significantly correlated with the previous year wild grilse returns ($p=0.005$; adj. $R^2=0.712$; $n=8$). The regression equation is:

$$\text{Liscomb wild MSW returns}_{(i+1)} = 3.76 + 0.0396 \times \text{Liscomb wild 1SW returns}_{(i)}$$

The regression was limited to the 1989 to 1996 period (one-sea-winter salmon years), which appear to be influenced by the same survival effects, to improve the forecast capability of the model (Fig. 4).

Assessment results

In 1997 the number of one-sea-winter and multi-sea-winter salmon which returned to the Liscomb River was only a small fraction of the number needed to meet the non-acid-impacted (nominal) spawning requirement of 4.0×10^6 eggs (Table 6). Total eggs contributed to the river from returns would have been 155,886 eggs (this number includes the eggs from the 32 fish removed for broodstock), or 3.8% of the non-acid-impacted spawning requirement.

Although the number of fish which returned to the Liscomb River in 1997 was the lowest on record, the size of one-sea-winter fish which emigrated as 2- or 3-year old smolts was significantly larger in 1997 (t-test; $p<0.01$) for both hatchery and wild than fish processed at the trap between 1979 and 1985.

	Scale-aged 1SW fish (fresh water age 2 or 3)					
	Wild			Hatchery		
Source	n	Mean	S.D.	n	Mean	S.D.
1979-85[2]	405	52.8	0.5	546	52.2	0.7
1997	20	55.0	3.13	29	55.1	2.73

The low hatchery return rates are a continuation of a relatively short-term trend which began in the early 1990s (Table 7b). Coincident with the lower return rates, which were reported at the other monitoring stations along the Atlantic coast, on the St. John River , N.B., the LaHave River, and elsewhere (Anon 1997), the temperature of the North West Atlantic Ocean, particularly near the south Labrador Sea, was becoming cooler (Drinkwater *et al.* 1997). Regardless of the exact cause of the lower returns, they are a reflection of the lower marine survival of Atlantic salmon since the 1990s began.

Forecast

The regression relationship between the wild multi-sea-winter salmon in one year and wild one-sea-winter salmon the previous year for the Liscomb River counted at the fishway can be used to forecast a return of 5 MSW fish (95% C.I. 0-28) to the river in 1998. Although this number is low, recent low returns and particularly low numbers of 1SW fish in 1997 contribute to expectations of low numbers of large salmon spawners in 1998, in spite of improvements in the marine habitat index (sea conditions believed to be affecting salmon survival, D. Reddin[3], pers. comm.).

Musquodoboit River

The Musquodoboit River is one of the few non-acidic rivers in SFA 20. The watershed, which is approximately 95 km long from headwaters to river mouth, drains an area underlain by limestone deposits so has some protection from the impacts of acidic precipitation. A map of the drainage and a more detailed description of the system is provided in O'Neil *et al.* (1997b).

Conservation requirements

The number of eggs required to seed the habitat, at 2.4 eggs per m^2, is 1.9 million. The habitat of the Musquodoboit River, exclusive of areas which are less than 0.12% grade, has been measured from orthophotos to be 791,900 m^2. A summary of the biological characteristics and source of data for the stock was provided in O'Neil *et al.* (1997b), but an additional 19 fish were sampled in 1997, so the summary data were revised accordingly:

[2] Semple and Cameron 1990.

[3] D. Reddin, Fisheries and Oceans, Science Branch, St. John's, Newfoundland.

Eggs per female of mean fork length	Proportion female	Proportion in run[4]	Egg deposition per fish
1SW: 58.2 cm =3,672	0.077	0.591	167
2SW: 74.9 cm =6,720	0.722	0.409	1,984
Average eggs per fish			2,151
Fecundity[5]	Eggs = $446.54e^{0.0362FL}$	Total samples = 88	

The number of salmon and grilse required to meet the conservation requirement is 362 and 522, respectively, as follows:

Habitat area =	791,900 m^2	
Conservation eggs =	2.4 eggs per square meter	
Total eggs required =	2.4 x 791,900 =	1,900,560 eggs
Average eggs per adult fish =	2,151	
Number of fish required =	1,900,560/2,151 =	884 fish
Proportion of 1SW fish in run	0.591	
Required number of grilse and large salmon	Grilse: 522 (7.8% of eggs)	Large salmon: 362 (92.2% of eggs)

Estimation of stock parameters

In 1996, a mark-and-recapture program took place on the Musquodoboit River which relied on anglers to apply caudal fin tail punches (holes punched with paper hole punches) to fish which were caught. DFO staff subsequently (near spawning in late October) sampled fish during broodstock collections and examined captured fish for marks. The resulting data were used to generate a population estimate. A similar program was attempted in 1997; a select group of anglers, working in cooperation with the Musquodoboit River Association and DFO fisheries officers, agreed to apply marks to angled fish to assist in the population estimate. Although a number of fish were marked, only a single marked fish was recovered among the 19 fish sampled in October. Fish on the Musquodoboit River are among the earliest spawning of those sampled around the province (T. Goff[6], pers. comm.). They typically spawn the week of Oct. 20. On October 21, 1997, fish were not present in the spawning areas where they have been seined on numerous occasions in the past. The low water in 1997, which persisted well into October, probably prevented fish from accessing spawning grounds until early November. Some fish (10 grilse and 4 salmon) were sampled on October 21 in a pool several kilometers down river from our usual sampling site. A subsequent trip to the river on November 4 yielded an additional five samples; few relative to previous experiences.

A regression of large salmon on grilse the previous year, using sport catch data for the Musquodoboit River, 1983-97, was not significant (p=0.145). Stocking of 1-year and 2-year old hatchery smolts was known to have an effect on returns of 1SW salmon the next year and, hence, 1SW sport catch. The linear regression did not take into account the impact smolt stocking would have on returns so the relationship between Musquodoboit River 1SW sport catch in one year and MSW sport catch the following year was further examined (Table 8a). To remove the stocking effect, the 1SW sport catch for the years 1983-1996, when the angling stub program was in effect, was regressed on estimated returns of hatchery smolts as 1SW salmon in the same year (calculated by multiplying the LaHave River 1SW salmon return rate by the

[4] The proportion of run data is based on the proportion of grilse and salmon reported in the angling fishery from 1983 to 1996.

[5] Cutting *et al.* (MS1987) produced a fecundity relationship for the LaHave River which was used to estimate eggs per female for these data.

[6] T. Goff, Fisheries and Oceans, Science Branch, Mersey Fish Culture Station, Queen's Co., N.S.

smolts stocked (Amiro and Jefferson 1997 and 1998); Table 8a). This regression was found to be significant (1SW salmon sport $catch_i$ = 113.238 + 0.29798 * hatchery smolt returns as 1SW $salmon_i$; R^2_{adj}=0.61; p=0.0006; n=14). The residuals from this regression represent the 1SW salmon sport catch with the effects of stocking removed. MSW salmon sport catch in year i+1 was then regressed on these residuals (year i) and the resulting equation was found to be significant (MSW salmon sport $catch_{i+1}$ = 152.786 + 0.76065 * residual from 1SW salmon sport catch on hatchery smolt $returns_i$; R^2_{adj}=0.24; p=0.043; n=14).

The contribution of hatchery fish to the river was estimated by O'Neil *et al.* (1997b) to be 42% of grilse returns and 18% of large salmon returns.

Assessment results and discussion

The preliminary sport catch on the Musquodoboit River for 1997 as derived from angler reports was 20 grilse and 17 large salmon (Table 2). These numbers are well below the previous five-year average of 131 grilse and 82 large salmon. The catch rate estimated from the LaHave River in 1997 was 0.347 (Amiro and Jefferson 1998) and from the St. Mary's River, 0.110 (see St. Mary's River below). Applying this range of catch rates to the Musquodoboit River catch results in a range in total returns from 107 to 336 fish. Preliminary angler effort on the Musquodoboit River in 1997 was only 220 rod-days, only 15% of the 1992-96 mean effort estimate (Table 2). Effort on the LaHave River was over 3,000 rod-days, and near 50% of the 1992-96 average effort. In addition, DFO staff seined 19 fish from two locations on the Musquodoboit River in 1997 and it is unlikely that they would have captured almost 20% of the entire run which would have been the case if only 107 fish returned to the river. Consequently, the catch rate estimated from the St. Mary's River was used to estimate returns against requirements (Table 6).

The estimated egg deposition in 1997 based on the angler data and St. Mary's River catch rate was 722,736 eggs, or 38% of the conservation requirement.

Forecast

Sport catch

A forecast sport catch of 167 1SW salmon for 1998 was calculated from the regression relationship between sport catch and hatchery returns, as follows: The number of 1SW fish expected to return in 1998 from the release of hatchery smolts was calculated by multiplying the number of smolts stocked in 1997 (21,700) by the previous five-year (smolt years 1993-1997) average 1SW hatchery return rate of 0.83%. The resultant 180 expected 1SW hatchery fish was used in the regression equation (1SW salmon sport $catch_i$ = 113.238 + 0.29798 * hatchery smolt returns as 1SW $salmon_i$; R^2_{adj}=0.61; p=0.0006; n=14) to estimate the 1998 1SW sport catch.

A forecast sport catch of 66 MSW salmon for 1998 was calculated using the residual from the regression of 1SW sport catch on hatchery smolt returns. This residual value was calculated as follows: the predicted 1SW salmon sport catch for 1997 (with stocking effect removed) of 134 fish was estimated using the number of hatchery smolts to return as 1SW salmon in 1997 (68), from the above regression; the 134 value was subtracted from the angler-reported 1SW salmon sport catch of 20 fish to arrive at the residual (-114; Table 8a). The residual was used in the regression equation (MSW salmon sport $catch_{i+1}$ = 152.786 + 0.76065 * residual from 1SW salmon sport catch on hatchery smolt $returns_i$; R^2_{adj}=0.24; p=0.043; n=14) to estimate the MSW sport catch (Table 8b).

Returns

Forecast return estimates can be approximated in more than one manner for the Musquodoboit River. 1). The number of hatchery smolts stocked in the Musquodoboit River in 1997 (21,700 fish) was similar to the number stocked in 1996 (21,800). If the return rate in 1998 is similar to the recent rate on the LaHave River (1993-97 hatchery grilse return rate to Morgan Falls was 0.83%), roughly 180 hatchery grilse would be expected to return to the river. Given the proportion of hatchery fish in returns found by O'Neil *et al.* (1997b) of 42%, total grilse returns in 1998 could be estimated at 428 fish. This number would be approximately 80% of the grilse requirement.

2). The forecast return in 1998 to the Musquodoboit River sport catch, based on the regressions described above, of 167 grilse and 66 large salmon results in return estimates of 585 grilse and 231 large salmon after applying the long-term mean LaHave River catch rate of 0.285. These return estimates indicate that grilse returns will approximate the requirement, but large salmon numbers will only acheive 64% of the requirement.

Salmon River, Guysborough

Salmon River, Guysborough, is located at the eastern end of SFA 20, drains an area of 347 km^2 and discharges into Chedabucto Bay (Fig. 1). The river drains an area underlain by geology with some buffering capacity and is less affected by acidic precipitation as are many of the rivers in SFA 20 (Table 1).

The lowermost non-tidal pools on the river are several kilometers above the location where the river discharges through a short crescent beach into Chedabucto Bay (Figure 5). Much of the angler effort occurs at the juncture of ocean and estuary where the fish frequently stage, often for weeks, before entering the river. Entry of the fish into the river seems to be largely governed by the water temperature and discharge although we do not have data to support that general observation.

The river contains a run of sea-run brown trout which are fished almost as avidly as salmon and often at the same locations.

Conservation requirements

Habitat

The orthophoto-measured rearing habitat area for Salmon River, Guysborough, is 1,178,900 m^2. This area measure is exclusive of river and stream areas less than 0.12% gradient. Several sizable lakes are found in the system.

Biological characteristics

The biological characteristics of the stock have not previously been described. Data were collected in 1997 from 127 fish (Table 9a) to provide the necessary information to construct a stock composition structure.

Eggs per female of mean fork length	Proportion female	Proportion in run	Egg deposition per fish
1SW: 56.5 cm = 3,069	0.35	0.624	670
2SW: 74.5 cm = 6,199	0.83	0.280	1,736
2 sp.1:64.5 cm = 4,199	0.20	0.040	168
3 sp.2: 78.4 cm = 7,206	1.00	0.040	288
Average eggs per fish			2,862
Fecundity[7]	$Eggs=340.832e^{0.0389*FL}$		

Egg and adult requirements

The number of eggs necessary to meet the conservation requirement of 2.4 eggs per m^2 is 2,829,360 (Table 6).

Habitat area =	1,178,900 m^2	
Conservation eggs =	2.4 eggs per square meter	
Total eggs required =	2.4 x 1,178,900=	2,829,360
Average eggs per adult fish =	2862	
Number of fish required =	2,829,360 / 2,862 =	989
Proportion of 1SW fish in run	0.624	
Required number of grilse and large salmon	Grilse: 617 (23% of eggs)	Large salmon: 372 (77% of eggs)

Estimation of stock parameters

Angler assistance was solicited to conduct a mark-and-recapture experiment on Salmon River, Guysborough. A total of 91 Atlantic salmon was marked by placing a hole punch in the upper lobe of the caudal fin as described in the St. Mary's River mark-and-recapture experiment (see below). Fish (63) were seined on September 18, 1997, for examination for marks and for sampling. Ten of the fish seined on this occasion had been marked by anglers. The most successful angler on the river (see Appendix 2) assisted in the seining and provided input regarding marks which led us to believe that we would not be able to identify all angler marks with confidence, hence the ten marks observed were described as 6 clean marks and 4 "possibles". Consequently, DFO returned to the river on October 8, 1997, for a second collection of fish in order to estimate the adult salmon population size independent of the angler marks. A total of 91 fish was captured on the second trip, 28 previously marked by DFO and 11 by anglers (Table 9a and 9b).

The nature of the data would have permitted a population estimate by Schnabel or Bailey procedures (c.f. Ricker 1975) which were not included here because of uncertainty in angler marks. Petersen and Bayesian estimates were calculated for both the DFO data set and a combination of the DFO and angler-mark data (Table 9c).

[7] Fecundity based on St. Mary's River data (Marshall 1986).

Assessment results and discussion

The adult salmon population returns (pre-fishery) estimate (Bayesian) for Salmon River, Guysborough, was 215 or 545 fish for the data set limited to DFO or the DFO and angler data set combined, respectively (Table 9c). In either case, the returns estimate would be well below the conservation requirement of 989 fish (Table 6).

Most fish are angled on Salmon River, Guysborough, where the river meets full salt water adjacent to a crescent barrier beach (Figure 5). A tidal estuary approximately 4 km long is located above the barrier beach which fish must pass through before they enter full fresh water. Fish often stage at the barrier beach for weeks before moving upstream, depending on discharge from the river. In 1997, all 91 marks applied by anglers were placed on fish caught in the vicinity of the barrier beach. DFO conducted the first seining in the two largest pools (Crusher and Salmon Hole) in the river which happen to be located just above the uppermost reaches of the estuary. On the second seining trip, two pools were seined which are located 5 km or more upriver from the first seining location. One of the ten fish captured upriver had been marked by an angler; none had been marked by DFO. Consequently, the only DFO marked fish captured on the second seining were captured in the same two pools where they were previously marked. These data suggest that the DFO data would provide a robust estimate of the population size of salmon in the two pools but not necessarily the entire river. The uncertainty about the recognition of angler-applied marks limits the validity of the population estimate based on the combined-data. If we assume that the angler marks were identified without fault, the resulting population size estimate of 545 fish would represent 55% of the spawner requirement in terms of fish.

Supporting evidence for one population estimate over the other can be obtained by examining catch rates on Salmon River, Guysborough, and comparing those with catch rates elsewhere. If the combined-data population size estimate were correct (545 fish), the capture rate of fish on Salmon River, Guysborough, based on the angling catch of 212 fish derived from angler reports, was 0.389 in 1997. This catch rate is high relative to the 0.110 estimated for the St. Mary's River, but similar to the rate of 0.347 reported for the LaHave River in 1997 (Amiro and Jefferson 1998). A catch of 212 fish based on the lower population estimate of 215 fish (Table 9c) would result in the unlikely catch rate of 99%. Thus, the combined-data population estimate is more in keeping with the catch rate derived for the LaHave River. Examination of angler effort indicates that although the preliminary estimate of around 550 rod-days for Salmon River, Guysborough, is less than one-half of the 1992-96 mean effort estimate of 1,228 rod-days, it is similar to the comparative level of effort reported for the St. Mary's River (547 rod-days). The relatively high catch rate when compared with that on the St. Mary's River suggests anglers had a better opportunity to catch fish as they staged near the barrier beach rather than move upriver on this lower-than-average discharge year (Environment Canada discharge data, for St. Mary's River, unpublished).

Anecdotes about the run of salmon in Salmon River, Guysborough, included reference to migrations of fish which did not take them out of Chedabucto Bay during the marine phase of their life cycle. These claims are unsubstantiated. Additional references to the variety of salmon which enter the river near the barrier beach were partly substantiated during the sampling in 1997 when three adipose-clipped grilse were captured in a pool just above tide head. The fish bore clips typical for the identification of hatchery products on many systems in Nova Scotia yet no fish have been stocked from hatcheries into Salmon River, Guysborough, in the past decade.

St. Mary's River

Biological characteristics

Marshall (1986) previously described the biological characteristics for the St. Mary's River Atlantic salmon stock. The data used to estimate those stock descriptors were derived from sample data collected during

a period when there were commercial and relatively unlimited recreational harvest fisheries (during the years 1969-1984). Additional sample data that were more recently collected were used to define the biological characteristics for the stock to reflect the run compositions after significant reductions in harvests in commercial and recreational fisheries. The more-recent data included in the review were samples of 707 fish collected during the years 1989 to 1997 and included broodstock collections, some limited angling data (fish less than 63 cm. in length), and collections made by Fisheries and Oceans either alone or with the St. Mary's River Association. No single-year sample could be considered representative of the entire stock so data of several years were combined to limit the opportunity for bias.

Mean length-at-age (Table 10a) was assumed to be the same as that reported by Marshall (1986) because much of the recent-year length data were not available to verify in time for inclusion in this assessment (currently held by the St. Mary's River Association). An examination of fish length is probably warranted to confirm the 1986 summary of data because examination of the length of 1SW fish sampled in 1997 indicated that they were larger by a small amount (3%).

Sea-age proportions

One-sea-winter fish (including a few small repeats) comprised 77.2% of the 707 fish sampled which is roughly equal to the percentage (78%) noted by Marshall (1986). Two-sea-winter fish and similar-sized repeats and three-sea-winter fish and large repeats made up 16.4% and 6.4% of the sample, respectively (Table 6). These data represent a small deviation from that reported by Marshall (1986) where 2SW and 3SW fish made up 14% and 9%, respectively, of the earlier sample.

Gender ratios

The percentage of males and females in the run was derived from a subset (425 samples) of the data used to estimate proportions at age; not all fish in the larger sample were sexed. Females represented 50.0% of the one-sea-winter component of the run; 68.1% of the 2SW (and some similar-sized repeats) component, and 80% of the 3SW and large repeats component (Table 10a).

Conservation requirements

The conservation requirements for the St. Mary's River have been estimated by one of three methods: (1) the application of a uniform spawning requirement in eggs to the habitat area, however measured; (2) application of eggs to habitat relative to the quality of the habitat so that the spawner requirement reflects the true capability of the habitat to support juveniles (uses simulation modeling and is based on the Atlantic Salmon Regional Acidification Model; Korman *et al.* 1994); and (3) a stock-and-recruitment technique which derives an optimal estimate of spawners from the stock-and-recruit relationship and is independent of habitat (Ricker 1975).

Habitat

Habitat area for the St. Mary's River has been measured by an on-site survey by MacEachern (1955) to be 3,078,500 m^2 and by a more standardized and comprehensive technique using orthophotos which results in a rearing area 29% larger than that measured by MacEachern, at 5,871,700 m^2 (Table 10b). Atlantic salmon juveniles are seldom found in habitat in Nova Scotia stream areas which are less than 0.12% grade (Amiro 1993). The orthophoto-measured habitat for the river exclusive of the area less than 0.12% grade is 3,985,400 m^2 (Table 10b).

Egg and adult requirements

The conservation requirement for the river, in eggs, has been defined by the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC; Anon 1991a and 1991b) to be based on 2.4 eggs/m^2 for fluvial habitat within the river. The egg requirement for the St. Mary's River under this definition would be 7.4 million and 9.6 million eggs for the MacEachern and orthophoto habitat areas, respectively (Table 10b).

The revised biological characteristic data for the river (Table 10a) can be used to estimate the required number of spawners at the CAFSAC-defined conservation rate. The two habitat area estimates would require: for the MacEachern area, 3,129 salmon (2,415 small and 713 large); or for the orthophoto area, 4,049 salmon (3,127 small and 923 large; Table 10a).

Examination of the estimated St. Mary's River egg depositions, based on an average of 2,361 eggs per fish (Table 10a) and returns derived from the LaHave River calibrated capture rate in the recreational fishery (Table 11) and St. Mary's River catch data, 1974 to 1997, indicated that the number of spawner eggs has only met the orthophoto-based conservation requirement on ten occasions (Figure 6). Given a spawning requirement of over nine million eggs, a harvest fishery is not viable, on average, in two years out of three on the St. Mary's River.

The juvenile densities in the river have remained relatively constant at around 6-7 parr per 100 m^2 (O'Neil *et al.* 1997b). Densities of 24-30 parr per 100 m^2 would be expected in order for Elson's "normal abundance" (Elson 1967), on which the conservation requirement is predicated (Anon 1991a), to have been met. In spite of estimated returns which have exceeded the nine million egg requirement, juvenile numbers remained at about one-quarter of the number which could have been expected from such escapements (Figures 6 and 7; Table 12).

Two alternate methods used to estimate the required number of spawners for the St. Mary's River were: 1) a Ricker stock-and-recruitment analysis and 2) the Atlantic Salmon Regional Acidification Model (ASRAM; Korman *et al.* 1994).

St. Mary's River optimum spawning requirement derived by stock-and-recruitment

The number of fish captured in the recreational and commercial fisheries was used to estimate stock-and-recruitment. The number of angled fish was used to estimate in-river returns by dividing the St. Mary's river annual angling catches by annual catch rates determined for the LaHave River. This method was used because St. Mary's River catches have been shown to be correlated with counts at Morgan Falls of the LaHave River (O'Neil *et al.* 1997b). The methodology for estimating the catch rate has been described by Amiro and Jefferson (1997). Escapement (stock) was estimated from in-river returns minus angling removals and a 10% mortality of hooked and released fish. The period chosen was 1974 until the present because catch rates were only available for that period.

Data collected on the St. Mary's River from 1969 to 1997 were used to derive stock and recruit data (1,700 samples). Recruits were calculated by applying the ages and proportions of each age obtained from the sampling data to returns as estimated from the angling data and summed with estimated harvests in the St. Mary's River estuary commercial fishery. The contribution of the commercial catch to recruits was estimated as follows: Logbook data of individual commercial fishers whose traps were located in the estuary (i.e., inside the headlands at the outermost reaches of the river harbour at Barachois Point on the west, topographic map 11F/4 military grid 879865, and Cape St. Mary's on the east, military grid 905875), for the years 1980-84, were used to calculate an average percentage of Fisheries Statistical District 17 catch which was attributable to the estuary traps. The logbook reported catch for the commercial traps in the estuary for 1980-84 was added to the angling returns to estimate recruits. For the years 1974-79, the average proportion was applied to the FSD 17 commercial catch to derive recruits taken in the commercial fishery for those years.

Recruits included fish with total age 3 to 6 as determined from the sample data; recruits aged 2, 7 and 8, were not included in the analysis because of their relatively small contribution:

Age of fish used in the Ricker stock-and-recruit

Total age	Proportion
2	0.2
3	42.7
4	34.9
5	14.8
6	5.9
7	1.5
8	0.2

The analysis was completed according to the method described by Ricker (1975).

St. Mary's River optimum spawning escapement estimated through simulation modeling

The methodology used to derive an optimum spawner escapement using ASRAM (Korman *et al.* 1994) was described by Amiro *et al.* (1996) and can be summarized as follows: Habitat area for the entire St. Mary's River as measured by orthophoto, which is classed according to gradient, was used in the simulation process. The simulations were run to equilibrium ($<\pm$ 15% variation in recruits) for fixed egg depositions between 0 and 400 eggs per 100 m^2. Escapement at maximum recruitment was 3.85 x 10^6 eggs deposited or 1,629 adults at 2,361 eggs per fish. These data indicate that the optimal egg deposition rate for this simulation was 65.6 eggs per 100 m^2. The model included an assumed in-river loss for all adult fish of 15% due to natural mortality, poaching, etc. but exclusive of any loss due to fisheries. In other words, the simulation was run under the assumption that fisheries were not occurring.

Research data

Juvenile densities

Several electrofishing sites previously established to monitor juvenile Atlantic salmon densities were revisited in 1997 to determine if recent low adult returns would be reflected in juvenile densities and whether juveniles are related to estimated numbers of spawners. The electrofishing methodology was previously described by O'Neil and Harvie (1995).

Comparison of parr densities across years

The mean parr densities for the river in 1997 were 6.6 age-1+ and 7.2 total parr per 100 m^2 (Table 12). Atlantic salmon parr distributions are highly influenced by gradient (Amiro 1993). A curvilinear (quadratic) relationship exists between total parr ($p=0.001$) and age-1+ parr ($p=0.004$) densities and gradient (Table 13; Fig. 7; O'Neil *et al.* 1997b). Gradient was included in the analysis to compare densities across years. The natural logarithms of the densities were used in all analyses to meet assumptions. The assumptions of analysis of variance could not be met for the comparison of 1+ or total parr across years because of interactions among the variables. Fry (0+ parr) densities were compared across years without the incorporation of the gradient variable because fry distributions are not influenced to the same degree as older fish are by gradient. Fry densities were found to differ across years; the 1997 fry density was the second highest of the available data ($p<0.001$; Table 13).

Not all sites were fished in all years. In an attempt to standardize sites across years, the most frequently fished sites were selected for separate analysis. The sites chosen were those common to most years when fishing occurred, 1985, 1986 and 1990 through 1997, and included the sites numbered 4, 5, 8, 10,

and 23 (Fig. 8). Gradient and site were included as covariables with year in the analyses. A significant difference in 1+ parr density (p=0.029) was noted among the years, but multiple comparisons failed to show any difference in densities between specific years (Table 13). The same comparison with total parr as the dependent variable showed a significant difference among years (p=0.032), but failed to show differences in densities between specific years.

Smolt sampling

The early marine survival of smolts is related to size (Ritter 1989). Little was known about the size of smolts in the St. Mary's River so a limited sampling program was undertaken in 1997. Parr size and difference in size (growth) from parr to smolt are key variables in the ASRAM simulation modeling, so data were sought to verify data borrowed from a neighboring river (Stewiacke) for previous modeling exercises. Parr size data were already available for the St. Mary's River so smolts were sampled in 1997 between May 21 and June 9 on four tributary streams where electrofishing had occurred in 1996; the Nelson, Indian Man, McKeens and Moose (Fig. 8; Appendix 1). The mean length of the age 2+ smolts sampled from the tributaries was 15.0 cm (n=47; 95% C.I. 0-29; Table 14).

Estimation of stock parameters

1997 returns estimate

In 1997, a mark-and-recapture experiment was used to estimate returns to the St. Mary's River. Preliminary plans to install a trap to mark fish and subsequently employ a series of seining operations to examine fish for marks was replaced, due to resource limitations, with an alternate plan to have anglers apply marks and to seine fish to apply and capture marks.

Mark application: Seven anglers were supplied with single hole punches (a paper hole punch typically available from stationery stores), angler diaries, and a detailed set of instructions regarding mark application. Anglers were instructed to place a hole punch in the upper lobe of the caudal fin prior to releasing the fish. Anglers were cautioned not to stress the fish unduly and not to try to mark fish angled under excessively warm water conditions (they were asked to use their own judgement). The details regarding the marking of fish were to be recorded in their angler diaries, such as date, time, pool location, and general size and condition of fish. The individuals selected to participate in the marking program were known either to the authors as highly successful anglers and interested in the program or were recommended by the St. Mary's River Association.

Angler reports of marking 15 fish were known to be incomplete. Diaries were not returned by 3 of the fishers so a record of fish marked was obtained from 2 of those fishers, but not the third, by telephone. Four of the fish marked by anglers were subsequently caught during seining (Table 15a).

Marks were also applied to 67 fish captured by seining on the river at several different pool locations on September 15, 16 and 17. The lower caudal fin was marked with a hole punch to allow us to distinguish marks applied by the two groups. Fish were marked at several locations on West River, St. Mary's, at Silver's Pool (the forks pool where the two branches meet), and on a main stream pool about 5 km downstream from Silver's Pool. Fish were not present in the three pools examined on East River, St. Mary's (Table 15b; Fig. 8). Fish captured during seining were measured, scale sampled and gender was noted.

Recapture of marked fish: A total of 117 fish was captured by seining several pools on West River, St. Mary's and Silver's Pool, on October 6 and 7, examined for marks and sampled as in the marking operation. Snorkel divers looked through three pools on the East River, St. Mary's, but no fish were observed (Table 15b).

Index river for estimating future returns of large salmon

A significant predictive relationship has been found between the multi-sea-winter salmon sport catch on the St. Mary's River and the LaHave River wild 1SW salmon counts the previous year (O'Neil and Harvie 1995; O'Neil *et al.* 1997a and 1997b). The relationship described previously was reinforced with the addition of the 1996 LaHave trap and 1997 St. Mary's sport catch data set ($p=0.000$; $R^2adj.= 0.72$; $N=12$; Table 16). The regression equation is based on the period from 1983-96 (1SW or grilse years) and is of the form (Fig. 9):

$$\text{STM MSW sport catch}_{(i+1)} = -36.2 + 0.214 \times \text{LaHave (at Morgan Falls) wild 1SW trap counts}_{(i)}$$

This equation excludes the 1984 and 1985 grilse year points because of bias in the angling data during the 1985 and 1986 angling years (O'Neil *et al.* 1997a).

Parr density relationship to escapement or number of spawners

Fry (0+ parr) and 1+ parr densities were examined for a relationship with the appropriate previous-year spawner eggs. The number of spawners was estimated using the catch rate derived for the LaHave River, as described above, applied to the St. Mary's River sport catch, minus fish harvested, plus a 10% hook-and-release mortality rate on any fish released. The number of spawner eggs was estimated by attributing approximately 1,565 eggs to each grilse spawner and 5,062 eggs to each large salmon spawner (Table 10a). The regression of fry densities in year i+1 on spawner eggs in year i was not significant ($p=0.287$). A similar regression of 1+ parr (adjusted for the significant gradient effect) was also not significant ($p=0.601$; Table 13).

Assessment results and discussion

Mark-and-recapture population estimate

Eight of the 67 fish marked were subsequently captured (Table 15a). Petersen (Ricker 1975) and Bayes algorithm (loc. cit. Gazey and Staley 1986) post- fishery population estimates were calculated to be 891 (95% C.L. 477-1,823) and 1,000 (mode; 5th and 95th percentiles 600 and 2,300) fish, respectively (Table 15c; Fig. 10). The Bayes probability estimate is used as the population estimate for the river because the Petersen estimate is known to be biased in a negative direction when sample sizes, particularly recaptures, as in this case, are low (Ricker 1975). Anglers reported catching and releasing 111 fish so, at an assumed mortality rate of 10%, the return estimate for the river would be 1,011 fish (Table 15c). The summer water levels and temperatures in the St. Mary's River were affected by the prolonged drought of 1997 so a mortality rate on fish caught and released of 10% would seem consistent with conditions (Bielak 1996).

No attempt was made to estimate a population size by incorporating data obtained from fish marked by anglers because of the uncertainty regarding the number of marks applied.

Exploitation or capture rate estimation

The capture rate for the St. Mary's River in 1997 was 0.110, 111 fish were angled, and the pre-fishery population size was estimated at 1,011 total returns. The 1997 estimated catch rate is low relative to the typical assumed average value which has been used for the St. Mary's River of 0.30 to 0.35 (O'Neil *et al.* 1997b). The poor angling conditions in 1997 and the low abundance of fish probably contributed to a low catch rate. Although low, the rate was somewhat higher than the lowest of the catch rates estimated for the LaHave River (0.093 in 1994, Fig. 11) over the 1974-96 time period. The catch rate for the LaHave

River in 1997, 0.347, was higher than that observed on the St. Mary's River. The difference is attributed to extreme difference in angler effort (preliminary estimate of over 4,000 rod-days on LaHave; approximately 540 rod-days on St. Mary's) due at least in part to regulation differences; anglers on LaHave River were allowed to harvest grilse in 1997 from June 1 to July 11, after which the river was closed to angling; the entire fishery was hook-and-release only on the St. Mary's.

The Ricker stock-and-recruitment relationship indicated that the optimal spawning escapement for the St. Mary's River was 2,463 fish (Fig. 12).

The number of fish which spawned (escapement) in 1997 represented a varying proportion of the conservation requirement depending on the method employed to estimate requirements, as follows:

1997 Escapement : 1,000 spawners or 2,362,316 eggs	Number required		Percentage of requirement achieved in eggs in 1997
Requirement estimation method	adults	eggs	
Habitat * 2.4, MacEachern area	3,129	7,388,400	32%
Habitat * 2.4, Orthophoto area	4,050	9,564,960	25%
ASRAM simulation	1,629	3,845,971	61%
Ricker stock and recruit	2,463	5,815,143	41%

Juvenile densities and spawner eggs

Fry (0+ parr) and 1+ parr densities were not correlated with spawner eggs from the appropriate previous year (Table 13).

A regression of fry from one year and 1+ parr densities the following year, using all sites in all years, was significant ($p<0.0005$). However, a similar relationship using the means over all sites was not significant ($p=0.844$; Table 13). Hence, the low parr and fry numbers are consistent with generalized low juvenile densities in the St. Mary's River system, but those numbers cannot be correlated with spawner eggs based on estimated returns. These findings support those reported previously by O'Neil *et al.* (1997a; 1997b) that there must be either higher-than-normal mortality of eggs or sac fry (i.e., low redd emergence) or escapements which are far below those estimated with catch rates applied to angling catch.

Forecast

In-season forecast

Wild grilse returns to the Liscomb River are correlated with the grilse sport catch on the St. Mary's River (O'Neil *et al.* 1997b). Returns of wild grilse to Liscomb by July 15 are correlated with total returns so the count of wild grilse by July 15 can be used to estimate the total grilse sport catch on the St. Mary's River, assuming a normal fishery (O'Neil *et al.* 1997b). In 1997, the 14 wild grilse counted at the counting facility on the Liscomb River by July 15 was used to forecast a year end count of 206 wild grilse (as compared with 27 actual) which in turn was used in the Liscomb - St. Mary's relationship to forecast 575 grilse to the sport fishery (Fig. 13). Anglers reported catching and releasing 78 grilse on the St. Mary's River in 1997, which is considerably below expectations based on these relationships, but consistent with that observed by the end of the salmon run on the Liscomb.

Reviewer comments on the 1996 SFA 20 assessment encouraged exploration of the possibility of using the LaHave River returns or counts as an in-season forecast tool for estimating returns to the St. Mary's River. In an attempt to develop such a tool, two options were examined which took advantage of the

known correlation between returns to Morgan Falls on the LaHave River and the St. Mary's River sport catch (O'Neil *et al.* 1997b). The St. Mary's River retained grilse sport catch was regressed on LaHave River total grilse counts (reconstructed for losses in the angling fishery) for the entire run and for a period limited to the typical angling season on the St. Mary's River. The regressions were not significant (p=0.335 and p=0.123, respectively). Similar regressions, both for the entire run and limited to fish returning within the St. Mary's angling season, with only the wild component of LaHave River grilse counts, were also found to be not significant (p=0.266 and p=0.084, respectively).

Retained grilse sport catch by July 6 on the St. Mary's River, obtained from angler reports, was found to be a significant factor in estimating the total season estimated retained grilse sport catch (season total retained grilse = 278.14 + 1.3491*July 6 retained grilse; R^2=0.68; p=0.0003; n=13). Estimates of grilse sport catch by July 6 are not available until the end of the angling season, so this regression is not of practical use as an in-season estimator of total returns. The regression of LaHave River total season grilse counts on LaHave River grilse counts to July 6 was found to be significant (season total grilse count = 749.16 + 1.5073*July 6 grilse count; R^2=0.77; p=0.00004; n=13) with a slope parallel to that of the St. Mary's River regression (analysis of covariance divergent slopes p=0.737; Fig. 14). Further exploration is necessary to determine if a link exists between these two regressions so that LaHave River counts could be used as an in-season forecast tool for estimating returns to the St. Mary's River.

Large salmon forecast

A forecast of 29 large salmon to the recreational salmon fishery in 1998 was calculated from the regression relationship between the wild grilse counts on the LaHave River and the St. Mary's River large salmon catch. Applying a 29% catch rate (the mean catch rate 1974-97 from the LaHave River calculated catch rates for the period 1974-96 and the St. Mary's River catch rate based on the population estimate for 1997, Table 11) to the forecast catch results in a return forecast of 100 fish, approximately 14% of the previously-used (MacEachern area-based) conservation requirement. A Bayesian probability distribution based on the predictive relationship between the LaHave grilse counts and St. Mary's MSW sport catch and standard error of estimate for the regression was used to estimate the probability that the 1998 forecast would exceed the spawning requirement (after adjustment using the 29% capture rate). The probability that the forecast would be greater than 207 fish (i.e., 713 large salmon required x 0.29=207) was 5.01%.

Grilse forecast

The five-year average grilse catch was used to forecast the sport catch in 1998 and the 29% capture rate applied to that catch to forecast returns:

Capture rate	5-year average grilse catch (1993-97)	Estimate of returns	Grilse spawner requirement estimation procedure	Grilse requirement	Forecast percent of grilse requirement	Probability that return est. meets requirement[a]
29%	434	1,496	MacEachern @ 2.4	2,415	62%	29.8%
29%	434	1,496	Orthophoto @ 2.4	3,127	48%	14.0%
29%	434	1,496	ASRAM	1,258	119%	66.1%
29%	434	1,496	Ricker stock-recruit	1,901	79%	44.9%

[a] The probability that the return estimate meets the requirement is estimated from a Bayes probability distribution generated from the five-year average and standard deviation.

Thus, the forecast grilse return in 1998 will achieve from 48 to 119% of the conservation requirement in terms of numbers of fish, depending on the spawner requirement estimation procedure used.

Evaluation of the grilse forecast based on the five-year average

The practical usefulness of the five-year average grilse sport catch to forecast sport catch for the subsequent year was examined by looking at historical catch data for the St. Mary's River (O'Neil *et al.* 1997b). Running averages (5-year) of grilse catches on the St. Mary's River were calculated for the years 1974 to 1996 and compared with the actual grilse catch in the subsequent year (Fig. 15). A total of 19 comparisons was made and in six cases the actual grilse catch would have exceeded or fallen short of the average by at least 50%. In other words, 32% of the cases examined would have differed from the forecast number by over 50%.

The smoothing effect of the five-year average data indicated that three general trends in grilse sport catch have occurred over the 23-year period. Catches were generally on the rise from the mid-1970s until the early 1980s, remained relatively stable until 1990 and have declined steadily since 1990 (Fig.15). The trend for the latter years is the more pronounced. Grilse catches in six of the last seven years (forecast years 1991-1997) have fallen short of their respective preceding five-year averages, with the 1996 value the only exception.

The five-year average data provide insight into general trends but have not proven particularly effective at forecasting grilse sport catch for a particular year.

Returns forecast in eggs

The 1998 returns forecast to the St. Mary's River, in terms of eggs, range from a low of 29.8% (orthophoto area at 2.4 eggs) to a high of 74.0% (ASRAM estimated requirement) of the conservation requirement, depending on how the egg requirement is estimated. Total forecast eggs was calculated from the forecast 100 large salmon (at 5,062 eggs per fish) plus the five-year average grilse forecast, based on the average catch and catch rate, of 1,496 fish (at 1,565 eggs per fish), to be 2,847,440 eggs in 1998.

West River Sheet Harbour

West River, Sheet Harbour

The West River, Sheet Harbour, has yielded as many as 600 salmon a season to the angling fishery since record keeping began in 1951. The watershed, which shares an estuary with East River, Sheet Harbour, is seriously acid-stressed (pH~4.9) except for one tributary, the Little West, where the level of winter pH is near 5.2 (Table 1 and 3).

A program to provide refugia for juvenile salmon in the acidic waters, by spreading limestone gravel, was continued in 1997, bringing the total stream length treated to about 3 km.

The angling fishery has been closed on West River, Sheet Harbour, since 1993, as a means of protecting the stock. Returns of salmon to the West River, Sheet Harbour, are known to be low from local residents' knowledge and information provided by trout anglers.

The conservation requirement calculations for West River, Sheet Harbour, were provided in O'Neil and Harvie (1995). The requirement for a non-acid-impacted West River was estimated at 797 grilse (Table 6).

Research data

Juvenile salmon densities were monitored at several sites in 1997 to fulfill DFO's obligation to the fisheries resource management plan referred to above under East River, Sheet Harbour, and to determine if the liming program has had a positive impact on juvenile survival. Salmon were present at only four of the six

sites visited in 1997, and numbers were so low at one site that a density could not be estimated (Table 17). At the one limed site visited in 1997, the density of fry and parr was higher than prior to liming (Fig. 16). The juvenile densities may not have improved as a result of the liming within such a short time frame and the observed increase in numbers may have been due to other factors. However, as only a portion of the site was limed and returns to the river were believed to be exceptionally low, it would be difficult to account for differences in juvenile densities unless a more comprehensive survey were completed. Several other limed areas were not electrofished in 1997.

Water quality has been monitored on the system during 1997 as input to a larger scale review of conservation requirements in acid-stressed systems (Table 3). Acidic precipitation in the autumn of 1997 in addition to the flushing of wetlands after prolonged drought (Environment Canada discharge data, unpublished) resulted in a depression in pH in November which probably negatively impacted on juvenile survival.

Management considerations

None of the acid-stressed streams on the Eastern Shore of Nova Scotia seem capable of producing sufficient smolts to meet conservation requirements. The current low marine survival rates contribute to even lower returns from these already-impacted systems. It is unlikely that any of these systems will be able to sustain a harvest under the present manner of estimating spawning requirements for the foreseeable future (i.e., until the precipitation is no longer more acidic than non-polluted rain and marine survival improves).

The Musquodoboit; St. Mary's; and Salmon, Guysborough, rivers are currently relatively little impacted by acid precipition but are subject to the present low marine survival rates. The number of large salmon forecast to return to the St. Mary's River in 1998 is 14% of the requirement. Estimates of returns to the Musquodoboit River in 1998 are also for fewer spawners to return than are required to meet conservation levels. Forecasts based on the relationship between large salmon and grilse spawners foretell of low large salmon numbers in 1998 because of low numbers of grilse in 1997, even if marine survival rates improve immediately. Consequently, the non-acid-impacted rivers in SFA 20 are not expected to have surplus spawners in 1998. Improved marine survival would be necessary for the situation to change for 1999 and beyond.

Hook-and-release angling fisheries would have little impact on the spawning stock if angling practices are restricted to periods when the water temperatures are less than 21 C (Bielak 1996; B.Tufts[8], pers. comm.)

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[8] B. Tufts, Queens University, Ontario

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Table 1. The habitat areas, pH, and 1997 angling seasons for the Atlantic salmon rivers of SFA 20, Eastern Shore Nova Scotia, arranged according to pH category from Watt (1986).

pH category from Watt (1986)		River	Habitat area [1] m^2*10^2	Winter pH taken 1986 unless date specified pH [2]	D-M-Y	Dates for the 1997 angling seasons
1	<4.7	Salmon: Halifax Co.	2,811	4.15	23-02-93	June 01 - Aug. 29
		Lawrencetown Lake	6,446	4.52		June 01 - Aug. 29
		Cole Harbour	1,244	4.54		June 01 - Aug. 29
		Larry's	2,410	4.61		June 01 - Aug. 29
2	4.7-5.0	Porters Lake (East Brook)	2,332	4.75		June 01 - Aug. 29
		Tangier	13,583	4.80		June 01 - Aug. 29
		Isaac's Harbour	2,043	4.82		June 24 -Sept. 22
		New Harbour	3,148	4.84		June 24 - Sept. 22
		Clam Harbour	2,736	4.85		June 01 - Aug. 29
		Liscomb	16,856 [3]	4.88[6]	21-11-96	June 01 - Sept. 15
		Little Salmon	750	4.93		June 01 - Aug. 29
3	5.1-5.4	Gaspereau Brook	2,823	5.05	13-01-88	June 01 - Aug. 29
		West Sheet Harbour	3,700 [5]	5.06[6]	18-11-96	closed
		East Sheet Harbour	29,749	5.13[6]	19-11-96	June 01 - Sept. 30
		Port Dufferin	5,389	5.15		June 01 - Aug. 29
		Halfway Brook	1,604	5.17		June 01 - Aug. 29
4	>5.4	Ecum Secum	7,663	5.44		June 01 - Aug. 29
		Quoddy	6,849	5.44		June 01 - Aug. 29
		Moser	15,208	5.46	22-12-88	June 01 - Aug. 29
		Ship Harbour Lake Charlotte	19,615	5.54		June 01 - Aug. 29
		Country Harbour	3,270	5.91		June 24 - Sept. 22
		Saint Mary's	30,785 [4]	5.98		May 10 - Sept. 30
		Salmon: Guysborough Co.	11,789	6.12		June 24 - Sept. 22
		Musquodoboit	7,919	6.48		June 01 - Aug. 29
		Guysborough	4,217	6.58		June 24 - Sept. 22
		Total	204,939			

[1] Unless otherwise specified, area greater than 0.12% gradient was estimated from aerial photographs and orthophotos using methods described by Amiro 1993.

[2] Data from 1986. More current data available for summer pH's only. Winter pH's are not expected to have changed more than 0.1 or 0.2 pH units since 1986 (W. Watt, pers. comm., Dr. Walton Watt, Diadromous Fish Division, Science Branch, Fisheries and Oceans, Halifax, N.S.).

[3] Habitat area estimated from on-site proximate survey and reported by Semple and Cameron (1990).

[4] Area estimate based on proximate survey conducted by MacEachern (1955).

[5] Habitat area estimated from proximate survey by Ducharme (1972).

[6] Data obtained from Dr. Gilles LaCroix, Fisheries and Oceans, St. Andrews, N.B.

Table 2. Atlantic salmon sport catch and effort for rivers in Salmon Fishing Area 20, Eastern Shore, Nova Scotia, for 1997 (preliminary), 1996 and mean catches, 1992-1996.

	1997 Preliminary				1996				1992 - 96 means							
	Grilse		Salmon		Grilse		Salmon		Grilse				Salmon		Effort	
River	retained	released	released	Effort	retained	released	released	Effort	retained	95% C.I.	released	95% C.I.	released	95% C.I.	roddays	95% C.I.
Salmon Fishing Area 20																
Clam Harbour	0	0	0	0	0	0	0	0	0	N/A	0	N/A	0	N/A	3	N/A
Cole Harbour	0	0	0	0	0	0	0	1	0	N/A	0	N/A	0	N/A	14	N/A
Country Harbour	0	0	0	0	0	4	5	13	7	11	4	5	3	3	72	90
East: Sheet Harbour	1	0	1	161	27	6	0	257	17	19	3	4	2	4	173	170
Ecum Secum	0	4	0	181	0	27	5	105	27	32	7	14	5	4	319	225
Gaspereau Brook	0	0	0	1	0	0	0	0	0	1	0	0	0	0	14	18
Guysborough	0	0	0	0	0	0	0	0	1	3	0	0	2	2	10	9
Halfway Brook	0	0	0	0	0	0	0	0	0	N/A	0	N/A	0	N/A	10	N/A
Isaac's Harbour	0	0	0	0	0	0	0	11	3	5	0	1	0	0	31	29
Kirby	0	0	0	1	0	0	0	0	2	N/A	0	N/A	0	N/A	20	N/A
Larry's	0	0	0	0	0	0	0	0	0	N/A	0	N/A	0	N/A	1	N/A
Lawrencetown Lake	0	0	0	0	0	1	0	5	0	0	0	1	0	0	5	3
Liscomb	0	3	0	13	0	1	0	55	13	10	4	6	0	1	318	256
Little Salmon	0	0	0	0	0	11	7	65	0	N/A	6	N/A	4	N/A	35	N/A
Moser	0	1	0	10	0	35	0	83	53	56	18	22	3	6	650	552
Musquodoboit	1	19	17	220	0	209	116	620	72	66	59	105	82	52	1432	1288
Necum Teuch	0	0	0	0	0	0	0	0		N/A		N/A		N/A		N/A
New Harbour	0	0	0	12	0	1	0	22	15	12	3	3	0	1	195	197
Port Dufferin	0	0	0	0	0	1	0	8	7	9	1	1	0	1	98	91
Porters Lake (East Brook)	0	0	0	0	0	0	0	0		N/A		N/A		N/A		N/A
Quoddy	0	0	0	0	0	0	0	0	0	N/A	0	N/A	0	N/A	12	N/A
Rocky Run Porters Lake	0	0	0	0	0	0	0	0		N/A		N/A		N/A		N/A
Saint Francis	0	0	0	0	0	0	0	0	0	N/A	0	N/A	0	N/A	1	N/A
Saint Mary's	0	78	33	547	0	596	177	1084	287	377	195	290	177	167	3323	2627
Salmon: Guysborough Co.	0	156	56	522	0	158	70	285	140	140	87	82	120	74	1228	810
Salmon: Halifax Co.	0	0	0	1	0	0	0	0	1	N/A	0	N/A	0	N/A	19	N/A
Ship Harbour Lake Charlotte	0	0	0	4	0	1	0	1	7	12	2	3	2	3	222	184
Tangier	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1
West Sheet Harbour	0	1	0	3	0	20	1	69	31	50	8	12	3	4	468	748
Totals	2	262	107	2108	27	1071	381	2684	677		392		444		10699	
1997 total as a percent of 1996	7	24	28													
1997 total as a percent of 1992-96 mean	0.3	67	24													

a With the exception of East River, Sheet Harbour, the sportfishing season was limited to hook and release for SFA 20 in 1996, 1997 and in 1994 for the period July 21-Aug. 11.

b Confidence intervals were not calculated for means which included fewer than 3 data points greater than zero.

c River closed in 1995,1996 and 1997.

d Estimated from angler cards; many cards were missing effort so effort data were estimated from CPUE's on returned completed cards.

Table 3. Sample site locations and pH of samples taken from November 1996 to November 1997 on East River, Sheet Harbour; West River, Sheet Harbour, and Liscomb River[1].

River and site number	Location	Date						
		Nov. 96	Apr-97	Jun-97	Aug. 97	Sept. 97	Oct. 97	Nov. 97
		pH						
East River,Sheet Harbour								
13	Just above Antidam on the low end of Fifteen Mile Stream	5.27	5.11	4.98	5.64	5.82	5.71	5.17
18	Twelve Mile Stream just below Governor Lake	5.46	5.88	5.28	5.80	5.93	6.13	4.98
27	Ten Mile Stream just below Ten Mile Lake	5.18		5.02	5.43	5.49	5.46	5.12
29	Twelve Mile Stream below where Ten Mile meets Twelve Mile	5.17	5.20	5.10	5.46	5.59	5.58	4.97
34	Twelve Mile just above Marshall & above trib which enters 12 Mile on true right bank	5.13	5.07	5.01	5.42	5.51	5.61	4.85
37	Seven Mile stream below Lake	5.15	5.16	4.95	5.39	5.50	5.36	5.13
42	Main East River below Marshall Flowage but above Grant River	5.15	5.04	5.16	5.43	5.46	5.51	4.84
43	Main East River at mouth (highway 7)	5.06	5.10	5.12	5.40	5.46	5.47	4.83
West River, Sheet Harbour								
48	Outflow from Rocky Lake	5.05	4.96	4.84	5.21	5.29	5.19	4.97
51	Main West at Beaverdam Road	4.80	4.78	4.73	5.31	5.07	5.04	4.66
53	Killag River at Beaver Dam Road	4.88	5.00	4.79	5.43	5.06	5.45	4.70
56	Lower end of Killag River just above Black Brook	5.19		4.99	5.98	5.31	5.91	4.83
57	Main West River at the Killag Road Bridge	5.06	4.99	4.91	5.77	5.56	5.86	4.70
63	Little West near mouth	5.37	5.27	5.13	5.54	5.46	5.46	5.13
64	Main West at Highway 7	5.06	5.00	4.92	5.40	5.46	5.47	4.81
Liscomb River								
2	Below Big Liscomb Lake, main river	5.65	5.06	5.72	5.77	5.85	5.68	5.00
7	Below Rush Lake, main river	5.00	4.93	5.28	5.59	5.34	5.59	5.02
10	Main Liscomb at Seloam's Lake Road	4.98	4.96	5.17	5.58	5.22	5.34	5.02
30	Little Liscomb just above Hardwood Lake Brook above Yankee Lake	4.68	4.75	4.92	5.31	4.84	5.18	4.55
32	Main Liscomb below Ladle Lake	4.89	4.82	5.06	5.59	5.41	5.43	4.67
36	Main Liscomb at fishway	4.89	4.80	5.04	5.30	5.35	5.40	4.63
37	Liscomb River at mouth (highway 7)	4.88	4.80	5.01	5.44	5.35	5.42	4.65

[1] pH data provided courtesy of Dr. Gilles LaCroix, Fisheries and Oceans, St. Andrews, N.B.

Table 4. Numbers of smolts released, numbers counted at the fishway, return rate, and destiny of Atlantic salmon captured at Ruth Falls fishway, East River, Sheet Harbour, 1992-1997.

		Number of fish counted at fishway [a]						Return rate in percent		Destiny of returns			
	Smolts released	Hatchery		Wild		Total		1SW	MSW		Released 15 Mile	Free	Food
Year	year i	1SW	MSW	1SW	MSW	1SW	MSW	yr(i+1)	yr(i+2)	Broodstock	Stream	swim	fishery
1992	26977												
1993	26900												
1994	26700	85	3	17	2	102	5	0.32	0.01	57	24	11	15
1995	36890	96	4	27	2	123	6	0.36	0.02	57	40	12	18
1996[b]	18700	135	16	11	1	146	17	0.37	0.06	77	59	14	13
1997[c]	25740	14	1	4	1	18	2	0.07	0.00	20	0	0	0

a. The barrier dam is passable under high water conditions so these counts are not complete.

b The barrier dam fish lift was only operated for part of the 1996 run; most fish were captured at the Ruth Falls diversion dam fishway which is located 4 km above the head of tide and above the majority of the angling fishery which harvested grilse. Preliminary angler reports indicate a harvest of 21 grilse; applying the proportion hatchery fish noted at the fishway (0.92) results in 19 hatchery grilse harvested so 135+19= 154, a reconstructed return of 154 fish and a revised return rate of 0.42%.

c. In 1997 all the trapping was done at Ruth Falls diversion dam.

Table 5. Number and age of Atlantic salmon juveniles reared at fish culture stations and released into rivers of Salmon Fishing Area 20, 1990-97.

River		Age	1990	1991	1992	1993	1994	1995	1996	1997
East River, Sheet Harbour		0+ parr	14055	35910	40210	25060	6000	26863	26000	
		1+ smolt	10449	21450	26978	26576	26771	26187	18700	25740
		2+ smolt						10790		
Liscomb		0+ parr	35832	69750	54485	40305	51325	30321	46000	
		1+ parr			6318	1323				53600
		1+ smolt	11557	17027	19236	11121	18966	35738	27500	25000
		2+ smolt	10836	8104	11279	10114	9258			
Moser		0+ parr	11200	13942						
		1+ smolt	21361	9608	19563					
Musquodoboit		0+ parr	8000	31146	31572	14600	37802	28316	17000	
		1+ smolt	23236	11672	22815	21464	11680	27359	21800	21700
St. Mary's	Main River	0+ parr				5008				
	West Branch	2+ smolt	5538							
	East Branch	0+ parr	25060		43315	63471				
		1+ parr	2565	7820	15293	10815	9561			
		2+ smolt	18201	20683		19638	19755	25900		
West River, Sheet Harbour		0+ parr	10035							
		1+ smolt	9598	9999		16704	9918			

Table 6. Habitat areas, spawning targets, adult requirements, angling catches, returns, estimated escapements, and surplus/deficits for the Eastern Shore (SFA 20) and several SFA 20 rivers.

River/ area	Habitat area m^2x10^2	Required eggs at 240 eggs per 100 m^2 (000's)	Spawner requirements		Preliminary 1997 Angling catch			Returns		Broodstock removed		Native harvest		Escapement[f]		Surplus/deficit	
			Grilse	Salmon	Grilse retained	Grilse released	Salmon released	Grilse	Salmon	Grilse	Salmon	Grilse	Salmon	Grilse	Salmon	Grilse	Salmon
Salmon Fishing Area 20[a]	116,070	27,857	9190	1690	2	262	107										
East River, Sheet Harbour	29,749	7,140	N/A	N/A	1	0	1	18	2 b	17	2	0	0	17	2	N/A	N/A
Liscomb (acid)	16,856	4,045	2113	0	0	0	0	73	11 b	25	7			73	11	-2,040	11
Musquodoboit	7,919	1,901	522	362	1	19	17	201	139	15	16			199	137 g	-323	-225
Saint Mary's	30,785 h	7,388	2415	713	0	78	33	843	168 d					835	165 d, h	-1,580	-548
Salmon, Guysborough (MIN)	11,789	2,829	617	372	0	156	56	134	81 c					126	78	-491	-294
(MAX)	11,789	2,829	617	372	0	156	56	340	205 c					332	202	-285	-170
West River, Sheet Hrbr[f](acid)	3,700	888	797	0	closed to fishing			N/A	N/A e					N/A	N/A	N/A	N/A

N/A Not applicable

a Baseline data for habitat areas and spawning requirements for SFA 20 were obtained from Anon 1978.

b Fishway count

c The returns estimate for Salmon River, Guysborough is derived from mark-and-recapture experiments. The "MIN" estimate was calculated from data collected by DFO by seining. The "MAX" estimate was calculated from marks applied by anglers and 2 subsequent samples by seining. Some confusion over the identification of marks applied by anglers limits the validity of the "MAX" estimate.

d Escapement estimate based on mark-and-recapture experiment in 1997 where total escapement was estimated at 1000 fish (95% C.I. 600-2300) and the number of salmon and grilse estimated from the proportion of each sampled during the mark-and-recapture. Returns equal escapement plus hook-and-release mortalities.

e Closed to angling 1994-1997. No estimate of returns possible.

f Escapement includes any fish removed for broodstock.

g Surplus/deficit based on the estimated return of 336 total fish x 0.591prop. 1SW in run (refer to text) minus removals and requirements.

h Based on MacEachern area at 2.4 eggs per square meter; refer to text.

acid - Rivers acid impacted and spawning requirements are under review.

Table 7a. Counts and returns (reconstructed to include angling removals) of wild and hatchery Atlantic salmon at the fishway trap at Liscomb Falls, Liscomb River, 1979-1997.

	Counts				Proportion of hatchery fish in counts		Returns			
	Wild		Hatchery				Wild		Hatchery	
Year	1SW	MSW	1SW	MSW	1SW	MSW	1SW	MSW	1SW	MSW
1979	60	2	485	2	0.89	0.50	72	3	585	3
1980	111	0	931	51	0.89	1.00	144	0	1206	66
1981	76	6	241	49	0.76	0.89	91	7	287	57
1982	252	10	827	41	0.77	0.80	276	12	907	47
1983	520	15	594	63	0.53	0.81	544	16	622	68
1984	606	48	331	42	0.35	0.47	647	48	353	42
1985	507	87	175	49	0.26	0.36	562	87	194	49
1986	736	117	766	108	0.51	0.48	827	118	861	109
1987	1614	88	523	54	0.24	0.38	1806	89	585	55
1988	477	76	431	44	0.47	0.37	548	77	496	44
1989	532	75	288	71	0.35	0.49	564	75	305	71
1990	955	44	438	22	0.31	0.33	1068	44	490	22
1991	586	38	178	22	0.23	0.37	622	38	189	22
1992	145	27	125	12	0.46	0.31	155	27	133	12
1993	134	11	128	12	0.49	0.52	141	11	134	12
1994	134	10	119	8	0.47	0.44	142	10	126	8
1995	150	6	98	7	0.40	0.54	162	6	106	7
1996	85	9	228	5	0.73	0.36	85	9	228	5
1997	27	1	46	10	0.63	0.91	27	1	46	10
Means:										
1991-96	206	17	146	11			218	17	153	11
1986-96	504	46	302	33			556	46	332	33
1997 as % of:										
1991-96	13%	6%	32%	91%			12%	6%	30%	91%
1986-96	5%	2%	15%	30%			5%	2%	14%	30%

Table 7b. Number of 1SW and 2SW returns from hatchery-reared smolts released at or above Liscomb Falls, Liscomb River, 1978-1996. Returns have been revised to include fish removed through the angling fishery.

Smolt year i	Smolts (1000s)	1SW returns (year i+1)	% 1SW returns	MSW returns (year i+2)	% MSW returns
1978	47.4	585	1.23	66	0.14
1979	57.7	1206	2.09	57	0.10
1980	26.9	287	1.07	47	0.18
1981	42.4	907	2.14	68	0.16
1982	43.8	622	1.42	42	0.10
1983	58.2	353	0.61	49	0.08
1984	50.0	194	0.39	109	0.22
1985	29.6	861	2.91	55	0.18
1986	19.0	585	3.08	44	0.23
1987	31.3	496	1.58	71	0.23
1988	48.4	305	0.63	22	0.05
1989	28.0	490	1.75	22	0.08
1990	22.4	189	0.84	12	0.05
1991	25.1	133	0.53	12	0.05
1992	30.5	134	0.44	8	0.03
1993	21.2	126	0.59	7	0.03
1994	28.2	106	0.38	5	0.02
1995	35.7	228	0.64	10	0.03
1996	27.5	46	0.17		

Table 8a. Musquodoboit River angling catch, numbers of smolts released, numbers returning as 1SW salmon, and residuals from the regression of 1SW salmon catch on smolts returned as 1SW salmon, 1982-1998. Predicted values are in bold.

	Angling catch		Smolts released	LaHave 1SW return rate[1]	Smolt returns as 1SW	Residuals from
	1SW	MSW	(year i-1)		(year i)	1SW~smolts
1982			0			
1983	97	111	0	0.0098	0	-16.238
1984	152	58	20555	0.0127	0	38.762
1985	401	388	24591	0.0146	300	198.336
1986	534	372	25582	0.0484	1190	66.102
1987	298	189	28155	0.0241	617	1.048
1988	377	272	41083	0.0393	1106	-65.953
1989	302	163	22329	0.0165	678	-13.231
1990	323	130	23236	0.0194	433	80.681
1991	132	144	11672	0.0042	98	-10.319
1992	62	23	22815	0.0360	420	-176.448
1993	174	103	21464	0.0084	192	3.655
1994	78	53	11680	0.0056	120	-71.055
1995	132	116	27359	0.0105	123	-17.783
1996	209	116	21800	0.0139	380	-17.558
1997	20	17	21700	0.0031	68	**-114.0**
1998				0.0083	**180**	

1 Data from Amiro and Jefferson 1997 and 1998

Table 8b. Summary of steps to forecast sport catch to the Musquodoboit River in 1998.

Step	Parameter being estimated	Calculation	Result
1	Estimate 1998 hatchery smolt returns as 1SW fish	1997 smolts released x 1993-97 average return rate: 21700 x 0.0083 =	180 1SW fish
2	Estimate 1998 1SW sport catch	113.238 + 0.29798 x 1998 hatchery smolt returns as 1SW fish =	167 1SW fish
3	Estimate 1997 1SW sport catch	113.238 + 0.29798 x 1997 hatchery smolt returns as 1SW fish =	134 1SW fish
4	Calculate residual 1997 1SW sport catch	Reported 1997 1SW sport catch minus estimate 1997 1SW sport catch 20 - 134 =	-114 1SW fish
5	Estimate 1998 MSW sport catch	152.786 + 0.76065 x residual 1977 1SW sport catch = 152.786 + 0.76065 x (-114) =	66 MSW fish

Table 9a. Age and lengths of Atlantic salmon seined on two occasions on Salmon River, Guysborough, during the autumn of 1997[1].

	Number		Mean length (cm)		Max. length (cm)		Min. length (cm)	
Sea-age	Males	Females	Males	Females	Males	Females	Males	Females
1	51	27	56.6	56.2	62.0	63.0	50.0	51.0
2 sp 1	4	1	64.4	65.0	66.5		62.0	
4 sp 1,2,3	0	1		75.0				
2	6	29	74.7	74.5	81.5	82.0	68.5	69.0
3 sp 2	0	5		78.4		82.5		73.5
4 sp 3	0	1		91.5				

1 Two fish could not be aged.

Table 9b. Number of fish marked by DFO and anglers and captured on the Salmon River, Guysborough, to estimate the number of adult Atlantic salmon escaped to the river in 1997.

Marks applied = 63 — Marking done on September 18, 1997.
Assumed no hook-and-release mortality on marked fish
Captures=92 — Capture dates October 8, 1997
Recaptures =28

	Hatchery				Wild				
	Salmon		Grilse		Salmon		Grilse		
DFO marks	Male	Female	Male	Female	Male	Female	Male	Female	Total
Marks				2	4	18	24	15	63
Capture				1	7	31	39	14	92
Recaptures in capture				1	1	11	10	5	28

	Hatchery				Wild				
	Salmon		Grilse		Salmon		Grilse		
Angler punches	Male	Female	Male	Female	Male	Female	Male	Female	Total
Angler Marks: 91 applied									
Angler marks recaptured in DFO mark run	1	1					7	1	10
Angler marks newly recaptured in DFO capture run					1	4	6		11

Table 9c. Estimates of adult Atlantic salmon returns to the Salmon River, Guysborough, based on mark-and-recapture experiments which resulted in two separate population estimates, DFO only, and DFO plus angler data.

	Petersen (corrected)		Bayesian	
	Estimate	95% C.I.	Estimate	90% C.I.
DFO only mark-and-recapture				
Post-fishery estimate	204	143-303	207	168-287
5% hook-and-release mortality[1]	11		11	
Pre-fishery estimate	215	154-314	218	179-298
DFO plus angler mark-and-recapture				
Post-fishery estimate	534	356-840	550	420-830
5% hook-and-release mortality[1]	11		11	
Pre-fishery estimate	545	367-851	561	431-841

[1] Hook-and-release mortality estimated at 5% because most angling occurred in the ocean at the river mouth at temperatures below 16 C. See Appendix 2.

Table 10a. Conservation level egg and adult spawner requirement calculations for the Atlantic salmon stock on the St. Mary's River.

Biological characteristics:

Fecundity: $Fec=340.832e^{0.0389FL}$
where FL= fork length

Size group	Eggs/female	Proportion female	Proportion of run	Eggs
57 cm; 1SW and small repeats	3,130	0.500	0.772	1,208
74 cm; small MSW	6,063	0.681	0.164	677
85 cm; large MSW including large repeats	9,301	0.800	0.064	476
		Average egg deposition per fish =		2,361

Spawning requirements:

Areal measurement	Habitat area (m^2)	Eggs at 2.4 eggs/m^2	Spawners: Total fish required (eggs÷2,361)	1SW (3,129x0.774)	Small MSW (3,129x0.163)	Large MSW (3,129x0.064)
On-site	3,078,500	7,388,400	3,129	2,415	513	200
			For a total of 2,415 grilse and 713 large salmon.			
Orthophoto (>0.12% grade)	3,985,400	9,564,960	4,050	3,127	664	259
			For a total of 3,127 grilse and 923 large salmon.			

Table 10b. Habitat areas and spawning requirements for two areal measurement techniques on the St. Mary's River.

	Habitat area in 100m^2	Habitat area (100m^2) >0.12% and < 5% grade	Conservation requirement eggs @ 2.4 eggs/m^2	Approximate number of adult salmon required: Total	Grilse	Salmon
On-site	30785	N/A	7388400	3155	2437	718
Orthophoto	58717	39854	9564960	4044	3155	890

Table 11. Atlantic salmon sport catch on the St. Mary's River, 1974 to 1997, the count of wild 1SW and MSW salmon at Lahave and Liscomb rivers, over the same period, and LaHave River catch rates in the angling fishery.

	Sport catch						Counts				LaHave River
	1SW			MSW			LaHave		Liscomb		
	Retained	released	Total	retained	released	Total	wild 1SW	wild MSW	wild 1SW	wild MSW	catch rates
1974	1735		1735	217		217	29	2			0.538
1975	238		238	73		73	38	5			0.426
1976	1386		1386	128		128	178	23			0.502
1977	605		605	158		158	292	25			0.284
1978	199		199	128		128	275	67			0.175
1979	1521		1521	87		87	856	67	60	0	0.311
1980	1969		1969	201		201	1637	288	111	0	0.153
1981	1133		1133	359		359	1866	366	76	6	0.319
1982	747		747	81		81	799	256	252	10	0.233
1983	663	69	732	175	61	236	1129	213	520	15	0.172
1984	709	197	906	65	165	230	2043	384	606	48	0.262
1985	1182	255	1437	0	856	856	1343	638	507	87	0.393
1986	1126	288	1414	0	944	944	1579	584	736	117	0.192
1987	524	88	612	0	321	321	2529	532	1614	88	0.351
1988	1209	230	1439	0	694	694	2464	390	477	76	0.216
1989	575	80	655	0	462	462	2087	511	532	75	0.382
1990	1612	451	2063	0	274	274	1880	396	955	44	0.343
1991	744	231	975	0	264	264	495	236	586	38	0.195
1992	284	35	319	0	152	152	1915	215	145	27	0.201
1993	738	171	909	0	396	396	791	112	134	11	0.337
1994	19	24	43	0	30	30	641	128	134	10	0.093
1995	394	150	544	0	131	131	577	143	150	6	0.275
1996	0	596	596	0	177	177	735	112	85	9	0.388
1997	0	78	78	0	33	33	303	68	27	1	0.347
										Average	**0.295**
	1997 St. Mary's River catch rate based on the estimated angling catch and population estimate was									0.110	
	Mean catch rate for the period 1974-97 using the LaHave River catch rate 1974-96 and St. Mary's 1997 rate =										0.286

Table 12. Mean Atlantic salmon 0+, 1+, 2+ and total parr densities per 100 m^2 for the St. Mary's River, 1985, 1986 and 1990-1997. The number of sites electrofished in each case is given (N).

	0+ parr		1+ parr		2+ parr		Total parr	
Year	Mean	N	Mean	N	Mean	N	Mean	N
1985	6.4	28	7.3	28	0.83	28	8.1	28
1986	11.3	37	5.1	37	1.36	37	6.4	37
1990	5.7	16	7.5	18	2.50	18	10.0	18
1991	5.8	21	4.4	22	0.96	22	5.4	22
1992	5.0	29	3.3	29	0.79	29	4.1	29
1993	15.6	10	8.4	10	0.40	10	8.8	10
1994	33.0	15	6.5	15	0.48	15	7.0	15
1995	17.2	23	5.1	23	0.95	23	6.0	23
1996	13.7	10	3.7	11	1.36	11	5.1	11
1997	27.8	16	6.6	16	0.58	16	7.2	16
All years	12.6	205	5.6	209	1.05	209	6.6	209

Table 13. Summary of ANOVAs, ANCOVAs and regressions for various comparisons in juvenile Atlantic salmon densities (0+, 1+, and total parr) as parr per 100 m^2, on the St. Mary's River.

Sites/areas	Dependent variable	ANOVA/regression effect(s)	N	P-value	Significant effect pairs
All sites	Ln(1+ parr)	Gradient	204	0.001	
		Gradient^2		0.005	
		Overall regression		0.004	
All sites	Ln(Total parr)	Gradient	204	0.000	
		Gradient^2		0.002	
		Overall regression		0.001	
All sites	Ln(0+ parr)	Year (1985, 86, 90-97)	205	0.000	85/94, 91/94, 92/94, 85/97, 90/97, 91/97, 92/97, 97/all others as group
All sites	Ln(1+ parr)	Year (1985, 86, 90-97)	204		Interactions
		Gradient			
		Gradient^2			
All sites	Ln(Total parr)	Year (1985, 86, 90-97)	204		Interactions
		Gradient			
		Gradient^2			
Sites 4, 5, 8, 10, 23	Ln(0+ parr)	Year (1985, 86, 90-97)	70	0.051	None
		Site		0.000	
Sites 4, 5, 8, 10, 23	Ln(1+ parr)	Year (1985, 86, 90-97)	70	0.029	None
		Site		0.181	
		Gradient		0.001	
		Gradient^2		0.009	
Sites 4, 5, 8, 10, 23	Ln(Total parr)	Year (1985, 86, 90-97)	70	0.032	None
		Site		0.324	
		Gradient		0.002	
		Gradient^2		0.021	
All sites	Mean of Ln(0+ parr) at year i+1	Eggs at year i	10	0.287	
All sites	Mean of Ln(1+ parr) adjusted for gradient at year i+2	Eggs at year i	10	0.601	
All sites	1+ parr at year i+1	Ln(0+ parr) at year i	100	0.000	
All sites	Mean of 1+ parr at year i+1	Mean of 0+ parr at year i	8	0.844	

Table 14. Location, mean weighted lengths of 1+ parr (1996), mean length of 2+ smolts (1997), and size-increase ratio, for three tributaries of the St. Mary's River.

Location	Mean weighted lengths of age 1+ parr in 1996	Number of smolts	Mean smolt lengths for age 2+ smolts in 1997	Size ratio smolt : parr
Indian Man Brook		1		
Nelson River	11.6	25	14.9	1.29
Moose River	11.1	31	14.9	1.34
McKeens Brook	11.4	6	15.7	1.37

Table 15a. Number of fish marked and captured on the St. Mary's River to estimate the number of adult Atlantic salmon escaped to the river in 1997.

Marks applied = 67 — Marking done on September 15-17, 1997.
Assumed no hook-and-release mortality between marking and captures.
Captures= 117 — Capture dates October 6 and 7, 1997
Recaptures = 7

	Hatchery				Wild				
	Salmon		Grilse		Salmon		Grilse		
	Male	Female	Male	Female	Male	Female	Male	Female	Total
Marks (applied by DFO)	1				3	7	26	30	67
Capture					6	12	50	49	117
Recaptures (DFO marks) in capture							4	4	8
Recaptures of angler marks							1	3	4

Table 15b. Seining locations and the number of fish marked and recaptured during the mark-and-recapture experiment on the St. Mary's River in 1997.

Location	Fish marked by DFO Sept. 15-17	Fish captured and examined for marks Oct. 6 & 7	Fish marked by DFO or anglers and recaptured by DFO	
			by anglers	by DFO
Upper Caledonia		13		
Sutherlands	6	37	2	2
Indian Man	0	31	1	3
Harrisons	20	25	1	2
Silvers East	14	0		
Silvers Main	18	11		1
Mitchells	9			
West Side Newtown	0			
Newtown	0			
McKeens	0			
Totals	67	117	4	8

Table 15c. Estimates of adult Atlantic salmon returns to the St. Mary's River based on mark-recapture data in 1997.

	Petersen (corrected)			Bayesian		
	Estimate	95% C.I.		Estimate	90% C.I.	
Post-fishery estimate	891	477	1823	**1000**	600	2300
10% hook-and-release mortality[1]	11	11	11	11	11	11
Pre-fishery estimate	902	488	1834	**1011**	611	2311

[1] Anglers caught and released 111 fish on the St. Mary's River in 1997.

Table 16. Summary of regression statistics for the relationship between the St. Mary's River large salmon sport catch and the return of wild grilse to the LaHave River the previous year. The 1984 and 1985 grilse years are excluded from the relationship[1].

Years	N	Adjusted R^2	Coefficients		p value
			Intercept	Slope	
1983-92	8	0.579	-0.57	0.198	0.017
1983-93	9	0.672	-58.54	0.225	0.004
1983-94	10	0.702	-41.3	0.217	0.002
1983-95	11	0.694	-12.33	0.203	0.001
1983-96	12	0.716	-36.23	0.214	0.000

1 1984and 1985 data were biased. See O'Neil *et. al*. 1997a.

Table 17. Summary of juvenile Atlantic salmon densities per 100 m^2 in the West River, Sheet Harbour, 1966-68, 1973-77 and 1994-97.

	Fry per 100m2												Parr per 100m2											
Site	1966	1967	1968	1973	1974	1975	1976	1977	1994	1995	1996	1997	1966	1967	1968	1973	1974	1975	1976	1977	1994	1995	1996	1997
1	46.6	20.2	17.5	1.6	3.5	9.7	10.5	5.7	2.3	2.8		7.6	2.4	8.1	0.8	0.4	0.5	0.3	0.6	0.2	2.3	0.7		1.6
1.1											6.2												1.0	
1.2											12.2												0.8	
2	30.9	10.5	11.6	8.6	7.1	10.1	14.9	13.1			a	1.0	7.2	4.1	2.8	1.1	2.3	0.7	0.0	1.0			a	1.3
3	88.4	9.7	9.6				10.2	14.9					4.4	2.3	4.2				0.5	0.0				
4					1.4		0.0	0.0	0.0	0.0		0.0					0.9		0.0	0.0	0.6	0.0		0.0
5	57.0						16.2	17.7	0.0	0.0	0.0	a	10.3						0.7	2.8	0.3	0.0	0.0	a
																					1.8	b		
6							0.0	0.6		0.0	0.0	0.0							0.0	0.0		0.0	a	0.0
7								14.6	1.4											1.5	3.8			
8	23.2		5.3										5.5		2.0									
9									0.5	2.2	7.8	1.3									0.7	4.3	4.8	3.8

a juvenile salmon present but no estimate possible due to low numbers
b density of adipose-fin-clipped parr released by hatchery

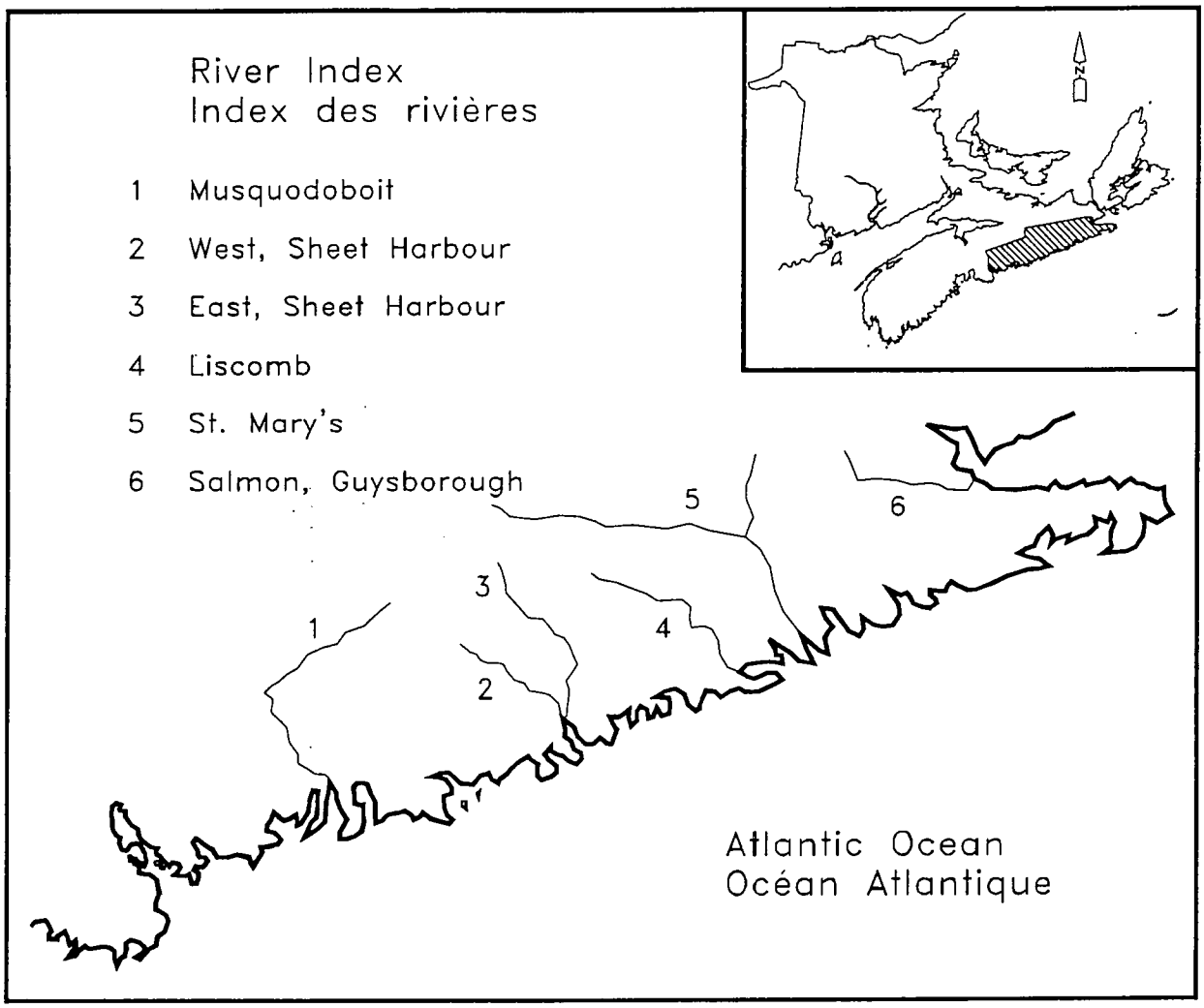

Figure 1. Map of the principal rivers of Eastern Shore of Nova Scotia, Salmon Fishing Area 20.

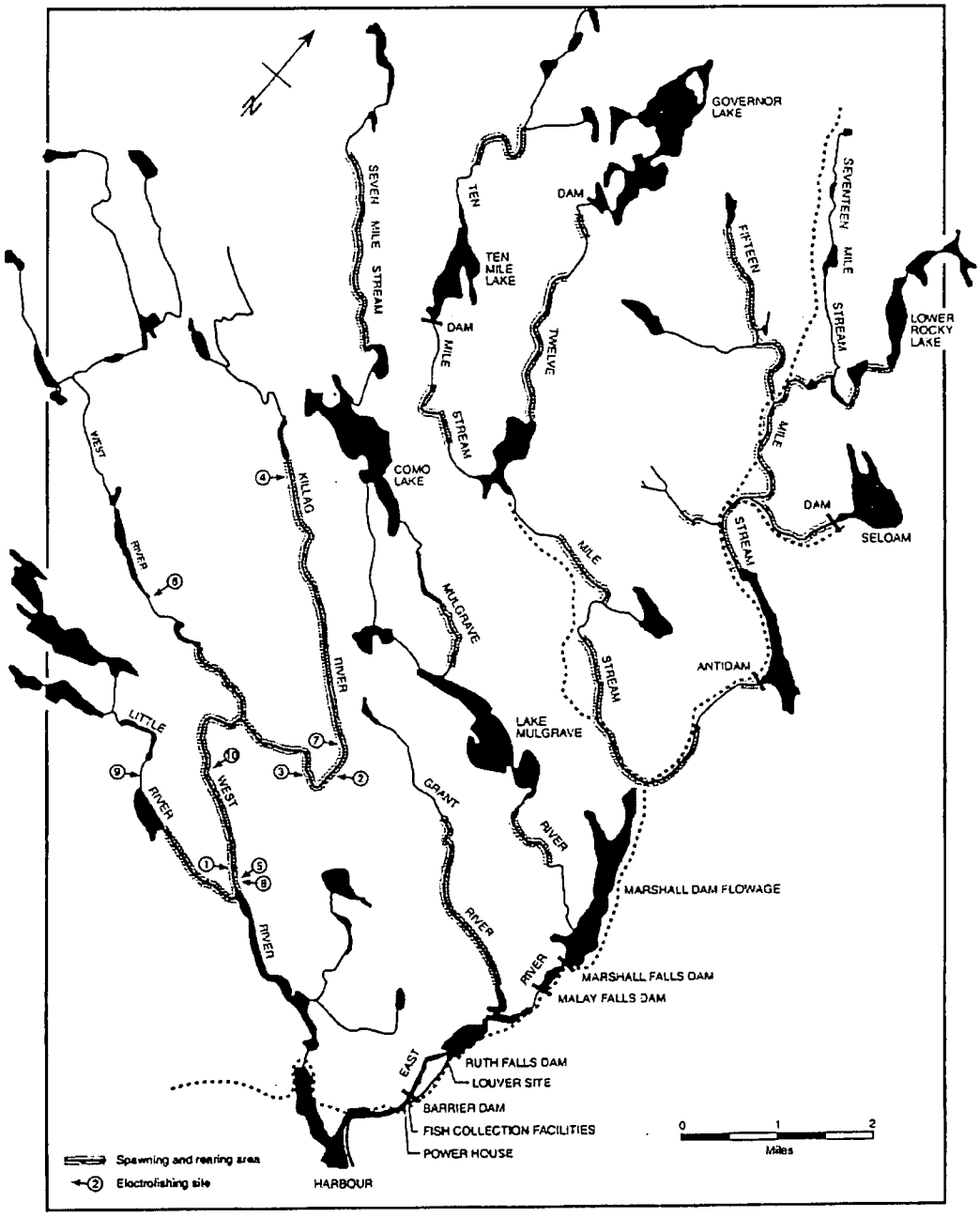

Figure 2. The dams and traps on the East River, Sheet Harbour, and the electrofishing sites on West River, Sheet Harbour.

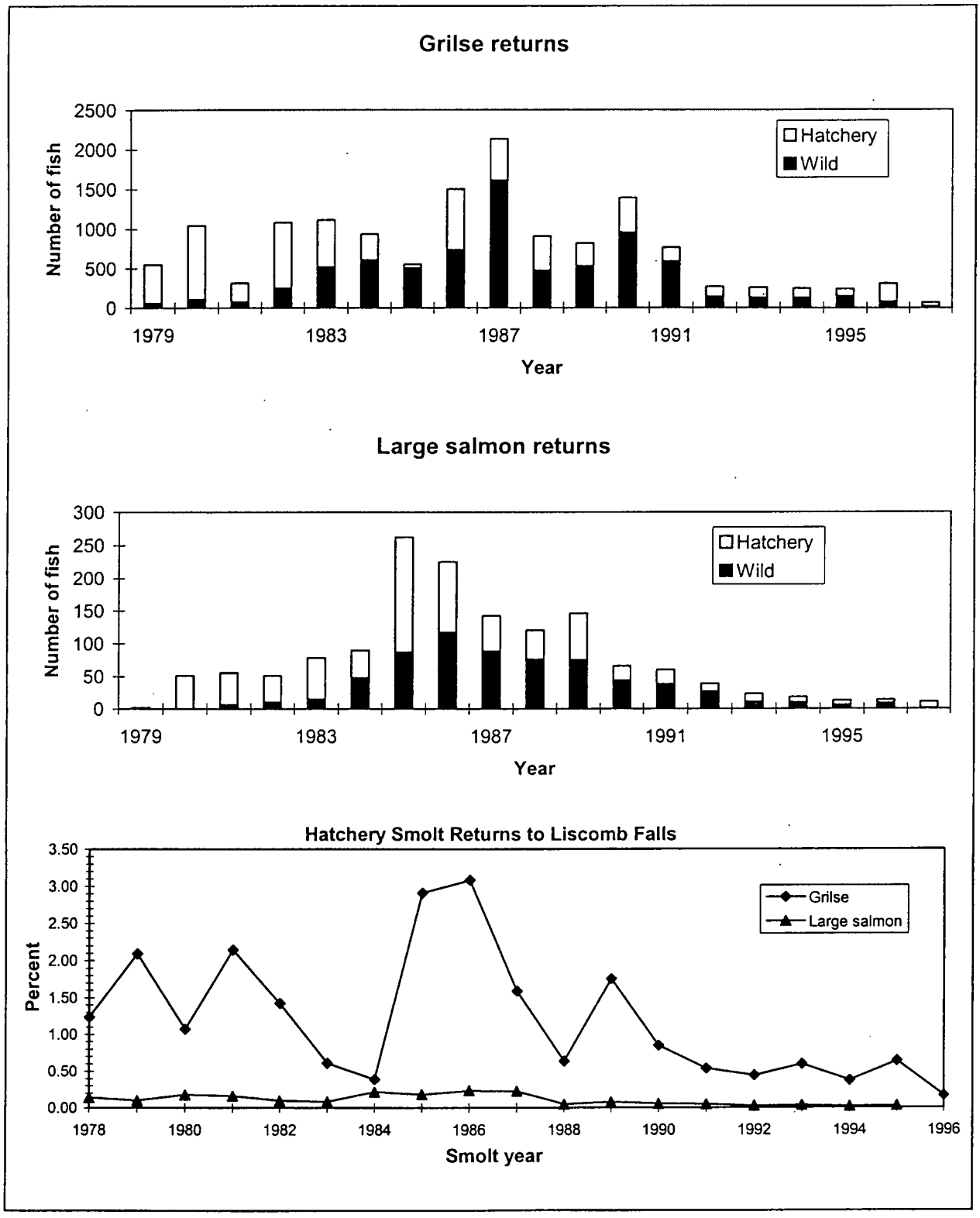

Figure 3. Counts of wild and hatchery salmon and percent return from hatchery smolts at the Liscomb Falls fish counting facility in recent years.

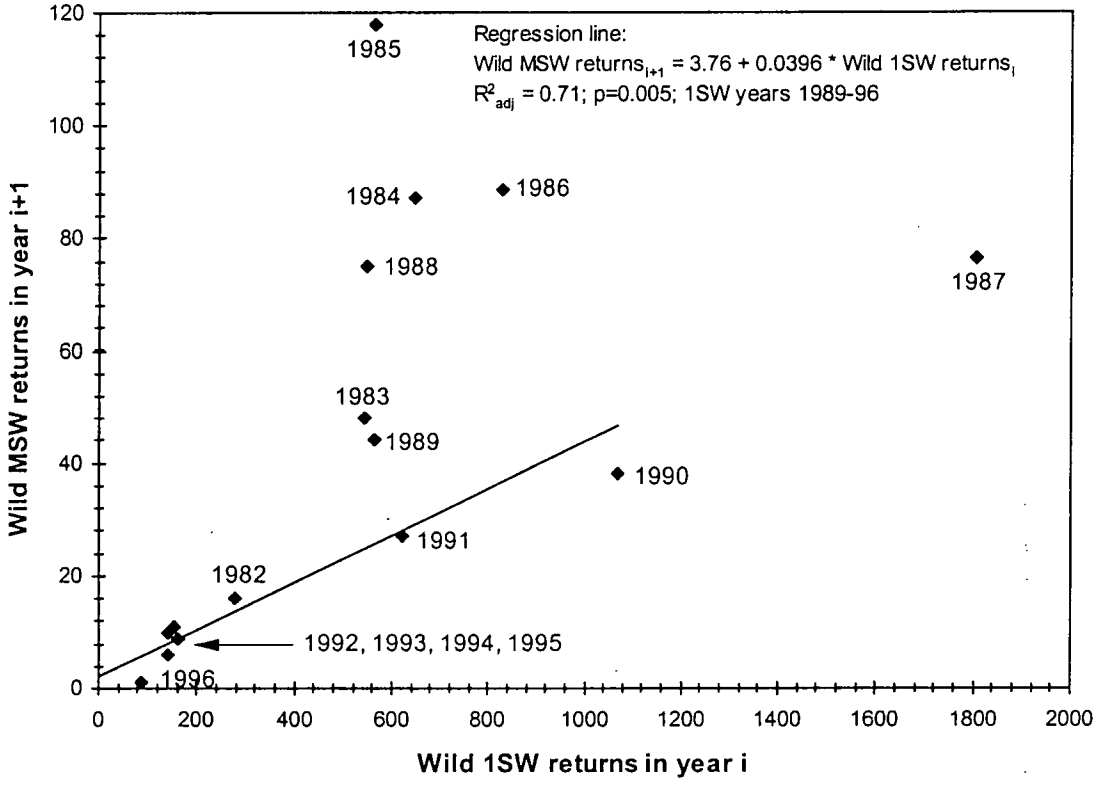

Figure 4. Scatter plot of the Liscomb River wild large salmon returns (year i+1) and wild grilse returns (year i), 1982-1996. Returns are reconstructed to include angling removals. The solid line represents the regression line fit to the 1989-1996 (1SW) years.

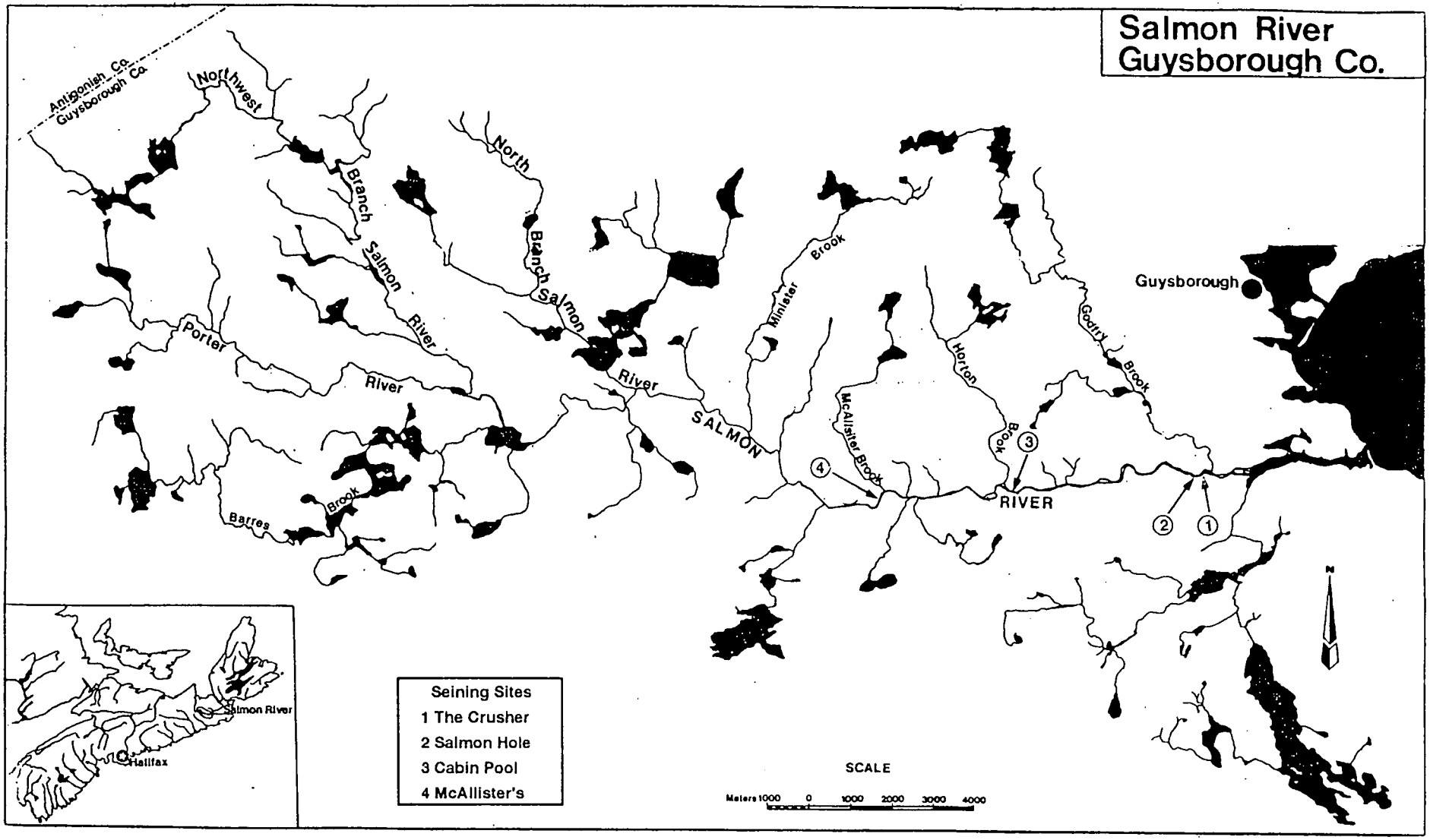

Figure 5. Location of four seining sites for Atlantic salmon on Salmon River, Guysborough Co., for the mark-and-recapture population estimate conducted in 1997.

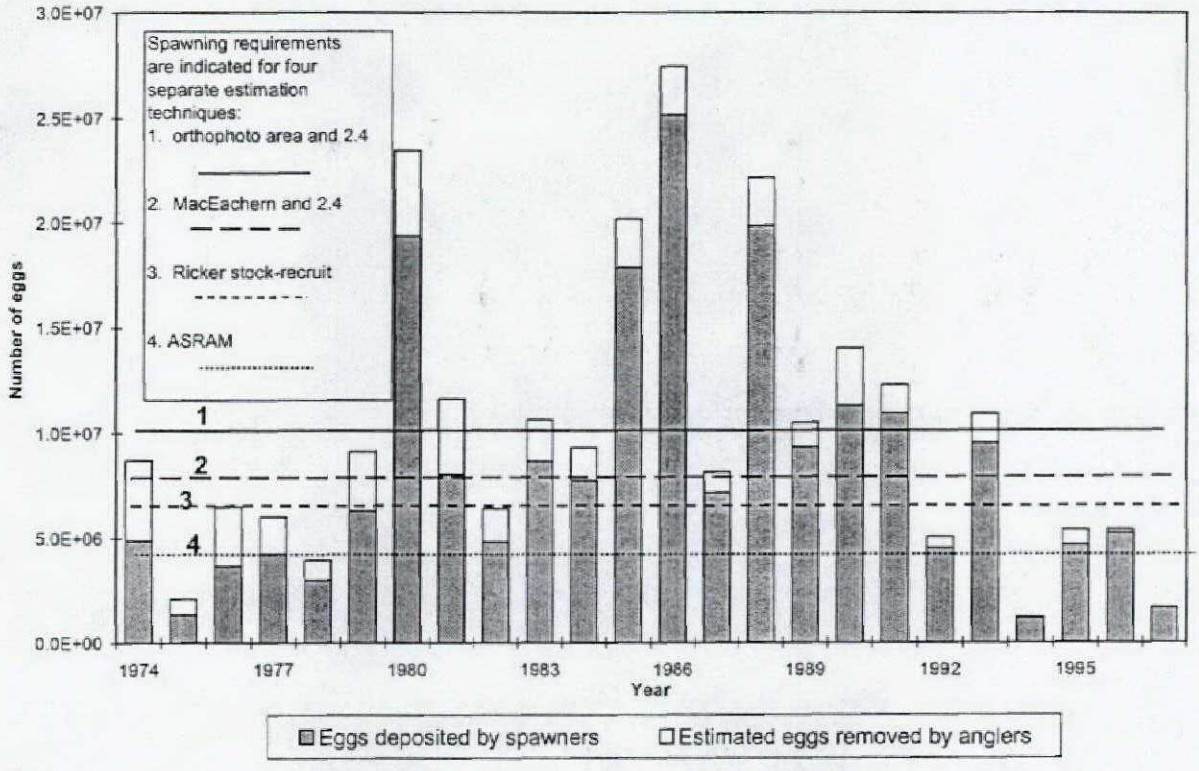

Figure 6 . Estimates of returns (entire bar) and escapements (shaded bar), in eggs, to the St. Mary's River, derived from angling catch data and capture rates, 1974-97, relative to four separate estimates of spawner requirements. The clear portion of each bar represents the proportion of estimated returns as eggs removed by anglers in the angling fishery.

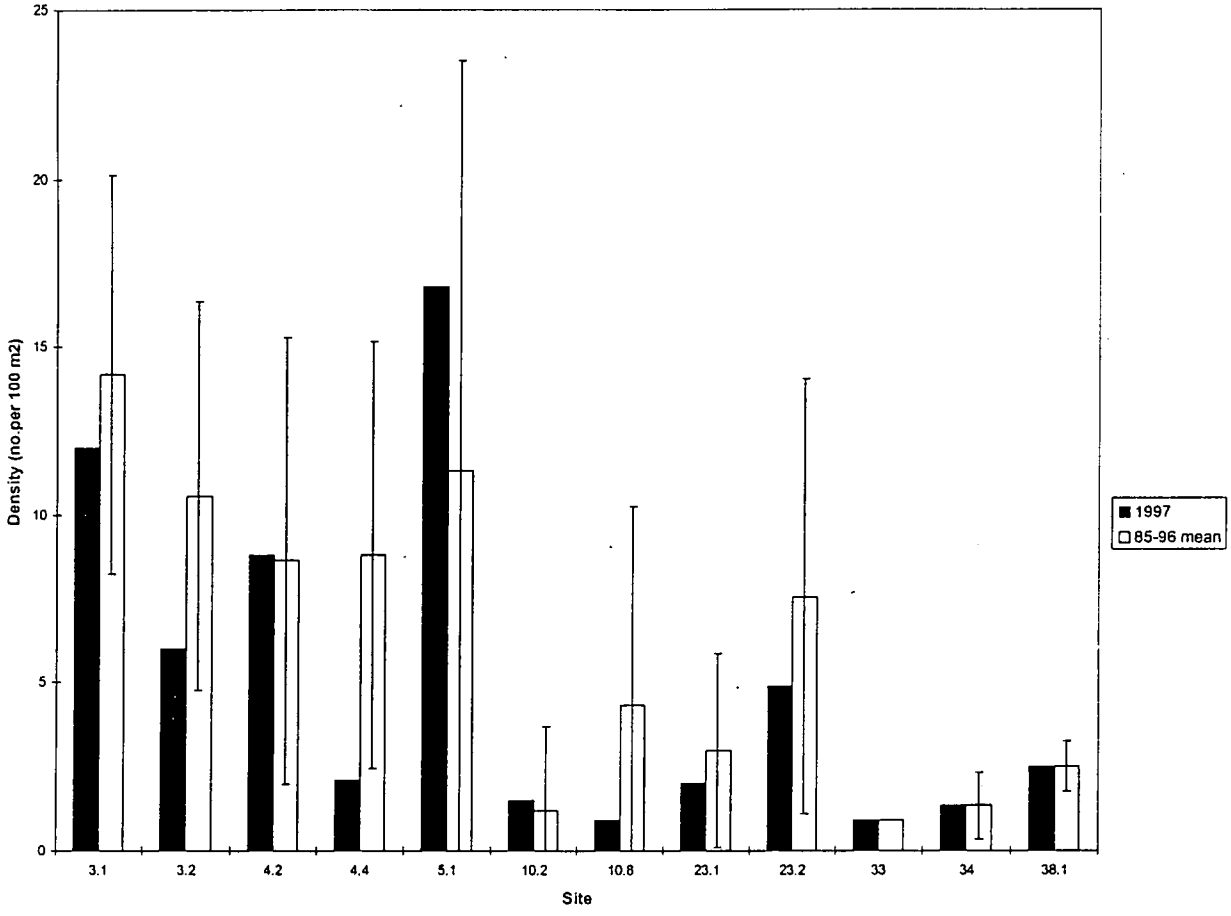

Figure 7. Saint Mary's River total parr densities for 1997 and mean densities for several previous years (1985, 1986 and 1990-1996) on 12 sites fished in 1997. Error bars represent 2 x standard deviation.

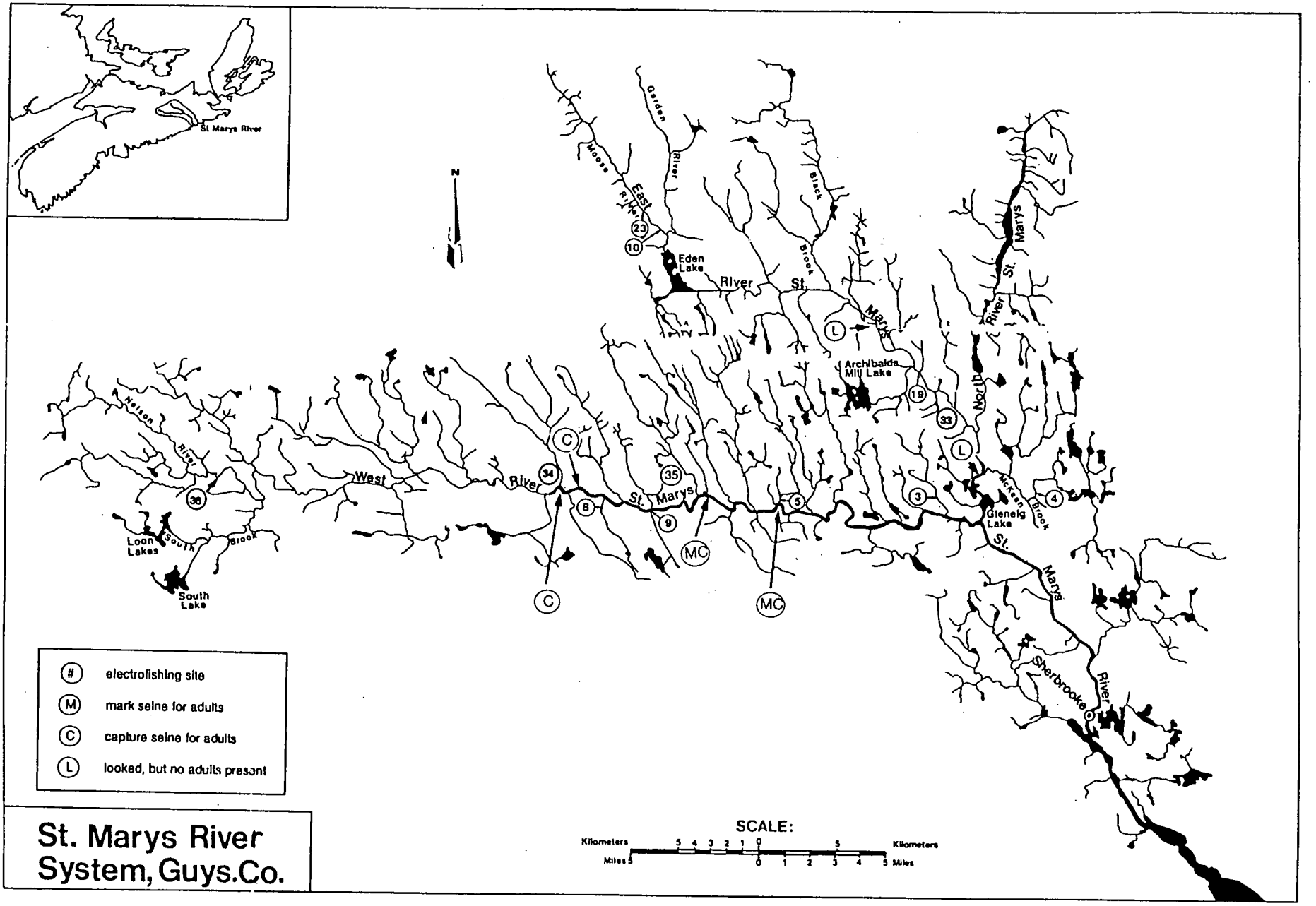

Figure 8. Location of the electrofishing sites on the St. Mary's River and the sites sampled for adult salmon during the 1997 mark-and-recapture population study.

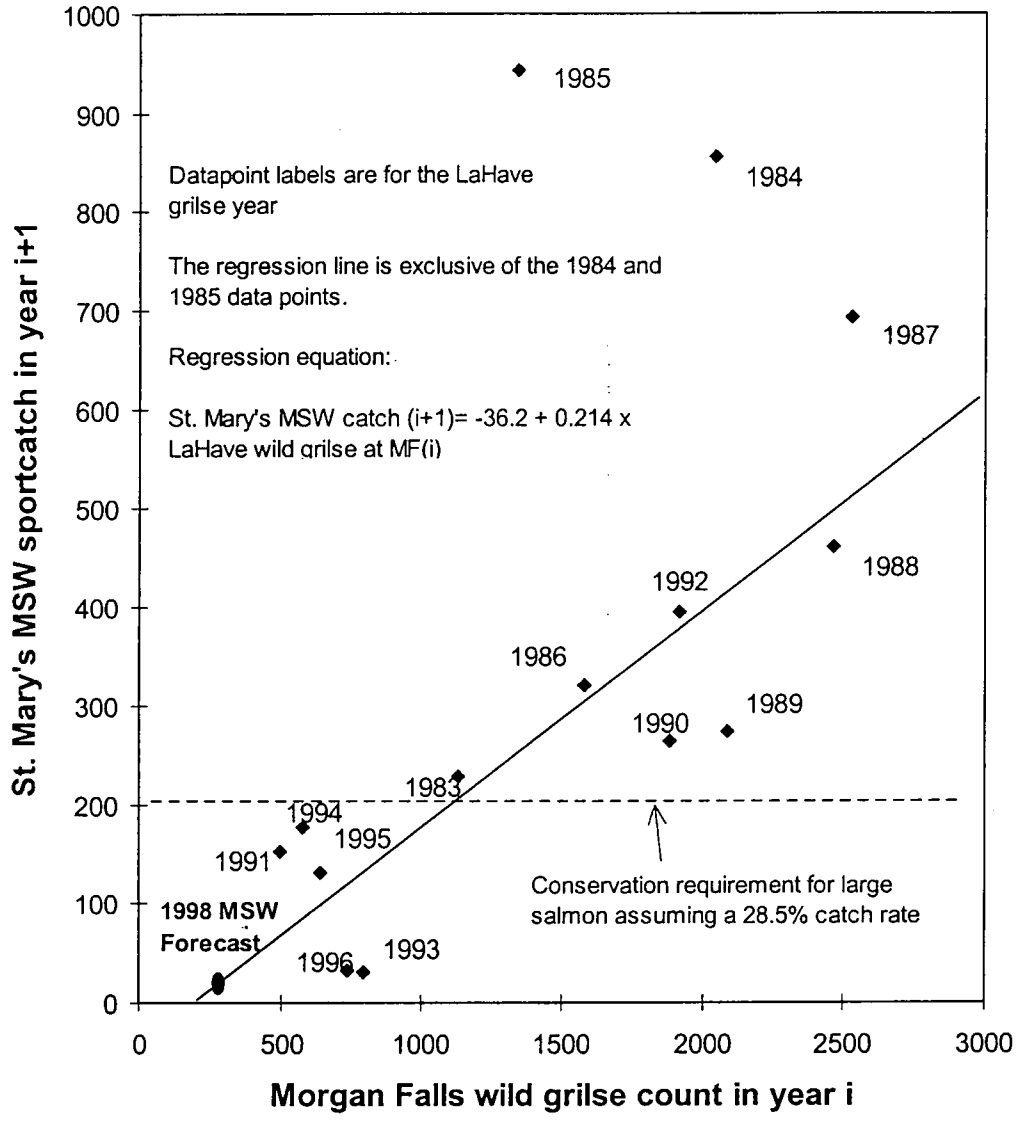

Figure 9. Plot of the St. Mary's River large salmon sport catch and the wild grilse returns to Morgan Falls on the LaHave River the previous year. The least squares best fit line (exclusive of the 1884 and 1885 grilse years data points) and 1998 forecast point are indicated.

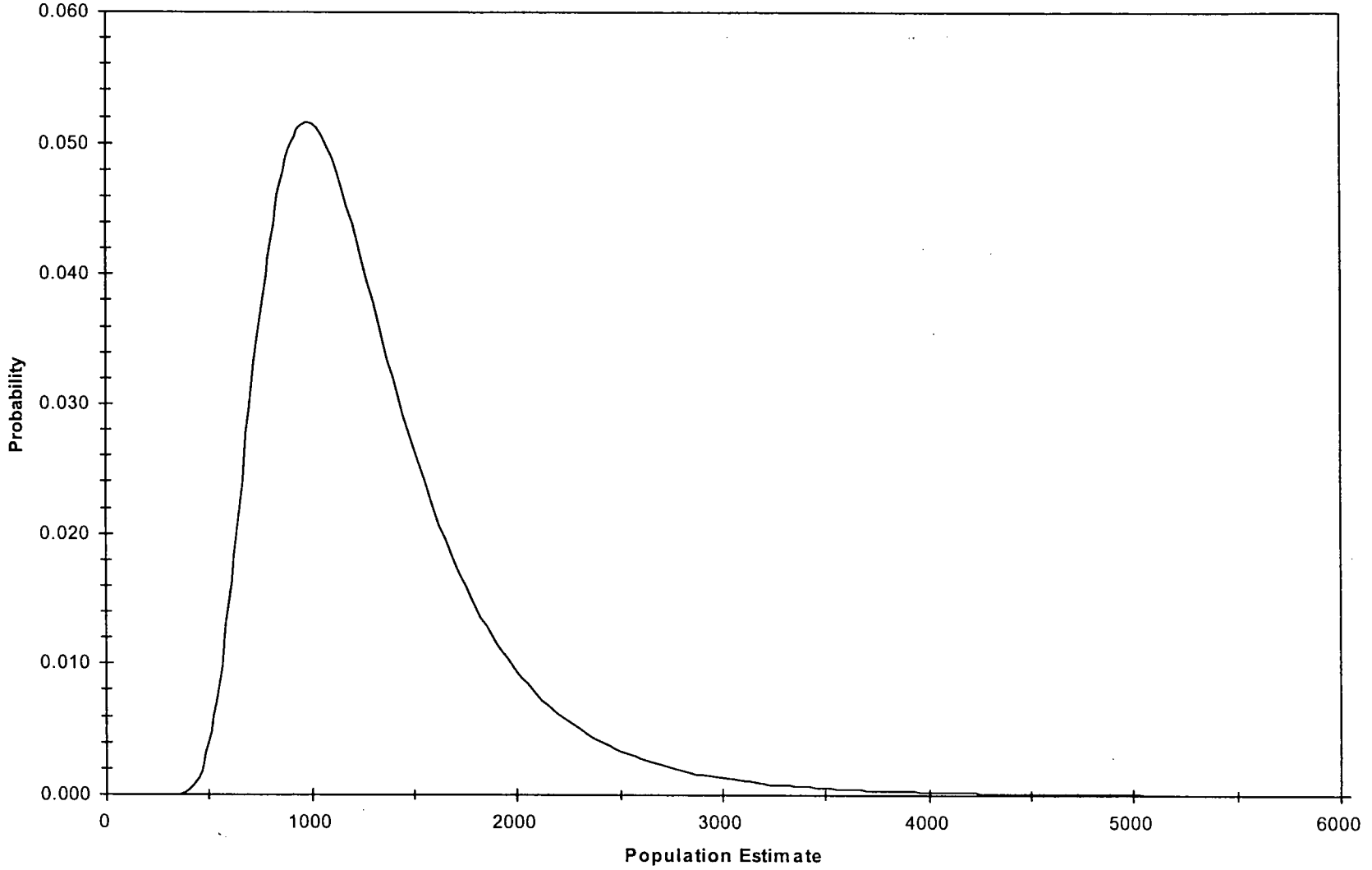

Figure 10. Probability distribution of the post-fishery population estimates of Atlantic salmon for the 1997 mark-and-recapture experiment used to estimate the adult salmon population size on the St. Mary's River.

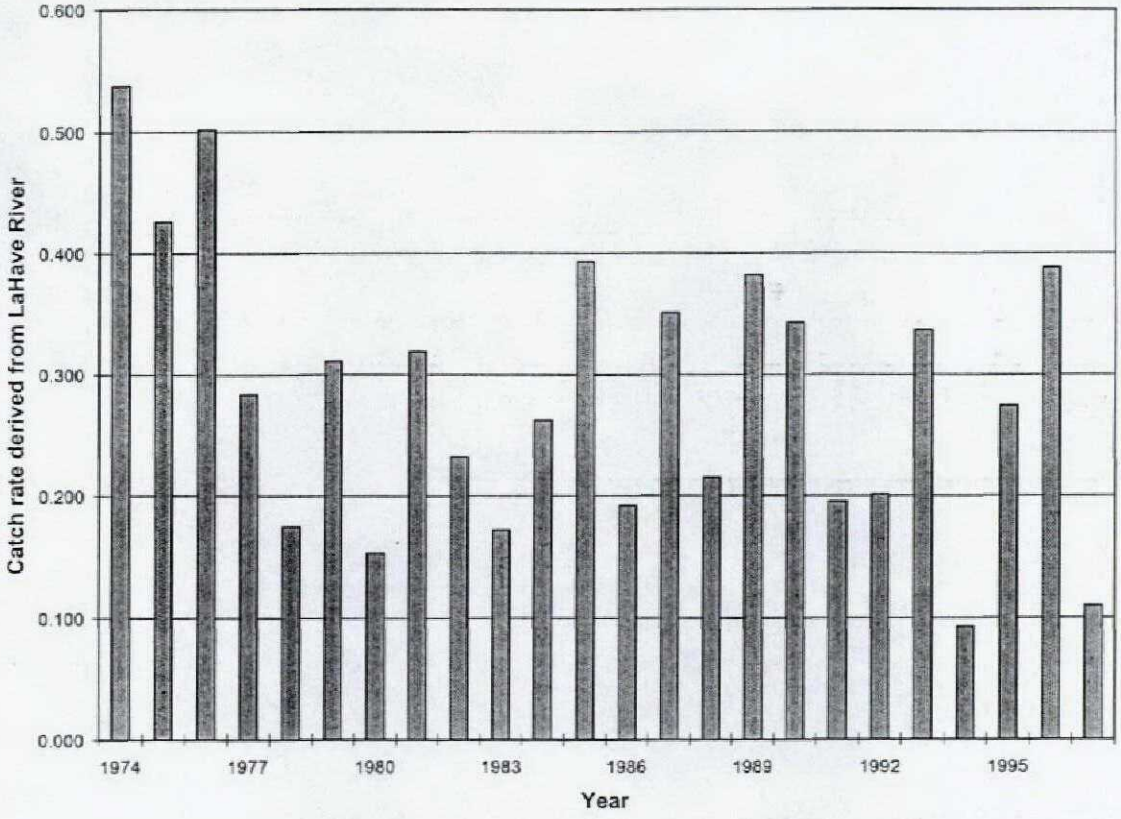

Figure 11. Catch rates derived from angling data and calibrated to Morgan Falls returns on the LaHave River, 1974-96. The 1997 catch rate was calculated from the St. Mary's River catch and population estimate.

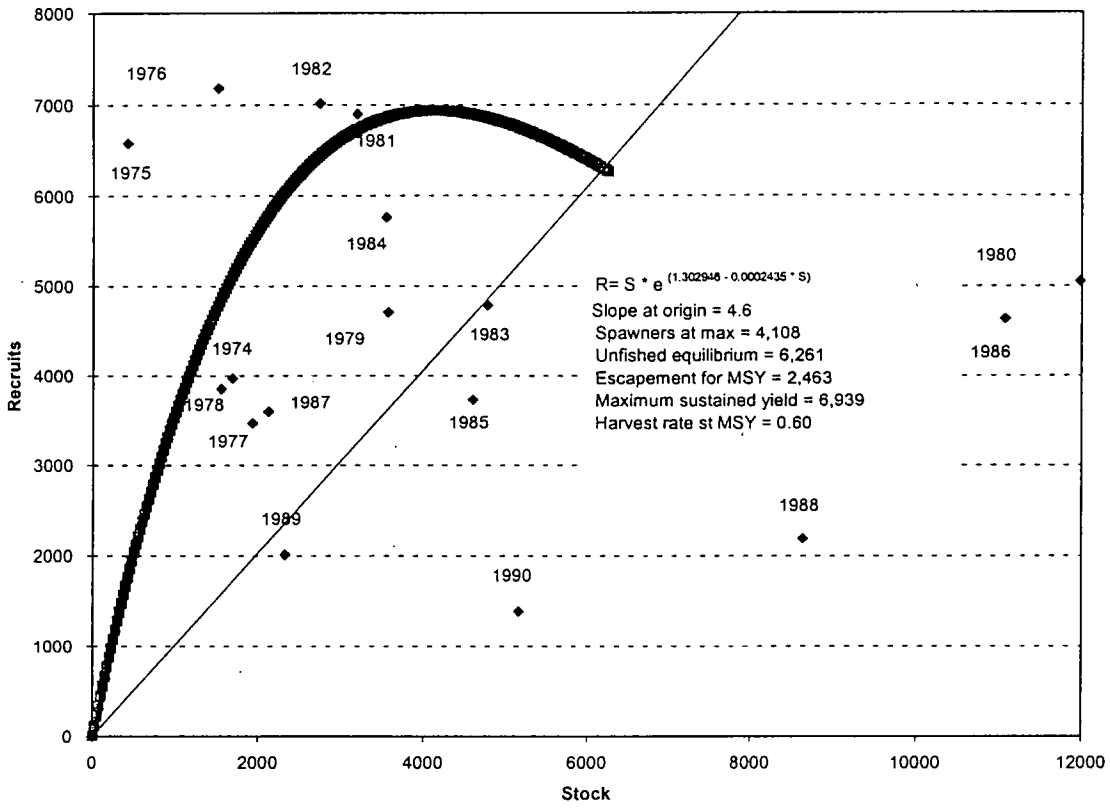

Figure 12. Stock and recruit plot for the St. Mary's River based on returns to the river reconstructed from the angling catch, using capture rates derived from the LaHave River (refer to text) and the commercial fishery landings within the estuary, for the period 1974 to 1997. Data point labels are for the stock years.

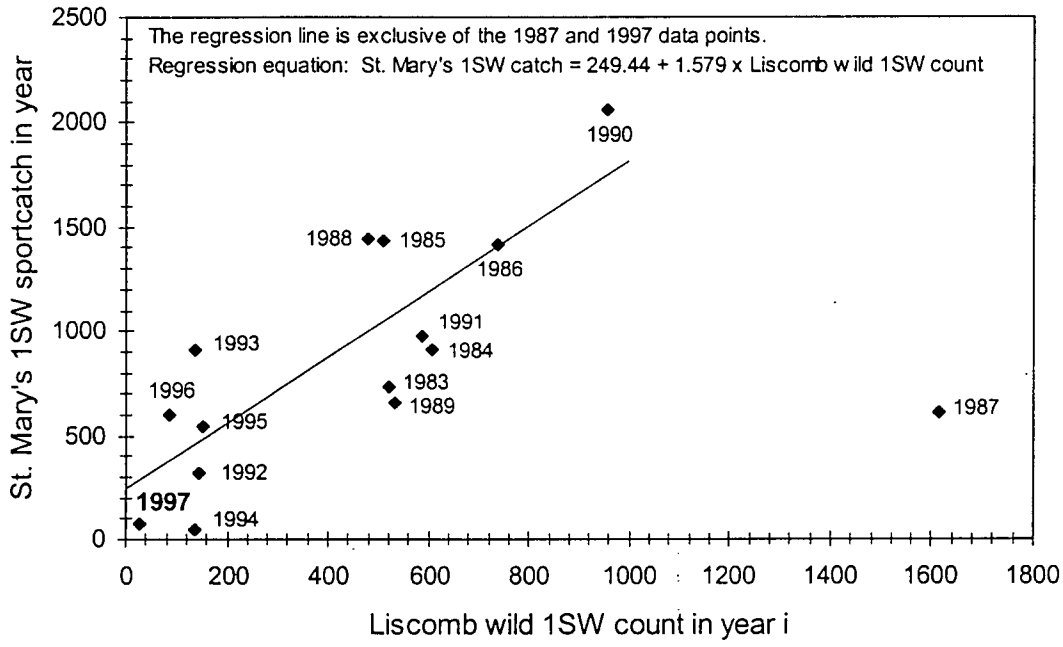

Figure 13. Scatter plot of the wild grilse returns to Liscomb River and the grilse sport catch on the St. Mary's River with a fitted regression line, for the years 1983 to 1997.

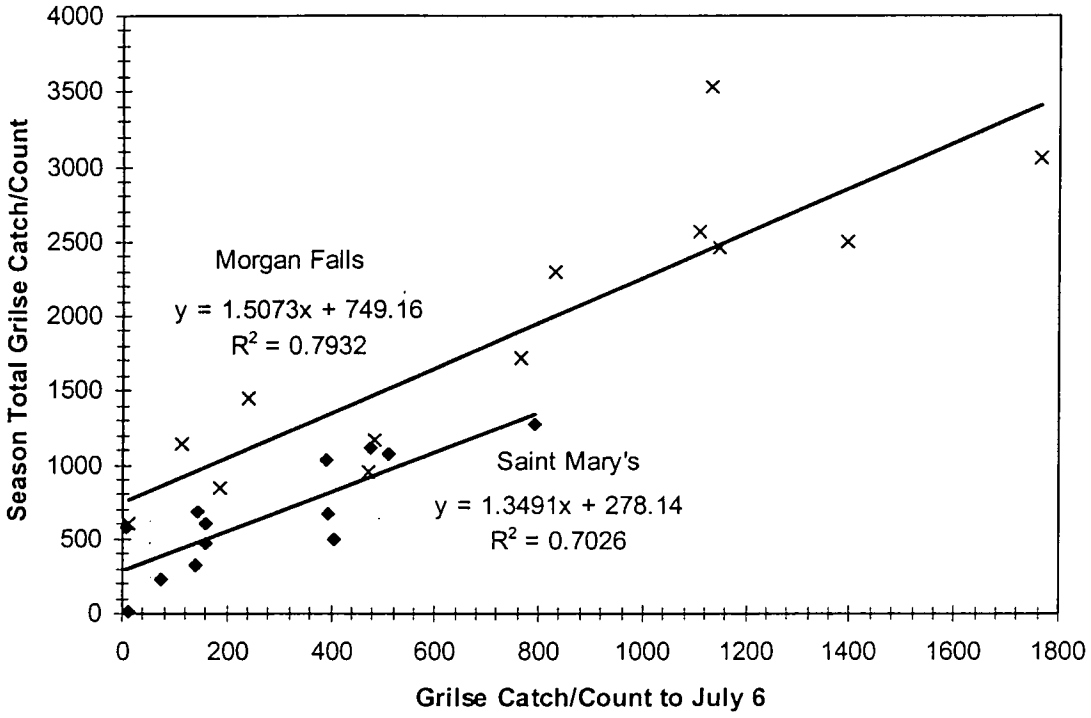

Figure 14. Regressions of Morgan Falls, LaHave River, total season grilse counts on grilse counts to July 6 and St. Mary's River angling season retained grilse sport catch on retained grilse sport catch to July 6, 1983-1995.

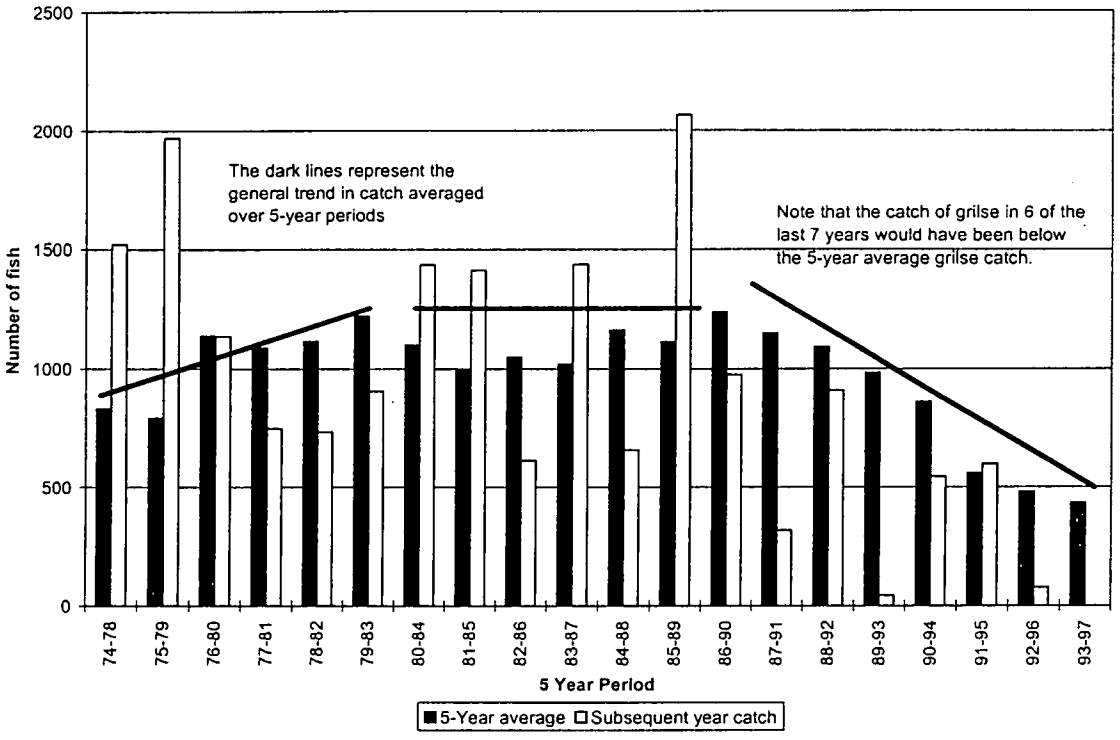

Figure 15. Five-year average grilse catches on the St. Mary's River from 1974 to 1997 (shaded bars) and the subsequent year catch (open bars).

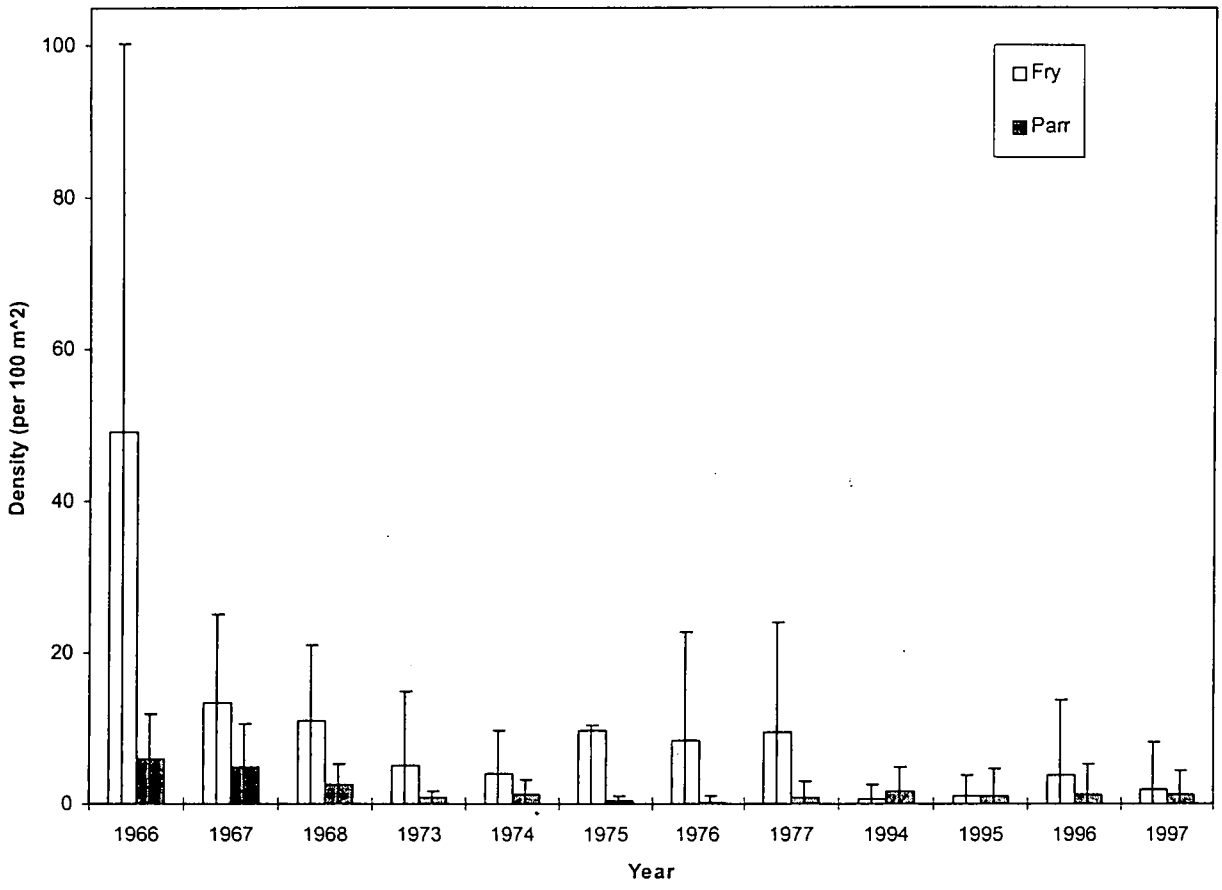

Figure 16. Juvenile Atlantic salmon densities of fry(0+ parr), total parr(1+ and 2+) and error bars (2*SD), on the West River, Sheet Harbour, for some years, 1966-1997.

Appendix 1

Summary of the smolt sampling and smolt characteristics from the fish collected on the Musquodoboit and St. Mary's rivers in 1997.

Atlantic salmon smolts were collected at various locations on the Musquodoboit and St. Mary's rivers in order to determine biological characteristics (i.e., age, length, weight, and gender). The sites fished included three tributaries in the Musquodoboit River and four streams on the St. Mary's (Fig. 1 and 2).

Methods

Sampling with fyke nets occurred over a 2-week period in late May and early June, 1997. Fish were captured on their downstream migration. Smolts were identified by external characteristics as juveniles that had lost the definition of the parr marks and had become silvery. The fyke nets were of a conventional fyke net design of several metal frames giving the net the structure which direct fish into the trailing trap. Our nets consisted of a leading rectangular frame with nets attached as wings, followed by 3 or 4 metal hoops. Nets were attached to the stream banks with ropes holding the wings in place. Heavy rock was used to anchor the front edge of the rectangular frame to the stream bottom. The resulting set-up formed a downstream "V" which was usually located in an area of the stream where the stream shape formed a natural funnel into a pool. Traps were usually set in the morning and left to fish overnight. They were checked and cleaned daily but were not necessarily set every day depending on staff availability and water conditions. Captured fish which were identified as probable smolts were dispatched, placed in individually labeled clear plastic bags and kept on ice until being placed in a freezer for examination at a later date.

On Kent Brook, Musquodoboit River, several attempts were made to collect smolts by electrofishing. A two-person team, one with a Smith-Root model 15-A backpack electrofisher (generator powered) and the other a dip net and bucket, fished approximately 1 kilometer of stream. Few smolts were captured by this method so fyke nets were used elsewhere.

Results

Musquodoboit River: Twenty-eight smolts were captured, 9 on Dickey Brook, 5 on Kent Brook and 14 on the North Branch Musquodoboit River (Table 1). Smolt fork-length ranged from a low of 10.8 cm to a high of 14.5 cm (Table 2).

St. Mary's River: Sixty-three smolts were captured, 25 on Nelson River, 1 on Indian Man Brook, 31 on Moose River, and 6 on McKeen's Brook (Table 1). Fork-length of the smolts ranged from 12.5 to 15.6 cm (Table 2).

Table 1. Location, dates, and numbers of Atlantic salmon smolts captured on the Musquodoboit and St. Mary's rivers in 1997.

Location	Date	Number of smolts	Water T temp °C
Musquodoboit River			
Dickey Brook	May 29	2	
	May 30	7	
Kent Brook	May 26	2	
	May 30	2	
	Jun 03	1	
North Branch Musquodobit	Jun 05	2	9.0
	Jun 06	6	12.0
	Jun 11	1	16.5
	Jun 12	4	18.5
	Jun 18	1	18.0
St. Mary's River			
Nelson River	May 21	0	8.0
	May 22	19	9.0
	May 23	6	5.0
Moose River	May 22	1	7.0
	May 23	2	6.0
	May 27	0	6.0
	May 28	0	8.0
	May 29	1	9.0
	May 30	27	10.0
Indian Man Brook	May 27	0	8.0
	May 28	0	8.0
	May 29	0	8.0
	May 30	1	9.0
	Jun 03	0	8.0
	Jun 04	0	7.0
	Jun 05	0	9.0
	Jun 06	0	8.0
	Jun 07	0	7.5
	Jun 08	0	7.5
	Jun 09	0	7.5
McKeen's Brook	Jun 02	0	17.0
	Jun 03	3	10.0
	Jun 04	2	9.0
	Jun 05	0	11.5
	Jun 06	0	12.0
	Jun 07	1	9.5
	Jun 08	0	9.0
	Jun 09	0	9.5

Table 2. Location, age, precosity, mean lengths and weights of Atlantic salmon smolts captured on the Musquodoboit and St. Mary's rivers in 1997.

Location	Age	Sex	Precocious	Number	Percent of catch	Weight in grams			Length in cm				
						Number	Mean	Stdev	Number	Fork	Stdev	Total	Stdev
Musquodoboit River													
Dickey Bk.	2	F		7	78	7	20.0	3.61	7	12.6	0.73	13.7	0.81
	3	F		1	11	1	20.1		1	12.9		14.0	
	2	M	yes	1	11	1	20.2		1	12.7		13.9	
	Subtotal Dickey Brook			9	100	9	20.1	3.13	9	12.6	0.64	13.8	0.70
Kent Bk.	2	F		1	20	1	20.2		1	12.4		13.0	
	2	M	?	1	20	1	14.5		1	10.8		11.7	
	2	M	yes	2	40	2	21.9		2	12.4		13.4	
	2	M		1	20	1	18.0		1	11.5		12.3	
	Subtotal male			4	80	4	19.1	4.94	4	11.8	1.13	12.7	1.17
	Subtotal Kent Brook			5	100	5	19.3	4.31	5	11.9	1.01	12.8	1.03
North Branch	3	?		1	8	1	32.4		1	14.5		15.8	
Musquodoboit	2	F		1	8	1	24.3		1	12.2		13.4	
	2	M	?	1	8	1	26.9		1	13.5		14.5	
	1	M	yes	2	15	2	25.7		2	13.5		14.5	
	2	M	yes	4	31	4	20.3*	8.20	4	12.2	1.66	13.2	1.36
	3	M	yes	2	15	2	28.3		2	13.6		14.8	
	1	M		1	8	1	33.3		1	14.3		15.5	
	2	M		2	15	2	31.6		2	13.7		14.8	
	Subtotal male			12	92	12	26.0	7.82	12	13.2	1.27	14.3	1.33
	Subtotal North Branch Musquod.			14	100	14	26.4	7.42	14	13.3	1.25	14.3	1.31
St. Mary's River													
Nelson River	2	?		4	19	4	25.4	2.32	4	14.0	0.37	15.0	0.10
	2	F		12	57	12	25.2	6.15	12	13.9	1.21	15.0	1.11
	3	F		2	10	2	25.8		2	13.8		15.1	
	Subtotal female			14	67	4	25.3	5.98	4	13.9	1.18	15.0	1.12
	2	M	?	1	5	1	20.4		1	12.9		13.9	
	2	M	yes	5	24	5	25.3	3.22	5	13.8	0.92	14.8	0.90
	3	M	yes	1	5	1	36.5		1	15.4		16.7	
	Subtotal male			7	33	7	26.2	5.56	7	13.9	1.06	15.0	1.11
	Subtotal Nelson River			25	100	25	25.6	5.29	25	13.9	1.03	15.0	1.01
Moose River	2	?		6	11	2	22.5		6	13.3	0.42	14.4	0.44
	3	?		3	39	2	27.1		3	13.6	1.18	15.2	1.97
	2	F		11	11	10	25.0	6.16	11	13.7	0.97	15.0	1.10
	3	F		3	50	3	29.8	4.40	3	14.6	0.66	16.1	0.72
	Subtotal female			14	14	13	26.1	6.01	14	13.9	0.98	15.2	1.11
	2	M	yes	4	14	4	28.3	1.79	4	14.2	0.43	15.4	0.47
	3	M	yes	4	29	4	23.3	4.01	4	13.4	1.12	14.7	1.19
	Subtotal male			8	111	8	25.8	4.01	8	13.4	1.12	14.7	1.19
	Subtotal Moose River			31	100	25	25.8	5.07	31	13.7	0.88	15.0	1.07
Indian Man Bk.	3	M		1	100	1	19.3		1	12.5		13.5	
McKeen Bk.	2	?		1	20	0			1	12.8		13.8	
	2	M	?	1	20	0			1	13.4		14.5	
	2	M		3	60	3	35.2	14.15	3	15.6	1.57	16.7	1.58
	3	M	?	1	20	0			1	13.0		14.2	
	Subtotal male			5	100	3	35.2	14.15	5	14.6	1.73	15.8	1.72
	Subtotal McKeen's Brook			6	100	3	35.2	1.72	6	14.3	1.72	15.5	1.74

* weights available for 3 samples only

? sample partially decomposed

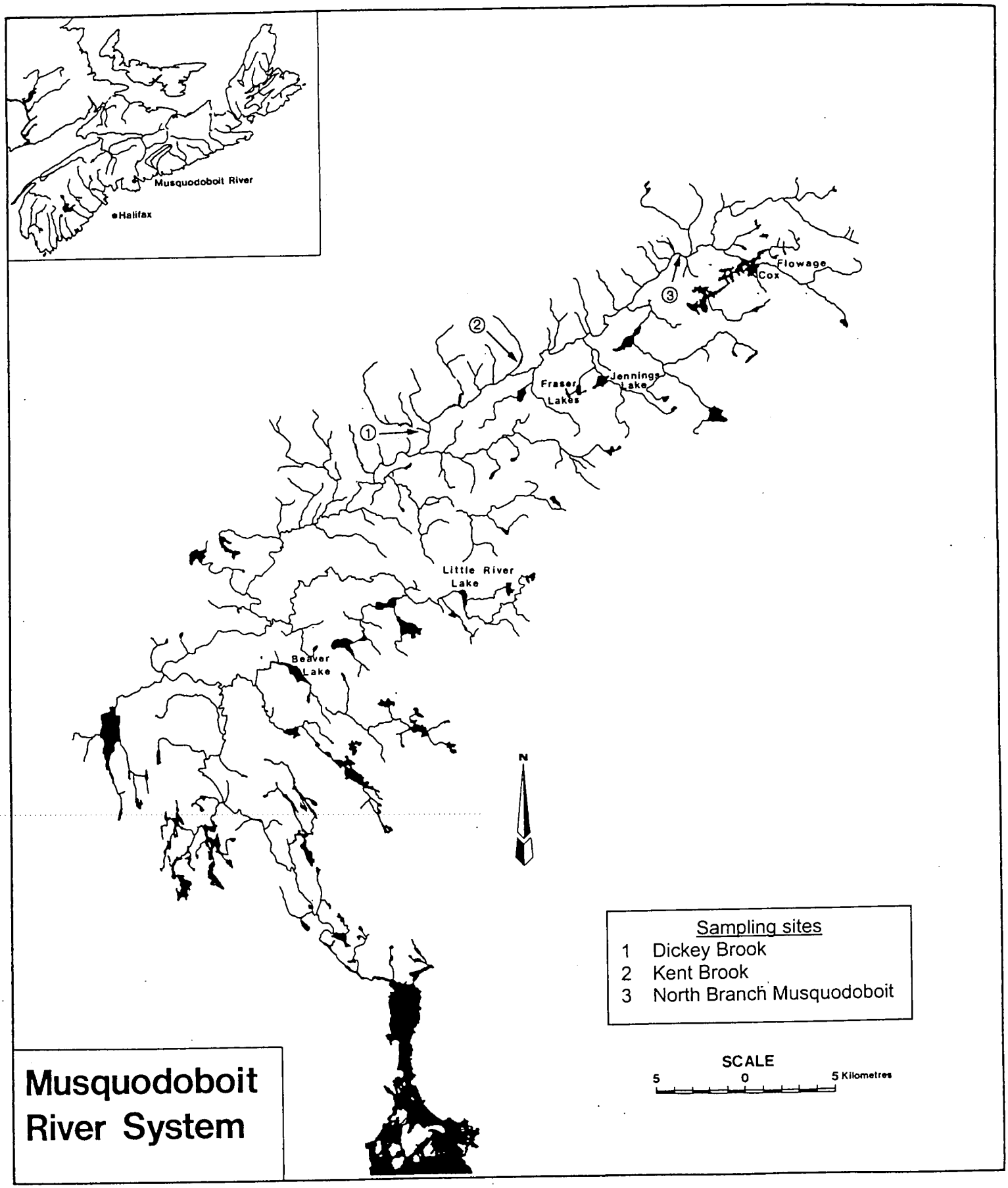

Figure 1. Sampling locations for Atlantic salmon smolts on the Musquodoboit River in 1997.

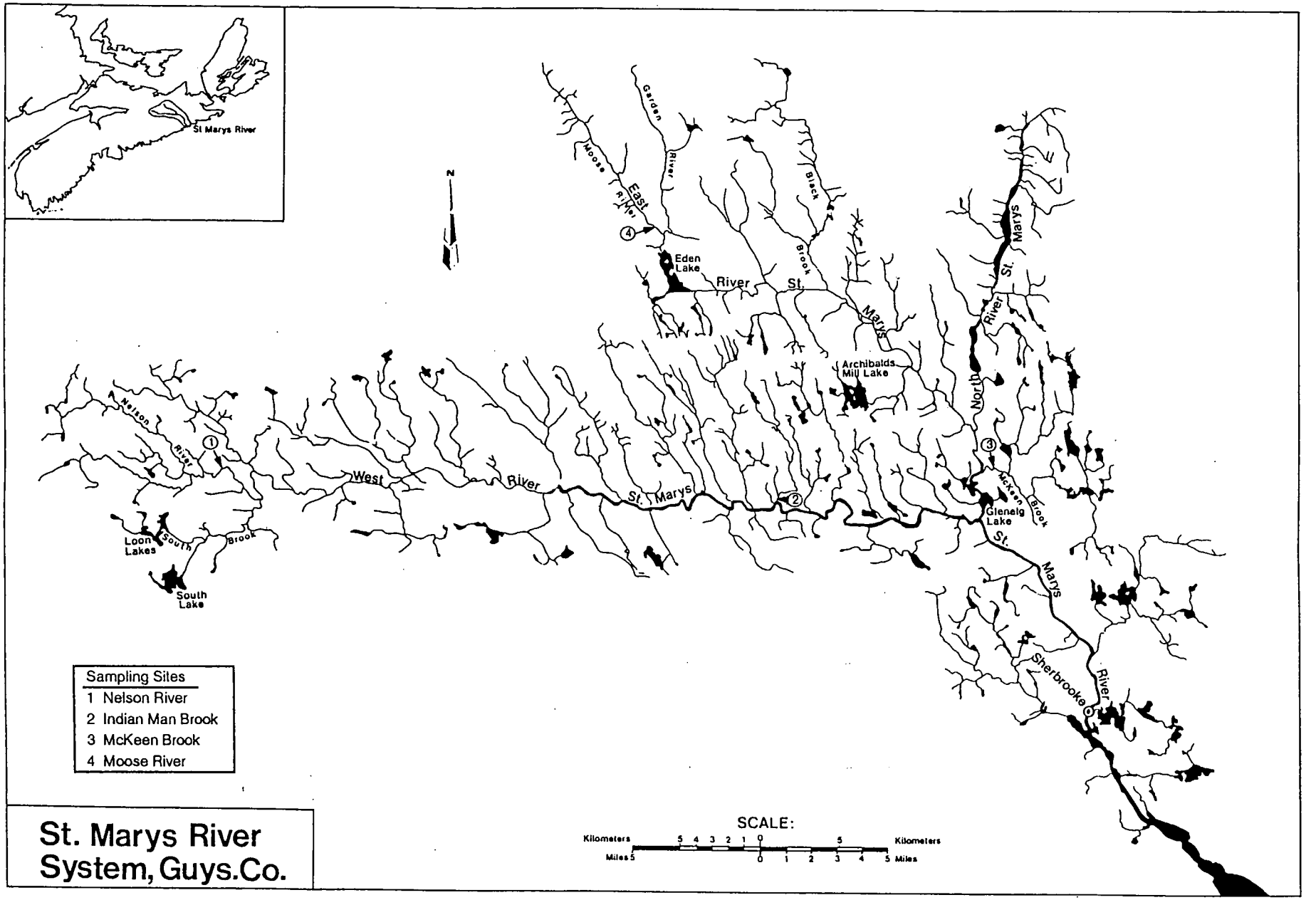

Figure 2. Sampling locations for Atlantic salmon smolts on the Saint Mary's River in 1997.

Appendix 2

and Oceans et Oceans

Shane O'Neil
Special Projects Biologist
Halifax, N.S.

Telex 01931552

Your file Votre référence

Pat Young
A/Field Supervisor
Sherbrooke, N.S.

Our file Notre référence

December 11, 1997

Subject: Salmon River, Guysborough Co.

As a result of the last two ZMAC meetings(prior to April 30, 1997), F/S R.P. McClung requested that a concerted effort be made on Salmon River this year to determine if there was any salmon mortality as a result of the hook and release fishery. A total of 23 foot patrols, two boat patrols and one snorkel dive were carried out. I did not observe any dead salmon on any of these patrols. I also had the opportunity to fish the river on six different days and did not observe any dead salmon. A few fishermen were observed beaching fish in order to recover hooks. These fishermen were advised to bend their barbs and release the fish in the water.

A capture/recapture experiment was initiated on the river this year with salmon fishermen who volunteered their services. Holepunches were used to mark the dorsal side of the caudal fins of released salmon. Six fisherman took part and the results were as follows:

Neil Watson	47
James MacDonald	22
Art Dunn	14
Michael MacDonald	4
Pat Young	3
Jim Flemming	1
Total----------	91

All fishermen should be congratulated for their efforts, especially Neil Watson who tagged over half of the marked fish, and who also provided a couple of fish cradles to safely handle the salmon while landing, marking and releasing them. On Sept. 18/97 , 64 salmon were seined and sampled from the Salmon Hole and the Crusher Pool. On Oct. 8/97, 91 salmon were seined and sampled from the Salmon Hole, Crusher, MacAllisters and the Cabin Pool. Thanks to Neil Watson and Hartley Dort for their assistance in the seining operations as well as F/O's Bill Barrie, Ken Ehler and Bill Ehler. Looking forward to another successful year in 1998!

cc F/S R.P. McClung, CEO R.C. Thompson