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Estimates of Atlantic Salmon Stock Status  
on the Eastern Shore of Nova Scotia,  
Salmon Fishing Area 20, in 1994

by

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### **Abstract**

The Atlantic salmon stocks of the Eastern shore of Nova Scotia, Salmon Fishing Area 20, exhibited an unprecedented decline in sport catch in 1994. The angling season was closed for a brief period and then limited to hook and release because of the low numbers of returning salmon. Returns of wild fish to the only counting facility in SFA 20, on the Liscomb River, were the lowest since 1981 for 1SW fish and since 1982 for MSW fish. The return rate of hatchery smolts to the trap during the past few years has been the only consistently low period during the time series (1978-93). Sport catch on the St. Mary's River reached an all-time low in 1994. A significant regression of St. Mary's MSW salmon sport catch  $(i+1)$  on LaHave River wild 1SW salmon counts at Morgan Falls  $(i)$  for two different time periods forecast a return of 192 or 102 MSW fish to the sportfishery in 1995. Forecast returns for either time series do not indicate targets will be met. Low numbers of fish during the past several years led to closure of the West River SH in 1994. Although sport catch data are not available for 1994, there is no evidence to support a harvest fishery in 1995. Juvenile density data on the St. Mary's River collected during 7 of the years from 1985 to 1993 did not exhibit any change in average density over time. Many of the rivers in SFA 20 are acid impacted so targets are under review. Evaluation of returns to SFA 20 rivers based on a range of exploitation rates and sport catch data indicates that nominal targets (based on 2.4 eggs/m<sup>2</sup>) were not met in 1994. Harvest fisheries for SFA 20 rivers can not be supported for 1995.

### **Résumé**

Les prises sportives de saumon de l'Atlantique en provenance de la zone de pêche du saumon 20, sur la côte est de la Nouvelle-Écosse, ont subi un déclin sans précédent en 1994. La saison de pêche à la ligne a été brièvement fermée, puis limitée à une pêche avec remise à l'eau des captures en raison des faibles montaisons. Les montaisons de saumon sauvage à la seule installation de dénombrement de la ZPS 20, sur la rivière Liscomb, étaient les plus basses depuis 1981 en ce qui concerne les unibermarins et depuis 1982 pour les pluribermarins. Pour ce qui est du taux de montaison des saumoneaux d'écloserie au piège de dénombrement, les deux dernières années représentent la seule période de baisse continue dans la série chronologique (1978-1993). Les prises sportives dans la rivière St. Mary's ont atteint un seuil sans précédent en 1994. Une régression significative des prises sportives de pluribermarins de la St. Mary's  $(i+1)$  par rapport aux dénombrements d'unibermarins sauvages de la LaHave aux chutes Morgan  $(i)$  au cours de deux périodes différentes laisse prévoir des montaisons de 192 ou 102 pluribermarins pour la pêche sportive en 1995. D'après les prévisions de montaison établies pour les deux séries chronologiques, il n'apparaît pas que les besoins cibles seront comblés. Le petit nombre de poissons durant ces dernières années a abouti à la fermeture de la rivière West-Sheet Harbour en 1994. Bien qu'on ne dispose pas des données sur les prises sportives de 1994, rien ne milite en faveur d'une récolte en 1995. Les données sur la densité des juvéniles dans la St. Mary's recueillies pendant sept des années 1985 à 1993 ne révélaient aucun changement de la densité moyenne dans le temps. Un bon nombre des rivières de la ZPS 20 sont acidifiées, aussi les cibles sont-elles en cours de réexamen. L'évaluation des montaisons dans les rivières de la ZPS 20 fondée sur divers taux d'exploitation et données sur les prises révèle que les cibles nominales (fondées sur 2,4 oeufs/m<sup>2</sup>) n'ont pas été atteintes en 1994. On ne peut justifier une récolte dans ces rivières en 1995.

### Summary Sheet - Liscomb River

**STOCK:** Liscomb River above Liscomb Falls Fishway, SFA 20.

**TARGET:** Currently under development due to acid stress; nominal target is  $3.69 \times 10^6$  eggs.

(egg target corrected from number published in SSR 95/2)

Year	1989	1990	1991	1992	1993	1994	MIN <sup>a</sup>	MAX <sup>a</sup>	MEAN <sup>a</sup>
<b>Recreational catch (1SW)<sup>b</sup>:</b>	65	177	68	19	14	25	14	289	120
<b>Counts:</b>									
Wild 1SW	532	955	586	145	134	134	134	1,614	632
Wild MSW	75	44	38	27	11	10	11	117	63
Hatchery 1SW	288	438	178	125	128	119	125	766	325
Hatchery MSW	71	22	22	12	12	8	12	108	58
Total	966	1,459	824	309	285	271	285	2,279	1,077
<b>Egg deposition/m<sup>2c</sup>:</b>	1.2	1.6	0.9	0.4	0.34	0.32	0.34	2.5	1.25
<b>Return rate of hatchery smolts:</b>									
1SW (%)	0.60	1.56	0.79	0.50	0.42	0.56	0.35	2.75	1.21
MSW (%)	0.23	0.05	0.08	0.05	0.05	0.03	0.05	0.23	0.13

<sup>a</sup> For the period 1985-1993.

<sup>b</sup> Below fishway 1985-92; for the entire river 1993-94; numbers include harvest and release.

<sup>c</sup> Above fishway.

**Recreational catches:** No retention of MSW fish since 1984. 1SW catches (1985-1994) have ranged from 14 in 1993 to 289 in 1987. Prior to 1993 the recreational fishery was limited to the 5 km of river below the fishway.

**Data and assessment:** Counts of adult fish are obtained at Liscomb Falls fishway. Return rates are based on adults returning from 1- and 2-year old smolts released from the Cobequid or Mersey Fish Culture Stations (10,000 and 11,380, respectively, in 1993). The largest tributary to the main river, the Little Liscomb, has pH levels believed to be incapable of supporting Atlantic salmon.

**State of the stock:** The nominal target egg requirement of 2.4 eggs/m<sup>2</sup> has been met only once since 1979 (1987); a significant contribution to egg deposition comes from hatchery-origin fish of Liscomb River stock. The 1994 escapement resulted in egg deposition of approximately one-seventh (13%) of nominal target.

**Forecast for 1995:** Forecasts of 1SW returns are unavailable. An annually-updated relation between 1SW returns in year t and MSW returns in year t + 1 predicts a return of 25 MSW salmon ( $p < 0.05$ ; 90% CI 0-82) in 1995.

### Summary Sheet - St. Mary's River

**STOCK:** St. Mary's River, SFA 20.

**TARGET:** 2,436 1SW fish; 437 small (74 cm) and 281 large (85 cm) MSW salmon ( $7.4 \times 10^6$  eggs).

**REARING AREA:** 3,078,500 m<sup>2</sup>.

Year	1989	1990	1991	1992	1993	1994	MIN <sup>a</sup>	MAX <sup>a</sup>	MEAN <sup>a</sup>
<b>Recreational catch:</b>									
1SW <sup>b</sup>	645	2,063	975	319	909	44	319	2,063	1,072
MSW	462	274	264	152	396	30	152	944	454
<b>Escapement (estimated) based on 30% exploitation rate:</b>									
1SW	1,318	3,761	1,736	663	1,722	47	663	3,761	2,026
MSW	1,494	886	854	491	1,019	70	491	3,052	1,458
<b>Egg deposition/m<sup>2</sup>:</b>	3.0	3.4	2.2	1.1	2.5	0.1	1.1	6.1	3.3
<b>Stocking:</b>									
Main River									
0+ parr					5008				
West Branch									
2+ smolt	7,216	5,538							
East Branch									
0+ parr	54,094	25,060		43,315	63,471				
1+ parr		2,565	7,820	15,293	10,815	9,561			
2+ smolt	8,588	18,201	20,683		19,638	19,755			

<sup>a</sup> For the period 1984-1993.

<sup>b</sup> Numbers include harvest and release.

**Recreational catches:** No retention of MSW fish since 1984. 1SW catches (1985-1994) have ranged from 319 in 1992 to 2,063 in 1990. The 1994 recreational fishing season was restricted by a closure July 21 - August 11 and subsequent limit to a hook-and-release fishery.

**Data and assessment:** The St. Mary's River sport catch was used as an indicator of returns to the St. Mary's River. The Liscomb River wild 1SW counts are correlated with the St. Mary's River 1SW sport catch ( $p=0.005$ ). The MSW sport catch is related to the LaHave River wild 1SW returns the previous year ( $p=0.005$ ). Targets were based on sample data collected from the recreational fishery between 1972 and 1984. Recent adult data from the West Branch suggest a repeat-spawning 1SW stock from that branch.

**State of the stock:** Total returns to the St. Mary's River can be estimated using an exploitation rate on sport catch data. At an exploitation rate of 30%, the St. Mary's River returns would have met target spawning requirements for 1SW fish only once since 1989 (in 1990) and for MSW fish in 4 of the previous 5 years (1989-93). The 1994 estimated escapement would have fallen short of target by over 2000 1SW fish and over 600 MSW fish. However, the 1994 sport catch may not represent returns as in other years because of the extra restrictions in place during the season.

**Forecast for 1995:** Forecasts of 1SW returns are unavailable. The relationship between St. Mary's River MSW sport catch and LaHave River wild 1SW returns the previous year forecasts an MSW sport catch in 1995 of 102 or 192 fish depending on the time series used for the regression. 1982-93 (excl. 1985) regression: 102 fish;  $p=0.009$ ; 90% C.I. 0-458. 1974-93 regression: forecast 192 fish;  $p=0.005$ ; 90% C.I. 0-572.

## 1. Introduction

### SFA 20

On the eastern shore of Nova Scotia, between Halifax and Canso, there are 31 rivers which have reportedly been fished for Atlantic salmon at some time in the past and 19 rivers which have been fished actively during the past few years (Fig. 1). The geology of the eastern shore has influenced the water chemistry and thus the quality of fish habitat. The influence has been primarily due to acidification and ranges from extreme effects such as in the Tangier River where the run of Atlantic salmon is believed to have been extinguished, to the Musquodoboit River where the underlying limestone geology has protected the water quality (Table 1).

Investigations on the state of Atlantic salmon stocks in several of those rivers, by a variety of means, either has recently occurred or can be described as ongoing. The purposes of this report are to describe the nature of those investigations, the objectives they are intended to accomplish and the results related to describing the state of the Atlantic salmon stock(s) on the eastern shore.

### Liscomb River

The Liscomb River drains an area of 400 km<sup>2</sup> and has been the site of a development project since 1977. In 1979, a fish trap began operating at Liscomb Falls where a ladder had been constructed to pass fish around the falls. Ninety percent of the rearing habitat in the river exists above the falls. The river is acid stressed (Table 1) and contains some tributaries which can not support Atlantic salmon (pH<4.7, W. Watt, pers. comm.<sup>1</sup>). The Liscomb trap is the only fish counting facility in SFA 20 with a recent history of operation, and thus the potential to serve as an indicator of stock status for similar rivers.

### St. Mary's River

The principal recreational fishery on the eastern shore of Nova Scotia occurs in the St. Mary's River. The watershed, which drains an area of 1,355 km<sup>2</sup>, consists of 2 main branches, the West which is 56 km in length, and the East which is 27 km in length. The two branches join at Glenelg to form the main St. Mary's River which empties into the ocean 19 km downstream at Sherbrooke.

The St. Mary's River has received considerable attention among Nova Scotia's Atlantic coast rivers because it contains a virgin 3SW salmon component which is believed to originate from the East Branch of the river.

A review of data available on the St. Mary's River in 1986 was unable to provide a forecasting capability for the salmon stock in that river (Marshall 1986). Since that review, the St. Mary's River

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<sup>1</sup> W.D. Watt, Freshwater and Anadromous Division, Science Branch, Fisheries and Oceans, Halifax, N.S.

Association and DFO have participated in a variety of sampling exercises intended to supplement the information available with the intention of completing an assessment of the stock. This document presents the data obtained and examines them relative to that intent.

### **West River, Sheet Harbour**

Historically, the West River Atlantic salmon sportcatch was second only to the St. Mary's River on the eastern shore of Nova Scotia. Catches, since 1951, have ranged from only a few fish in 1976 to over 500 fish in 1964 (Sport Catch Data Report Series numbers adjusted to license stub equivalents by multiplying by 1.32; see note on Table 2).

The West River Sheet Harbour (West River SH) shares an estuary with the East River SH. The East River SH is impounded for hydroelectric power production and only 5% of the production area is accessible to migrants from the sea. There is a salmon development project underway on the East River with the local river group and power company. The First Nations fishery which has occurred in the common estuary is believed to have taken fish of both East and West river origin. The East River SH stock is virtually 100% dependent on enhancement so does not currently have a conservation concern. Sportcatch on the West River SH, on the other hand, has exhibited a progressive decline, coincident with a decline in level of pH. Consequently, the stock is believed to be threatened.

## **2. Description of fisheries**

### **SFA 20**

Harvest of Atlantic salmon on Nova Scotia's eastern shore has been limited to recreational anglers and Native fisheries since 1984, the last year for an active commercial fishery. The last remaining commercial fishing license was retired in December of 1994.

A First Nations fishing plan for the Millbrook First Nations peoples included a quota for the East River at Sheet Harbour (East River SH) of 100 grilse, to be captured by various methods. A quota of 100 grilse to be taken by rod and reel was proposed for the Musquodoboit River for the Indian Brook First Nations fishing plan, but the agreement was not signed in 1994. In addition, the Native Council of Nova Scotia was issued tags for an Atlantic salmon harvest which included eastern shore rivers, but without a specific river quota.

The First Nations peoples of Millbrook worked with the Canada Department of Fisheries and Oceans and Nova Scotia Power Incorporated to operate a fish counting trap at the head of tide on the East River SH. They harvested **14 grilse** from the trap. There was no report of a harvest on the eastern shore rivers by the Native Council of Nova Scotia or the First Nation peoples of Indian Brook.

The recreational fishery was governed by regulations and quotas similar to 1993; an 8-1SW-fish season bag limit, mandatory release of large (MSW) salmon, and a two-fish daily limit. The rivers on the eastern shore were closed by variation order from July 21 - August 11 and reopened for hook-and-release until the the regularly scheduled closing dates (Table 1).

The sport fishery in 1994 was unprecedented as the poorest on record (Tables 2 and 3; Fig. 2). The 176 grilse reported killed were roughly one-tenth the previous 5-year mean of 1,718 fish. Comparison with longer-term means emphasizes the magnitude of the decline in catch; 1984-93 mean number of 1SW fish retained was 1,957, and the 1979-93 mean was 2,052 fish (Table 2). The decline was also noteworthy in the other Salmon Fishing Areas of Scotia-Fundy Region (Table 2).

The numbers of fish retained and released on individual rivers within the area were also lower than in previous years (Table 3). The angler effort declined to about 29% (4,676 rod-days) of the 1989-93 mean effort for SFA 20 of 16,158 rod-days. Anglers on two of the principal rivers within the area, the St. Mary's and Musquodoboit, noted in correspondence with DFO and at meetings that salmon fishers were not interested in going fishing because their "traditional indicators" failed to show evidence of fish. For those anglers, the indicators ranged from sighting of fish jumping in the estuary to seeing them in certain pools. Thus the low effort value was as much a response to the lack of evidence that fish were present as it was to low water conditions in July and August.

The low catch was influenced by factors other than abundance, namely the drought conditions which persisted well into the autumn on many of the eastern shore rivers and the closure of retention fisheries on July 21. However, the closures were enacted to protect stocks which were unusually low based on the available in-season indicators (see Research data below).

### **St. Mary's River**

The sport catch on the St. Mary's River in 1994 was 19 1SW fish retained, 24 1SW fish released and 30 MSW fish released. These numbers are the lowest on record (since 1951; Sport Catch Data Report Series) and are considerably lower than the recent 1989-93 mean catches of 788 1SW fish retained, 194 1SW salmon released and 310 MSW salmon released (Table 3).

Prior to the mandatory regulation to release MSW salmon, much of the St. Mary's angler effort was directed towards the virgin 3SW component of the run which was typically found in the river when the season opened, which was May 18 in 1983 and May 1 in 1980. The current season opens June 1 as a result of requests from the local river association and thus eliminates that early season large MSW salmon-directed fishery.

### **West River, Sheet Harbour**

Recent catches have fallen to less than 100 grilse per year and less than a dozen MSW salmon (Table 3). The river was closed to all recreational angling for Atlantic salmon in 1994.

Members of Millbrook First Nations did not set nets in the estuary at Sheet Harbour in 1994 as a result of concern over the condition of the West River stock. Instead, they agreed to harvest grilse (1SW fish) from the trap located at the head of tide on the East River SH.

## **3. Target**

### **SFA 20**

A conservation requirement for the entire eastern shore has not been developed because of the acidification of many of the rivers (Table 1). A nominal target can be estimated using the conservation 2.4 eggs/m<sup>2</sup> and habitat areas as determined by various researchers.

Source	Habitat area x 100 m <sup>2</sup>	Spawners required	
		1SW	MSW
Strategies for the long-term management (1986)	99,230	3,200	3,200
Atlantic Salmon Review (1978)	116,070	9,190	1,690
Amiro (c.f. 1993)	309,113	16,708 <sup>a</sup>	6,497 <sup>a</sup>

<sup>a</sup> Total fish as estimated by Amiro, pers. comm.<sup>2</sup>, (c.f. Amiro 1993) and proportioned according to the 1989-93 mean number of 1SW and MSW fish in the recreational fishery.

The lower two of these habitat estimates (99,230 and 116,070 rearing units, where one unit is 100 m<sup>2</sup>) are based on physical site surveys of many of the streams on the eastern shore but are not comprehensive and are known to be exclusive of numerous smaller tributaries within the various watersheds. The larger estimate of 309,000 units is based on orthophotographic map interpretations for area and gradient and can be expected to be more inclusive. As a minimum, the spawning requirement for the eastern shore rivers should be sufficient to provide eggs (nominally at 2.4 eggs/m<sup>2</sup>) to fill the smaller area. The larger habitat area estimate could be considered as a maximum. The current proportion of 1SW fish in the sport catch differs considerably from that used for the *Long-term Strategies* paper of 50%. The 1989-93 mean for SFA 20 is 72% 1SW. In either case, because many of the eastern shore rivers are acid stressed, the requirements can only be described as nominal. For the purposes of this exercise, both the *Long-Term Strategies* and the *Atlantic Salmon Review* targets will be considered.

### Liscomb River

The spawning requirements for the Liscomb River have been developed by Semple and Cameron (1990) to be 1,908 1SW fish and 280 MSW fish. These numbers are based on a habitat area of 1,538,500 m<sup>2</sup> above the falls (total area of 1,685,600 m<sup>2</sup>), an egg deposition of 2.4 eggs/m<sup>2</sup>, and an estimate of 1,849 eggs per fish. This habitat area is roughly one-half of that measured by Amiro (c.f. 1993; Table 1). The river is acid stressed so the actual target is under review. For the purposes of this paper, the more conservative habitat area will be used to assess whether spawning requirements have been met.

### St. Mary's River

The spawning requirement for the St. Mary's River was determined to be 2,436 1SW fish, 437 small (74 cm) MSW salmon and 281 large (85 cm) MSW salmon by Marshall (1986). The requirement was calculated based on a rearing area of 3,078,500 m<sup>2</sup>, an egg deposition rate of 2.4 eggs/m<sup>2</sup>, a fecundity-length relationship, and the proportion of each size category in the population. One-sea-winter fish represented 78% of the sample, small multi-sea-winter fish 14%, and large multi-sea-winter fish 9%. The rearing area was based on a survey conducted by MacEachern in 1954 (*loc. cit.* Marshall 1986). This area is 52% of the area measured by Amiro (1993; Table 1). The MacEachern production area can be

<sup>2</sup> Peter G. Amiro, Freshwater and Anadromous Division, Science Branch, Fisheries and Oceans, Halifax, N.S.



subdivided into the branches as follows:

Branch	Area (m <sup>2</sup> )	% of total
West	1,868,400	61
East	704,800	23
Main	505,300	16

For the purposes of this paper, the MacEachern area will be used for evaluating whether target was achieved.

The proportion of 1SW and small and large MSW salmon in the St. Mary's River salmon population was estimated by Marshall (1986) from samples collected from the angling fishery during several years, 1972-84, while the commercial salmon fishery was still active. There were not sufficient additional sample data to adjust those numbers based on returns after the commercial fishery was closed in 1984. The mean 1989-93 percentages of 1SW and MSW salmon reported in the recreational fishery were 76% and 24%, respectively (Table 3). In the absence of age data, those numbers suggest that the proportion at age has not changed appreciably.

#### **West River, Sheet Harbour**

The spawning requirement for the West River SH is under review because of the impact of the acidification. Spawning requirements for a non-acid impacted West River can be calculated from: (1) a habitat area of 370,000m<sup>2</sup> (Ducharme 1972); (2) a fecundity of 2,739 eggs per female (based on an average length of 53.6 cm and the egg-length relationship:  $\text{eggs} = 340 e^{0.038925X}$ ); (3) the assumption that 100% of eggs comes from 1SW fish; (4) a male:female ratio of 40.7:59.3; and (5) an egg deposition rate based on the conservative 2.4 eggs/m<sup>2</sup>. Assuming that there are sufficient male salmon to pair with the minimum number of females to provide the 888,000 eggs required, the number of adults needed to meet the target would be 822 1SW fish.

### **5. Research data**

#### **SFA 20**

In-season indicators of returns to the salmon rivers of SFA 20 have been increasingly necessary to respond with advice to managers regarding the state of the stock(s). On the eastern shore, however, there is currently only one facility, the Liscomb Falls fish trap on the Liscomb River, which can be examined for its suitability to serve as an "index" of returns. Counts in 1994 at the Liscomb Falls trap were 134 and 10 wild 1SW and MSW fish, respectively (Table 4, Fig. 3). Those numbers are the lowest observed counts since 1981 for 1SW fish and since 1982 for MSW salmon.

#### **Liscomb River**

The Liscomb River has been stocked with Atlantic salmon smolts annually since 1978 (Table 5). The number of hatchery returns in 1994 was 119 1SW and 8 MSW fish (Table 4). These figures were lower than any previous returns since 1980 with the exception of 1SW returns in 1985. The return rate during the past few years, 1990-94, has been the only consistently low period during the time series (Table 5, Fig. 3) and indicates a low sea survival of smolts.

## **St. Mary's River**

Adult data were collected by seining and through angler sample programs between 1985 and 1994, but were not thought to be of sufficient quality to adjust the proportion-at-age numbers for the population provided by Marshall (1986). The recent angling data were based primarily on 1SW fish and limited seining (primarily for broodstock) on the main branch. However, data collected on the West Branch in 1993, by seining, were useful in that they confirmed earlier evidence that the stock was primarily a 1SW stock (Table 6). One-sea-winter fish and repeat spawning 1SW fish comprised 93% of the West Branch sample. Stocking of smolts from an MSW x MSW East Branch St. Mary's stock occurred on the West Branch from 1985-1990. Progeny from 2SW returns from those releases can be expected to occur in the West Branch possibly until 1997, and may have accounted for some of the MSW fish in the sample. With these data one can infer that the West Branch stock is a repeat-spawning grilse stock and dependent on grilse spawners. Additional sampling would be required to confirm those proportions at age.

A stocking program on the East Branch of the St. Mary's was begun at the request of the local association in 1982. The objective of the program was to augment the numbers of virgin 3SW salmon in the face of perceived declining numbers. Contributions to the fishery of MSW fish are known to occur through reports of adipose-clipped fish provided to the St. Mary's River Association by anglers who fish the East and main branches. A review in 1993 of the sample data for the years 1984-91 indicated they were insufficient to evaluate the contribution of the stocking program, so broodstock collections ceased after the 1992 collection year. The last two-year-old smolts from that collection will be released in 1995.

Juvenile density data were collected by a number of DFO personnel and the St. Mary's River Association, for a variety of sites and years, from 1985-94 (Table 7a). The electrofishing sites were fished using a mark-recapture technique (Amiro et al. 1989) and adjusted Petersen population estimates (Ricker 1975) were calculated for 0+, 1+ and 2+ parr. In some years the 0+ parr densities were estimated by counting the number of 0+ parr on the mark run and applying the 1+ parr capture efficiency rate.

## **6. Estimation of stock parameters**

### **St. Mary's River**

Juvenile density data (total density and 1+ parr) were examined for differences between branches of the river (East, West and stem; Table 7c) using a one-way ANOVA (SYSTAT 1992) on all sites fished. Not all sites were fished in all years, so sites 4 and 5, the only ones fished in all 7 years, were assumed to be representative of their respective branches (site 4 on the East, site 5 on the West) and tested separately for differences between branches. The site 4 data are actually the average density of 2 contiguous sections which were fished separately, with the exception of 1986 when only one section was fished.

To evaluate whether parr density changed over the 7-year sampling period, densities (total density and 1+ parr) at the 5 sites with the fewest missing samples (Tables 7a and 8) were compared using a one-way ANOVA. Densities at those sites were assumed to represent the juvenile salmon population in the watershed.

Several variables were examined as possible indices of adult salmon returns to the St. Mary's River (Table 9). Relationships between the St. Mary's River sport catch, 1SW and MSW, and the counts of wild one-sea-winter fish counted at Liscomb Falls on the Liscomb River and at Morgan Falls on the LaHave River were explored. In addition, the effects of discharge were considered as a covariate to explain variability in the sport catch. Three time series of data were utilized: (1) the period from the year the fish counting facility began operating (1974 at LaHave and 1979 at Liscomb); (2) the period from 1983 onward,

when the Nova Scotia license stub program began (the catch data prior to 1983 are converted to approximate license stub equivalents; see footnote in Table 1); and (3) the period 1984-93, used when the Liscomb counts were included in regressions to remove any effect from the Liscomb start-up. The first Liscomb River returns occurred in 1979.

## 7. Assessment results

### SFA 20

Total returns to the eastern shore can be estimated by using a range of angling exploitation rates. Although the rate may vary depending on a number of factors, such as the river, the environmental conditions and run size, a range of 25%-45% should cover most situations. The range was chosen based on exploitation rates reported on (1) the LaHave River for 1SW fish of 29.5% and for MSW fish of 24.7% (Cutting et al. 1987); and (2) the West River Sheet Harbour (West River SH) data collected between 1966-70 (the last year that a fence was operated there). The West River exploitation rate was 44.9% (90% C.I. 35-55; unpublished data).

Given the sport catch in 1994, assessing whether the conservation requirement was achieved essentially becomes a rhetorical exercise. The deficit to the nominal target escapement was 8,620 1SW fish and 1,086 MSW fish, assuming that the exploitation rate was 25% and that the requirement was based on the "Atlantic Salmon Review" target (Table 10) which is more closely aligned with the proportion of 1SW and MSW fish in the recent sport catch. Review of the surplus/deficit during the last several years indicates that the nominal target requirement for the "Atlantic Salmon Review" has not been met for 1SW fish, 1989-94, and with only a modest surplus of MSW fish in three years during that same period (Table 10).

Regressions of the total  $MSW_{(i+1)}$  angling catch for SFA 20 on wild  $1SW_{(i)}$  returns to the Liscomb trap were not significant with or without the 1987 (drought year) in the time series ( $p > 0.05$ ).

### Liscomb River

The nominal conservation requirement for the Liscomb River above the falls was not met in 1994 (13% of requirement) and has been met only once since 1979, in 1987 (Summary sheet-Liscomb River). Given the acidity of the watershed, there is little likelihood of achieving the nominal target escapement.

The low recreational catch on the Liscomb River in 1993 and 1994, less than 26 fish total in either year (Table 3), is exceptional because anglers had access to the entire watershed for the first time since the development program began in 1977.

With the escapement numbers as low as they have been during 1993 and 1994, and the low pH of the watershed, natural production from the system will result in low returns from these year classes. Future harvest can not be recommended under these circumstances.

### St. Mary's River

The West Branch seining in the St. Mary's River in 1993 failed to capture virgin 3SW salmon and less than 7% of the sample was of 2SW salmon or 2SW repeats (Table 6). Broodstock collections which have occurred over several years on the East Branch have captured large numbers of virgin 3SW fish. The collections were often selective for the large fish so the data can not be used to assess the proportion at age. These data are also indicative but not definitive at limiting 3SW salmon to the East Branch of the river.

A significant ( $p=0.005$ ) predictive relationship was found between the multi-sea-winter salmon sport catch on the St. Mary's River and LaHave wild 1SW salmon counts (Table 11, Fig. 4). The regression equation is based on the period from 1974-93 and is of the form:

$$\text{STM MSW sport catch}_{i+1} = 71.153 + 0.189 \text{ LaHave (at Morgan Falls) wild 1SW trap counts}_i$$

When the regression was repeated for the years 1982-93 to limit the time series to the stub data, it was found to be not significant.

Examination of a plot of the relationship revealed that the 1985 and 1986 MSW salmon years were possible outliers. The significant studentized residual confirmed that the 1986 point was an outlier. Sport catch data are known to contain a bias in MSW catches for the first few years after it became mandatory to release large salmon. That bias has not been measured in a manner which would permit an adjustment of the sport catch data. Claytor and O'Neil (1991) identified a bias but failed to find a consistent adjustment between stub and trap data on the Margaree River, Nova Scotia. Comparison of the ratios of 1SW:MSW from Liscomb and LaHave trap counts, with stub data from those rivers during the same years, also failed to provide a consistent picture. Consequently, no attempt was made to "adjust" the 1985-87 sportcatch data and the regression for the years 1982-93 was repeated with 1986 removed (1986 sport catch year which was also the 1985 trap count year) and found to be significant ( $p=0.009$ ; Table 11, Fig. 5). The regression equation (1982-93, excl. 1985 trap count year) was as follows:

$$\text{STM MSW}_{i+1} = -62.109 + 0.256 \text{ LaHave 1SW}_i$$

Multi-sea-winter sport catch on the St. Mary's was not significantly related to Liscomb wild 1SW counts for the years 1979-93 or 1984-93 (Table 11). The latter time series would allow for removal of any Liscomb "start-up" effect.

Mean daily discharge for each of July and August from the sampling station at Stillwater on the St. Mary's River was summed to provide a variable to account for the environmental influence on angling catch (Table 9). When tested, discharge was found not to be significant as a covariate with the St. Mary's MSW catch data regressed on Liscomb or LaHave wild 1SW counts (Table 11) for either the short- or longer-term time periods.

The St. Mary's grilse catch was significantly related to the wild 1SW counts at the Liscomb trap with 1987 (drought year) excluded ( $p=0.005$ ; Table 11, Fig. 6). This relationship would be useful in providing a 1SW return estimate in the absence of an angling fishery. The large-salmon catch in year  $i+1$  was not found to be related to the grilse sportcatch in year  $i$  for the St. Mary's River (Table 11).

Juvenile salmon densities in the St. Mary's River were not found to differ for either the 1+ parr or total density between the East, West and stem (main) branches for all sites or when only sites with all years sampled (sites 4 and 5) were used (Table 7c). Comparison of population estimates for age 1 and 2 parr or 1+ parr only for the five most frequently sampled sites (Table 8), between years, also did not exhibit any significant difference. Thus, parr densities have not shown a substantial decline or increase over the period 1985-94.

Sites 4 and 5, which had continuity across years, were used to indicate if either the East Branch (site 4), West Branch (site 5) or the two sites combined provided a significant relationship to total sport catch. Inferences about parr densities based on spawning stock (sportcatch) were found not to be possible; the regressions with 0+ parr<sub>(i+1)</sub> or 1+ parr<sub>(i+2)</sub> were not significant (Table 7b).

## **West River, Sheet Harbour**

The sport catch on the West River SH was not significantly related to returns to the Liscomb River for either 1SW on 1SW fish or for West River SH MSW salmon on Liscomb wild 1SW counts ( $p > 0.05$ ). MSW salmon were considered negligible for determining targets because they comprise less than 8% of returns (Table 3). The biological characteristics for the West River SH stock were obtained from returns to the trap on the East River SH system (S. O'Neil, unpublished data) which were developed with West River SH stock (Ducharme 1972).

Total escapement estimates for the West River SH based on sport catch for the past 5 years (1989-93, there was no fishery in 1994), and a conservative 30% exploitation rate, have ranged from 26% in 1992 to 137% in 1989 of the non-acid-impacted adult returns target (Fig. 7). In other words, the number of adult salmon returning to the West River is dangerously low and has reached a point where the stock can no longer sustain a harvest.

### **8. Ecological considerations**

The water quality on the West River SH has been monitored to evaluate the potential for the survival of the stock. The local river association has expressed an interest in liming portions of the watershed to protect the natural run of West River SH fish. Winter pH levels, which are the more critical for salmon survival, have averaged 4.93 at the river mouth since 1986. Several tributary streams have had mean pH levels of 4.90 over the same period. The Little West River tributary has had a mean pH level of 5.23 since 1986.

### **9. Forecast/Prospects**

#### **SFA 20**

At present there is no indicator to predict returns to eastern shore rivers in 1995. The consistently low return rate for hatchery smolts to the Liscomb River over the past 3-4 years is unique during the 1979-94 time series (Table 5). Nominal target escapements for 1SW fish have not been met in several years and MSW fish only marginally in recent years based on a conservative 25% exploitation rate (Table 10). In addition, wild returns to Liscomb Falls and to the sport fishery of the eastern shore describe a several-year trend which has been downward. Based on the available data, unless a significant change in smolt survival at sea occurs, returns to the eastern shore in 1995 can be expected to be low and are unlikely to meet the nominal target.

#### **Liscomb River**

The number of wild MSW salmon forecast to return to the Liscomb River in 1995 is 25 fish (90% C.I. 0-82). This estimate is based on a regression of wild MSW fish in year  $i+1$  on wild 1SW fish in year  $i$  which gives the equation:

$$\text{MSW}_{i+1} = 17.517 + 0.053 \text{ 1SW}_i \quad (\text{adj. } R^2=0.302; p=0.02; n=15)$$

A similar equation in 1993 predicted a return of 27 MSW salmon in 1994 as compared with the 10 counted at the fishway.

Prospects for the coming year are poor with the prediction of 25 MSW salmon, which is only 9% of the nominal target for MSW fish.

### St. Mary's River

Sport catch on the St. Mary's River can be used with a range of exploitation rates and the stock characteristics identified in section 3, similar to that done for SFA 20, to estimate spawners and the surplus or deficit relative to the target. At an exploitation rate of 30% (based on LaHave estimate, Cutting et al. 1987), the St. Mary's River returns would have met target spawning requirements for 1SW fish only one year (1990) during the period 1989-93 and only 4 times in the previous 10 years 1984-93 (Table 12). Multi-sea-winter returns would have exceeded target escapements in 9 years of the same 10-year period. The MSW spawner surplus on the St. Mary's occurred only after the commercial fishery closed in 1984 (Table 12). Subjecting the 1994 catch data to the same exercise indicates a 1SW spawner shortfall of 2,392 fish and a deficit of multi-sea-year spawners of 621 fish. The unique nature of the 1994 angling season renders such an exercise less valuable in comparing escapements to targets. If the combined escapements of grilse and large salmon based on a 30% exploitation rate are expressed as eggs and compared with target eggs, the target was not achieved in 1994 or 1992 (Fig. 8). It should be kept in mind that these surplus/deficits are in reference to a requirement based on the rearing area defined by MacEachern (*loc. cit.* Marshall 1986) which is only 52% of that measured by Amiro (1993). Amiro (1993) noted, however, during his survey that the parr densities in the St. Mary's River were lower than in either the Musquodoboit River or Stewiacke River. He has hypothesized that the habitat area is compromised by physiographic conditions (P.G. Amiro, pers. comm.<sup>3</sup>) and may be branch-dependent. Some consideration has been and will be given to testing that hypothesis with the intent that the location of the lower-than-expected parr densities within the watershed (i.e., which branch) can be identified.

The regressions of the St. Mary's River large salmon sport catch on LaHave River wild grilse counts forecast a return of 192 MSW fish in 1995 (90% C.I. 0-572) for the long-term time series regression or 102 MSW salmon (90% C.I. 0-458) for the 1982-93 (excl. 1985) time series regression (Table 11). Either figure would result in an MSW spawner deficit of 526 or 616 MSW fish, respectively, relative to target.

Although there is little evidence to recommend in favour of a harvest fishery on the St. Mary's River, the recent low returns have not been as exaggerated as those noted at Liscomb River at the counting facility. However, unless early indications in 1995 cast doubt on the forecast number of MSW salmon, conservation requirements will not be met in 1995.

### West River, Sheet Harbour

Nominal targets are of no real value for the West River SH because of the serious effects of the acidification. With pH levels near 4.9 in much of the river, juvenile survival is threatened. The Little West River tributary, which contains 13% of the habitat in the system, should continue to support some salmon returning to that stream.

## 10. Management considerations

### SFA 20

Conservation requirements for SFA 20 are under review. Targets based on the conservative 2.4 eggs/m<sup>2</sup> for the eastern shore, as a unit, were not met in 1994 and are not likely to be met in 1995. Given the available data, a harvest fishery can not be supported, although some rivers within SFA 20 have not

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<sup>3</sup> Peter G. Amiro, Freshwater and Anadromous Division, Science Branch, Fisheries and Oceans, Halifax, N.S.

exhibited as exaggerated a downturn as SFA 20 as a whole.

### **Liscomb**

Similarly, the nominal spawning requirements for the acid-stressed Liscomb River were not met in 1994 and the forecast MSW returns in 1995 will only achieve 12% of the MSW target. Although there is no forecast ability for 1SW returns to the Liscomb, the progressively declining hatchery return has been paralleled by the wild 1SW return. Consequently, a harvest fishery on the Liscomb River can not be supported for 1995.

### **St. Mary's River**

The data were not sufficient to separate the St. Mary's River branches (East and West) with respect to juvenile production or proportions of fish at age. A forecast capability to each of the 2 branches was therefore not possible, but a relationship for the MSW sportcatch for the entire river on LaHave wild 1SW counts predicts 102 or 192 MSW salmon in the 1995 sport fishery. These two numbers both represent a shortfall in escapement based on an exploitation rate of 30%. Thus, although there is no forecast for 1SW returns to the St. Mary's River, there is no evidence that 1SW returns will increase or exceed target sufficiently to compensate for the forecast deficit in numbers of MSW salmon.

### **West River, Sheet Harbour**

The river was closed to angling in 1994. The evidence supports continuing with a no-harvest policy in 1995.

## **11. *Research recommendations***

1. The effects of acidification on Atlantic salmon rivers has been well studied. A model to evaluate the effects on the survival of juveniles and thus production has been developed by Korman et al. (1994). It is recommended that the SFA 20 rivers be reviewed with the intent of devising conservation requirements and realistic production estimates with the acidity taken into account.

2. Identify the research requirements necessary to complete stock status reports for each branch of the St. Mary's River. The data suggest that the river has not met target in recent years. The West Branch is primarily a grilse stock and is subject to harvest under current regulations. Can the West stock sustain a grilse harvest?

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Table 1. Atlantic salmon rivers of SFA 20 - eastern shore, with habitat area, pH and 1994 angling seasons.

River	Area * m <sup>2</sup> *10 <sup>2</sup>	Winter pH **	1994 angling season dates ***
Clam Harbour	3,009	4.85	June 24 - Sept. 22
Cole Harbour	2,730	4.54	June 1 - Aug. 29
Country Harbour	3,457	5.91	June 24 - Sept. 22
East Sheet Harbour	30,501	5.07	June 1 - Aug. 29
Ecum Secum	9,894	5.44	June 1 - Aug. 29
Gaspereau Brook	2,826	5.05	June 1 - Aug. 29
Guysborough	4,322	6.58	June 24 - Sept. 22
Halfway Brook	1,604	5.17	June 1 - Aug. 29
Isaac's Harbour	2,469	4.82	June 1 - Aug. 29
Larry's	2,632	4.61	June 1 - Aug. 29
Lawrencetown Lake	7,493	4.52	June 1 - Aug. 29
Liscomb	34,960	4.82	June 1 - Aug. 29
Little Salmon	750	4.93	June 1 - Aug. 29
Moser	15,270	5.03	June 1 - Aug. 29
Musquodoboit	23,125	6.48	June 1 - Aug. 29
New Harbour	3,148	4.84	June 1 - Aug. 29
Port Dufferin	7,954	5.15	June 1 - Aug. 29
Porters Lake (East Brook)	2,394	4.75	June 1 - Aug. 29
Quoddy	6,849	5.44	June 1 - Aug. 29
Saint Mary's	58,717	5.98	June 1 - Sept. 15
Salmon: Guysborough Co.	18,861	6.12	June 24 - Sept. 22
Salmon: Halifax Co.	2,834	5.03	June 1 - Aug. 29
Ship Harbour Lake Charlotte	20,518	5.54	June 1 - Aug. 29
Tangier	22,717	4.80	June 1 - Aug. 29
West Sheet Harbour	17,050	4.92	closed
Total	306,084		

\* Calculated by remote survey of aerial photographs (Amiro 1993).

\*\* Based on 1986 data.

\*\*\* Rivers closed by variation order July 21 - Aug. 11; reopened Aug. 12 for hook and release.

Table 2. Numbers of 1SW salmon retained, MSW salmon retained and released, and effort, by SFA, in the sport fisheries of Scotia-Fundy Region, 1974-1994.

Year	SFA 19				SFA 20				SFA 21				SFA 22**				SFA 23			
	Catch			Effort in rod-days	Catch			Effort in rod-days	Catch			Effort in rod-days	Catch			Effort in rod-days				
	1SW	MSW			1SW	MSW			1SW	MSW			1SW	MSW			1SW	MSW		
	Ret.	Rel.		Ret.	Rel.		Ret.	Rel.		Ret.	Rel.		Ret.	Rel.		Ret.				
1974	416	588		7,229	3,462	434		24,977	2,462	397		13,236	2,004	714		7,418	1,312	1,798	16,897	
1975	117	213		2,157	694	94		8,455	1,416	656		8,286	818	293		3,662	1,888	1,691	17,078	
1976	278	445		4,209	2,652	219		18,530	2,474	321		16,026	1,931	537		8,815	3,150	2,498	20,511	
1977	768	561		6,703	1,639	422		14,364	3,434	643		20,278	296	898		9,267	2,040	2,553	22,792	
1978	257	456		10,780	396	272		12,403	460	481		9,748	1,681	334		6,078	843	924	17,128	
1979	281	304		16,761	2,178	267		22,312	2,969	374		14,834	1,258	490		13,030	3,034	927	21,420	
1980	997	795		30,143	3,483	469		25,458	2,773	1,104		25,682	151	526		6,408	2,734	2,860	28,947	
1981	1,265	496		9,365	2,556	581		30,840	4,342	1,284		38,111	1,045	379		6,887	1,963	1,473	30,423	
1982	857	523		18,661	1,657	201		28,187	1,847	494		28,351	983	444		8,717	3,129	2,361	45,520	
1983	240	269		15,322	1,336	401		37,352	471	409		13,743	2,402	386		16,764	2,210	1,103	40,311	
1984	821	108	358	8,759	1,744	128	282	14,426	2,159	232	316	18,868	966	29	257	10,226	2,891	0	28,912	
1985	1,015	0	833	7,749	2,555	0	1,713	17,578	2,790	0	1,567	18,863	1,634	0	578	11,619	4,485	0	38,716	
1986	804	0	1,976	8,901	2,268	0	1,622	20,150	3,110	0	1,583	23,240	830	0	843	11,710	4,033	0	33,555	
1987	890	0	1,390	8,139	1,771	0	686	13,251	4,395	0	799	24,593	255	0	311	6,347	3,870	0	26,870	
1988	836	0	1,514	9,925	2,641	0	1,223	20,483	2,907	0	812	26,131	549	0	167	6,503	2,991	0	26,627	
1989	682	0	1,262	8,081	1,874	0	953	17,908	4,073	0	1,166	27,981	1,781	0	369	10,572	3,590	0	26,354	
1990	865	0	1,370	9,141	3,029	0	696	17,787	3,497	0	933	29,029	274	0	114	5,598	2,613	0	21,915	
1991	452	0	1,076	7,076	1,390	0	604	13,133	557	0	313	13,411	9	0	27	845	1,915	0	12,635	
1992	495	0	1,020	6,688	905	0	400	11,482	2,229	0	349	21,284	16	0	6	516	3,083	0	25,389	
1993	313	0	498	5,390	1,391	0	642	15,224	1,623	0	415	22,948	15	0	23	608	1,121	0	16,502	
1994	2	0	472	2,263	190	0	151	4,676	301	0	223	11,359	4	0	5	403	UNAVAILABLE			
Means																				
1979-93	721			11,340	2,052			20,371	2,649			23,138	**			**	2,911			28,315
1984-93	717			7,985	1,957			16,142	2,734			22,635	**			**	3,059			28,128
1989-93	561		1,045	7,275	1,718		659	15,107	2,396		635	22,931	**		**	**	2,464			21,570

\* SFAs 19-22 based on DFO estimates 1974-1983 adjusted by differential between DFO and Nova Scotia license stub returns, 1983; i.e., 1.52, 1.32, 1.36, and 1.04 and license stub returns since 1983. SFA 23 based on DFO estimates.

\*\* SFA 22 data for 1983 are based on Nova Scotia license stub data, not converted DFO figures. Most area 22 rivers were closed to fishing in 1991, 1992, 1993 and 1994.

Table 3. Atlantic salmon sportcatch and effort for rivers of Salmon Fishing Area 20, eastern shore, Nova Scotia, 1993 and 1994, contrasted with mean catches, 1989-93.

River	1994				1993				1989 - 93 means							
	Grilse		Salmon	Effort	Grilse		Salmon	Effort	Grilse				Salmon		Effort	
	retained	released	released		retained	released	released		retained	95% C.I.	released	95% C.I.	released	95% C.I.	roddays	95% C.I.
<b>Salmon Fishing Area 20</b>																
Ciam Harbour									0.8	1.9	0.0	0.0	0.0	0.0	7.8	12.9
Cole Harbour									4.0	6.1	0.3	0.6	1.3	2.4	18.3	22.6
Country Harbour	0	1	0	8	9	6	2	76	21.6	18.4	5.4	6.5	6.0	6.0	128.8	63.4
East Sheet Harbour	0	0	0	38	30	6	4	319	32.8	26.8	5.8	6.8	5.4	7.9	275.4	199.3
Ecum Secum	9	7	1	169	43	1	5	465	58.8	35.7	4.2	6.7	8.0	8.0	571.0	266.3
Gaspereau Brook	0	0	0	8	0	0	0	13	3.4	6.8	0.0	0.0	0.0	0.0	31.8	29.8
Guysborough	0	0	2	5	4	0	3	17	2.4	2.3	0.0	0.0	2.6	3.2	13.0	8.9
Halfway Brook	0	0	0	13					0.3	0.6	0.0	0.0	0.0	0.0	4.8	5.8
Isaac's Harbour	0	0	0	15	6	0	0	36	14.8	15.7	0.2	0.6	0.2	0.6	85.2	51.2
Kirby	1	0	0	1	2	0	0	28	4.4	4.4	0.2	0.6	1.6	4.4	31.8	10.0
Larry's									0.0	0.0	0.0	0.0	0.0	0.0	1.5	3.0
Lawrencetown Lake	0	1	0	9	0	0	0	2	2.2	2.8	1.2	2.0	0.2	0.6	21.8	26.1
Liscomb	14	10	1	308	13	1	0	349	58.0	76.8	9.6	10.3	3.8	4.5	601.6	218.1
Little Salmon					0	0	1	5	0.0	0.0	0.0	0.0	3.3	7.3	12.3	20.8
Moser	11	36	0	425	105	15	10	1108	138.4	73.6	17.2	16.4	10.6	7.4	1055.6	303.3
Musquodoboit	62	16	53	905	139	35	103	3059	159.0	107.8	40.4	32.0	113.2	68.7	2504.2	1389.5
Necum Teuch									0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
New Harbour	17	5	0	138	13	0	0	226	38.0	43.8	2.0	3.5	1.2	1.4	393.0	192.2
Port Dufferin	4	2	0	124	19	0	1	195	11.8	13.2	0.8	2.2	0.2	0.6	141.8	61.3
Porters Lake (East Brook)									0.3	0.7	0.0	0.0	0.0	0.0	1.3	2.9
Quoddy					0	0	0	15	0.2	0.6	0.0	0.0	0.2	0.6	15.6	8.2
Rocky Run Porters Lake									0.3	0.7	0.0	0.0	0.0	0.0	11.3	21.2
Saint Francis					0	0	0	1	0.0	0.0	0.0	0.0	0.0	0.0	1.5	3.0
Saint Mary's	19	24	30	1423	738	171	396	6199	788.6	616.7	193.6	202.3	309.6	150.6	5781.4	1151.5
Salmon: Guysborough Co.	52	161	63	854	179	33	103	1454	230.6	54.2	27.2	12.0	177.0	62.9	1740.6	208.0
Salmon: Halifax Co.					3	0	0	32	8.0	10.9	0.8	2.2	1.6	2.9	66.4	71.0
Ship Harbour Lake Charlotte	1	0	0	215	20	4	4	419	19.2	22.9	1.2	2.2	2.4	2.3	333.4	124.4
Tangier	0	0	0	3	0	0	0	2	0.0	0.0	0.0	0.0	0.0	0.0	10.0	8.6
West Sheet Harbour	0	0	0	15	68	9	7	1195	121.2	110.9	15.4	21.4	11.0	11.3	1257.4	583.5
<b>Totals</b>	<b>190</b>	<b>263</b>	<b>150</b>	<b>4676</b>	<b>1391</b>	<b>281</b>	<b>639</b>	<b>15215</b>	<b>1965.4</b>		<b>353.6</b>		<b>775.2</b>		<b>16157.8</b>	

Table 4. Counts of wild and hatchery Atlantic salmon from fishway trap at Liscomb Falls, Liscomb River.

Year	SFA 20 Liscomb Returns			
	Wild		Hatchery	
	1SW	MSW	1SW	MSW
1979	60		485	2
1980	111	0	931	51
1981	76	6	241	49
1982	252	10	827	41
1983	520	15	594	63
1984	606	48	331	42
1985	507	87	49	175
1986	736	117	766	108
1987	1614	88	523	54
1988	477	76	431	44
1989	532	75	288	71
1990	955	44	438	22
1991	586	38	178	22
1992	145	27	125	12
1993	134	11	128	12
1994	134	10	119	8
Means:				
1989-93	470	39	231	28
1984-93	629	62	325	56
1994 as % of:				
1989-93	29%	26%	52%	29%
1984-93	21%	16%	37%	14%

Table 5. Estimated numbers of 1SW and 2SW returns from hatchery-reared smolts released above Liscomb Falls, Liscomb River, 1978 - 1993.

Sea age	Smolt year i															
	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Smolts (1000s)	47.4	57.7	26.9	42.4	43.8	58.2	50.0	29.6	19.0	31.3	48.4	28.0	22.4	25.1	30.5	21.4
1SW returns (i+1)	485	931	241	827	594	331	175	766	523	431	288	438	178	125	128	119
%	1.02	1.61	0.90	1.95	1.36	0.57	0.35	2.59	2.75	1.38	0.60	1.56	0.79	0.50	0.42	0.56
MSW returns (i+2)	51	49	41	63	42	49	108	54	44	71	22	22	12	12	8	
%	0.11	0.08	0.15	0.15	0.10	0.08	0.22	0.18	0.23	0.23	0.05	0.08	0.05	0.05	0.03	

Table 6. Numbers at age, sex, and proportions, for the fish seined at 3 locations on the West Branch, St. Mary's River, 1993.

Age	Male	Female	Total	%
2.1	41	33	74	54.0
2.2		7	7	5.1
2.2 sp1	2	5	7	5.1
2.3 sp1	1	1	2	1.5
2.3 sp1,2	1	2	3	2.2
2.3 sp2	1	1	2	1.5
2.4 sp1,2	1		1	0.7
3.1	14	17	31	22.6
3.2 sp1		1	1	0.7
3.3 sp1	1	2	3	2.2
3.3 sp1,2	1	1	2	1.5
3.4 sp1,3		2	2	1.5
3.4 sp1,2,3		2	2	1.5
Total	63	74	137	
Percent	46.0	54.0		

Number (and percent) by sea age at first spawning

1SW	55 (87.3)	50 (67.6)	105 (76.6)
1SW plus 1SW repeats	62 (98.4)	66 (89.2)	128 (93.4)
2SW	1 (1.6)	8 (10.8)	9 (6.6)

Table 7a. Number of electrofishing sites fished, by year and branch, on the St. Mary's River.

Year	Branch			Total
	East	West	Main stem	
1985	6	19	3	28
1986	16	18	2	36
1990	14	3	2	19
1991	9	9	4	22
1992	16	11	2	29
1993	5	4	1	10
1994	13	7	0	20
Total	79	71	14	164

Table 7b. Summary of regression analyses of fry and 1+ parr densities per 100 m<sup>2</sup> on total angling catch (grilse and salmon) for sites 4 and 5 on the St. Mary's River (n=7).

Site	Regression variables		Adjusted R <sup>2</sup>	p-value
	Dependent	Independent		
4 (East)	Fry density (yr i)	Total catch (yr i-1)	0.019	0.339
	1+ Parr density	Total catch (yr i-2)	0.000	0.775
5 (West)	Fry density (yr i)	Total catch (yr i-1)	0.092	0.261
	1+ Parr density	Total catch (yr i-2)	0.216	0.164
Both	Fry density (yr i)	Total catch (yr i-1)	0.092	0.261
	1+ Parr density	Total catch (yr i-2)	0.207	0.170

Table 7c. Summary of analyses of variance of total (1+ and 2+ parr) and 1+ parr densities per 100 m<sup>2</sup> on the St. Mary's River.

Sites	Dependent variable	ANOVA Effect	n	p-value
All	Total density	Branches (East, West, Stem)	164	0.483
	1+ Parr density	Branches (East, West, Stem)	164	0.557
4 and 5	Total density	Branches (East, West)	14	0.264
	1+ Parr density	Branches (East, West)	14	0.280
4, 5, 8, 10, 23	Total density	Years (1985, 86, 90-94)	32	0.747
	1+ Parr density	Years (1985, 86, 90-94)	32	0.877

Table 8. Total (1+ and 2+ parr) and 1+ parr densities per 100 m<sup>2</sup> at five sites in the St. Mary's River, 1985, 1986, and 1990 - 94.

Site	1985	1986	1990	1991	1992	1993	1994
Total density (1+ and 2+ parr)							
#4 (East)	5.45	9.65	11.80	7.35	10.65	10.20	13.00
#5 (West)	21.60	14.90	18.60	5.80	14.80	6.60	7.00
#8 (West)	15.70	7.50	9.10	3.40	0.00	0.00	
#10 (East)	4.40	1.80	0.45	6.40	1.25		0.66
#23 (East)		3.65	7.60	8.10	6.00	10.40	4.90
1+ parr density							
#4 (East)	5.25	9.05	7.40	5.25	9.70	10.20	11.55
#5 (West)	14.40	12.80	14.10	5.80	14.20	6.20	5.70
#8 (West)	14.50	6.20	6.40	2.60	0.00	0.00	
#10 (East)	4.25	1.65	0.10	5.70	0.80		0.66
#23 (East)		3.00	7.25	8.00	2.15	10.00	4.90



Table 9. St. Mary's River catch data and possible related variables for examination of indices of the returns to the St. Mary's River.

Year	LaHave	LaHave	Liscomb	Liscomb	St. Mary's River sportcatch *		St. Mary's	Mean	Discharge year i+1
	wild 1SW	wild MSW	wild 1SW	wild MSW	1SW	MSW	MSW catch year i+1 **	daily discharge (July+Aug)	
1974	29	2			1734.5	216.5	72.6	25.2	1.9
1975	38	5			237.6	72.6	128.0	1.9	10.3
1976	178	23			1386.0	128.0	158.0	10.3	59.2
1977	292	25			604.6	158.4	128.0	59.2	10.1
1978	275	67			199.3	128.0	87.1	10.1	61.3
1979	856	67	60	0	1520.6	87.1	200.6	61.3	16.0
1980	1637	288	111	0	1969.4	200.6	359.0	16.0	35.0
1981	1866	366	76	6	1132.6	359.0	80.5	35.2	31.0
1982	799	256	252	10	747.1	80.5	175	31.1	92.0
1983	1129	213	520	15	663	175	228	92.0	24.4
1984	2043	384	606	48	698	228	856	24.4	29.3
1985	1343	638	507	87	1182	856	944	29.3	22.1
1986	1579	584	736	117	1126	944	321	22.1	4.7
1987	2529	532	1614	88	524	321	694	4.7	72.2
1988	2464	390	477	76	1209	694	462	72.2	15.9
1989	2087	511	532	75	565	462	274	15.9	33.2
1990	1880	396	955	44	1612	274	264	33.2	8.9
1991	495	236	586	38	744	264	152	8.9	9.8
1992	1915	215	145	27	284	152	396	9.8	41.9
1993	791	112	134	11	738	396	30	41.9	9.7
1994	641	128	134	10	19	30		9.7	

\* Catch prior to 1983 was collected by DFO officers, not via license stubs.

Those values have been converted to license stub equivalents by multiplying by 1.32.

\*\* MSW salmon sportcatch lagged one year so that the 1975 MSW catch is matched with the 1974 1SW catch.

Table 10. SFA 20 sportcatch, escapement based on three exploitation rates (25%, 35%, and 45%), and surplus or deficit spawners based on two nominal targets.

Year	SFA 20 sportcatch		Escapement based on exploitation rates *						Surplus / Deficit (-)			
	1SW	MSW	25%		35%		45%		Target A **		Target B **	
	retained	ret./rel.	1SW	MSW	1SW	MSW	1SW	MSW	25% expl.	MSW	25% expl.	MSW
1974	3462	434	10386	1302	6429	806	4231	530	7186	-1898	1196	-388
1975	694	94	2082	282	1289	175	848	115	-1118	-2918	-7108	-1408
1976	2652	219	7956	657	4925	407	3241	268	4756	-2543	-1234	-1033
1977	1639	422	4917	1266	3044	784	2003	516	1717	-1934	-4273	-424
1978	396	272	1188	816	735	505	484	332	-2012	-2384	-8002	-874
1979	2178	267	6534	801	4045	496	2662	326	3334	-2399	-2656	-889
1980	3483	469	10449	1407	6468	871	4257	573	7249	-1793	1259	-283
1981	2556	581	7668	1743	4747	1079	3124	710	4468	-1457	-1522	53
1982	1657	201	4971	603	3077	373	2025	246	1771	-2597	-4219	-1087
1983	1336	401	4008	1203	2481	745	1633	490	808	-1997	-5182	-487
1984	1744	410	5232	1640	3239	1171	2132	911	2032	-1560	-3958	-50
1985	2555	1713	7665	6852	4745	4894	3123	3807	4465	3652	-1525	5162
1986	2268	1622	6804	6488	4212	4634	2772	3604	3604	3288	-2386	4798
1987	1771	686	5313	2744	3289	1960	2165	1524	2113	-456	-3877	1054
1988	2641	1223	7923	4892	4905	3494	3228	2718	4723	1692	-1267	3202
1989	1874	953	5622	3812	3480	2723	2290	2118	2422	612	-3568	2122
1990	3029	696	9087	2784	5625	1989	3702	1547	5887	-416	-103	1094
1991	1390	604	4170	2416	2581	1726	1699	1342	970	-784	-5020	726
1992	905	400	2715	1600	1681	1143	1106	889	-485	-1600	-6475	-90
1993	1391	642	4173	2568	2583	1834	1700	1427	973	-632	-5017	878
1994	190	151	570	604	353	431	232	336	-2630	-2596	-8620	-1086

\* Escapement is calculated as (catch/expl. rate) \* 100 - retained catch

	1SW	MSW
** Target A is based on Long-term Strategies (1986); refer to text.	3200	3200
Target B is based on Atlantic Salmon Review (1978); refer to text.	9190	1690

Table 11. Summary of regression analyses for examination of indices of the returns to the St. Mary's River. Refer to table 9 for data.

Regression variables		Years	Adjusted R <sup>2</sup>	p-value	n
Dependent	Independent				
St 1SW (yr i)	Li 1SW (yr i)	1983 - 94	0.007	0.323	12
St 1SW (yr i)	Li 1SW (yr i)	1983 - 94, ex. 87	0.550	0.005	11
St MSW (yr i+1)	Li 1SW (yr i)	1979 - 93	0.134	0.098	15
St MSW (yr i+1)	Li 1SW (yr i)	1984 - 93	0.000	0.381	10
St MSW (yr i+1)	Li 1SW (yr i)	1979 - 93	0.076	0.246	15
St MSW (yr i+1)	Discharge (yr i+1)			0.677 (disch)	
St MSW (yr i+1)	Li 1SW (yr i)	1984 - 93	0.000	0.695	10
	Discharge (yr i+1)			0.911 (disch)	
St MSW (yr i)	Li MSW (yr i)	1979 - 94	0.630	0.000	16
St MSW (yr i)	Li MSW (yr i)	1979 - 94, ex. 87	0.736	0.000	15
St MSW (yr i)	Li MSW (yr i)	1983 - 94	0.632	0.001	12
St MSW (yr i+1)	La 1SW (yr i)	1974 - 93	0.332	0.005	20
St MSW (yr i+1)	La 1SW (yr i)	1982 - 93	0.203	0.080	12
St MSW (yr i+1)	La 1SW (yr i)	1982 - 93, ex. 85	0.501	0.009	11
St MSW (yr i+1)	La 1SW (yr i)	1974 - 93	0.313	0.016	20
	Discharge (yr i+1)			0.493 (disch)	
St MSW (yr i+1)	La 1SW (yr i)	1982 - 93	0.140	0.206	12
	Discharge (yr i+1)			0.621 (disch)	
St MSW (yr i+1)	St 1SW (yr i)	1974 - 93	0.000	0.989	20
St MSW (yr i+1)	St 1SW (yr i)	1974 - 93, ex. 87	0.000	0.749	19

Table 12. St. Mary's River sportcatch in numbers of fish, escapement based on an exploitation rate of 30%, and spawners relative to targets, 1974-94.

Year	St. Mary's sportcatch		Escapement based on 30% exploitation rate *		Spawners Surplus/Deficit (-)	
	1SW retained	MSW ret./rel.	1SW	MSW	1SW	MSW
1974	1735	217	4047	505	1611	-213
1975	238	73	554	169	-1882	-549
1976	1386	128	3234	299	798	-419
1977	605	158	1411	370	-1025	-348
1978	199	128	465	299	-1971	-419
1979	1521	87	3548	203	1112	-515
1980	1969	201	4595	468	2159	-250
1981	1133	359	2643	838	207	120
1982	747	81	1743	188	-693	-530
1983	663	175	1547	408	-889	-310
1984	698	228	1629	737	-807	19
1985	1182	856	2758	2768	322	2050
1986	1126	944	2627	3052	191	2334
1987	524	321	1223	1038	-1213	320
1988	1209	694	2821	2244	385	1526
1989	565	462	1318	1494	-1118	776
1990	1612	274	3761	886	1325	168
1991	744	264	1736	854	-700	136
1992	284	152	663	491	-1773	-227
1993	738	396	1722	1280	-714	562
1994	19	30	44	97	-2392	-621

\* Escapement is calculated as (catch/expl. rate)\*100 - retained catch; assumed a 10% mortality on hook and release MSW; target is 2436 1SW, 718 MSW (Marshall 1986).

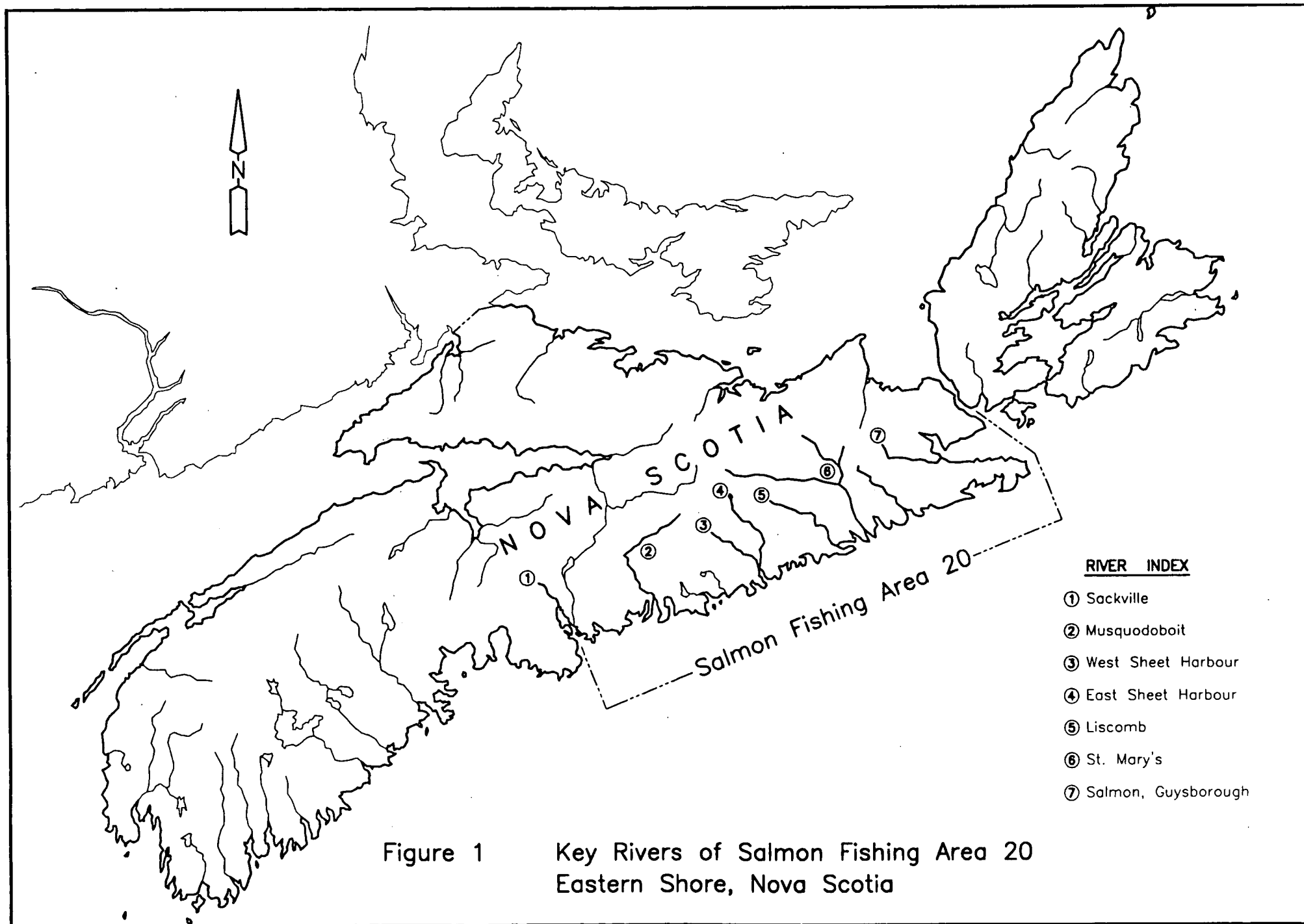


Figure 1 Key Rivers of Salmon Fishing Area 20  
Eastern Shore, Nova Scotia

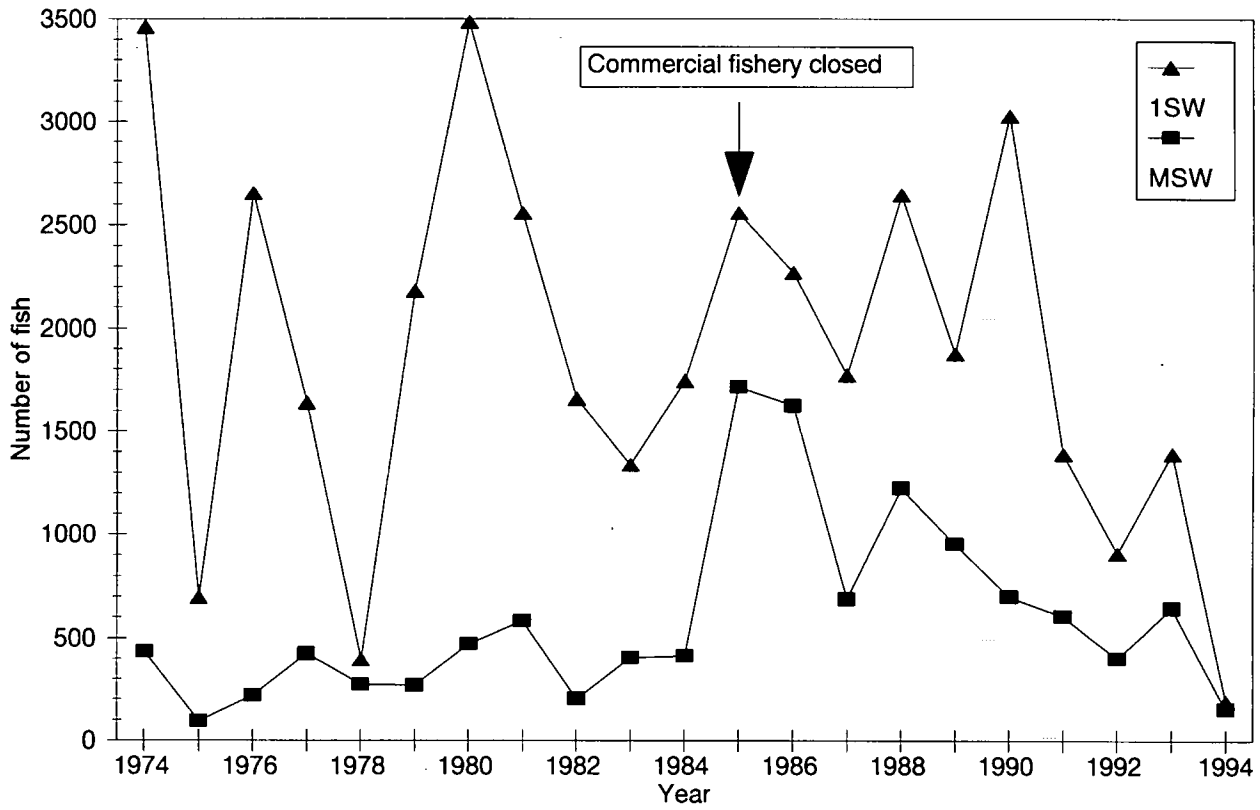


Figure 2. Atlantic salmon sportcatch of 1SW and MSW fish for SFA 20, 1974-94.

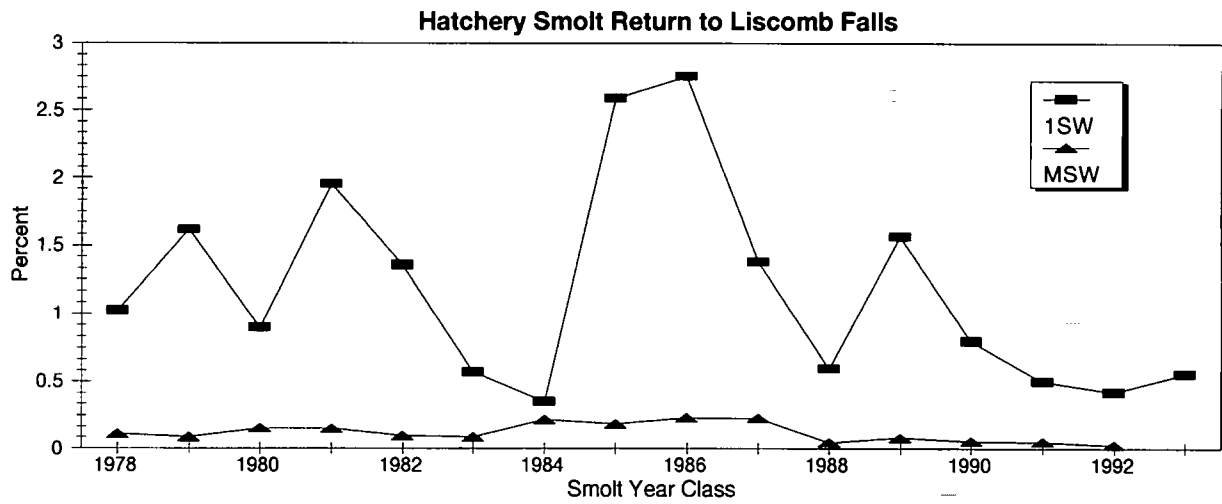
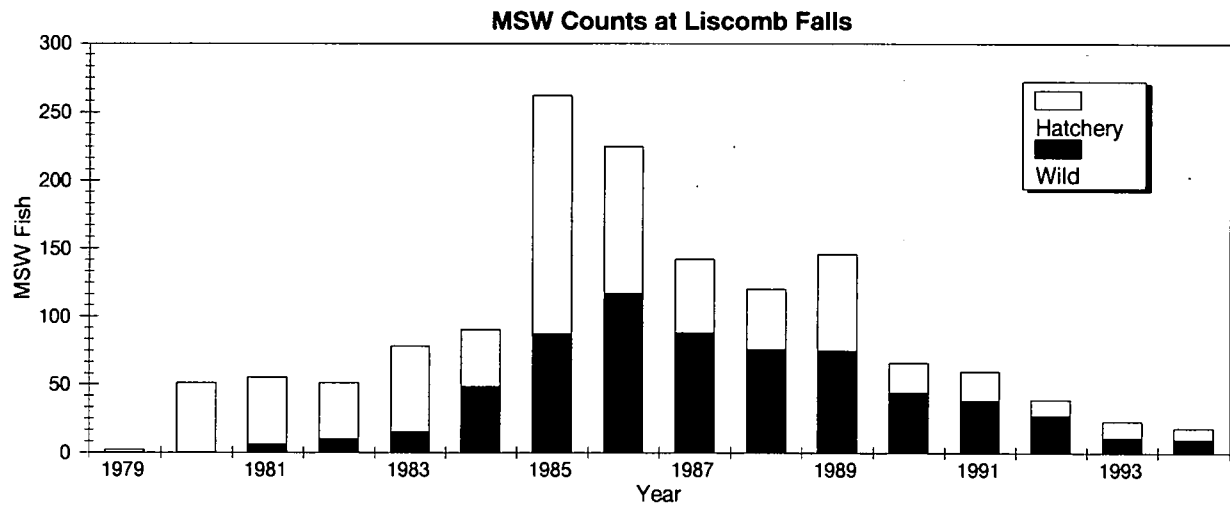
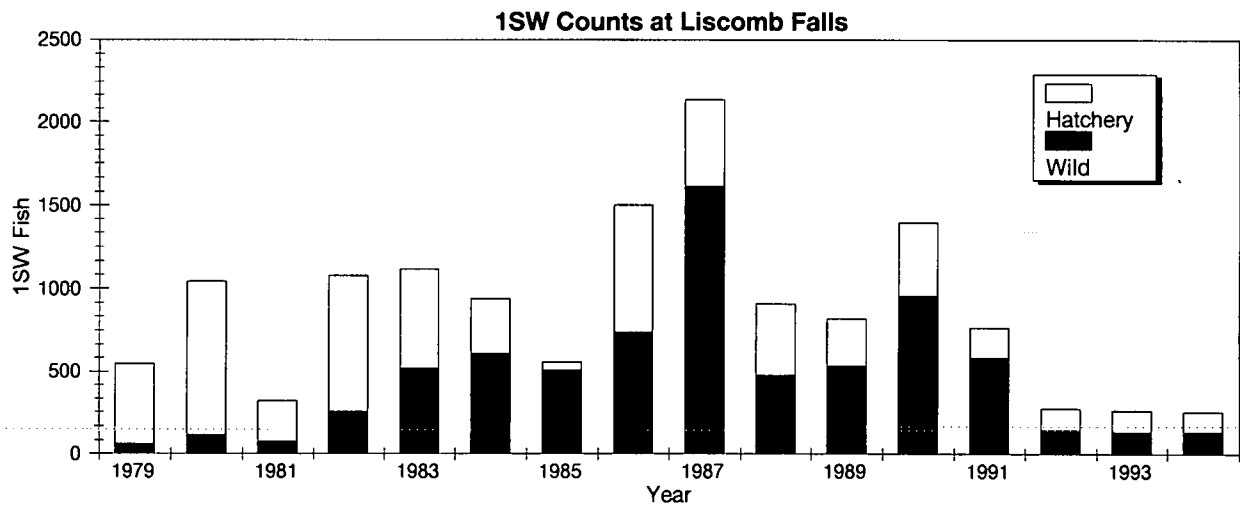


Figure 3. Counts of wild and hatchery salmon and percent return from hatchery smolts at the Liscomb Falls fish counting facility in recent years.

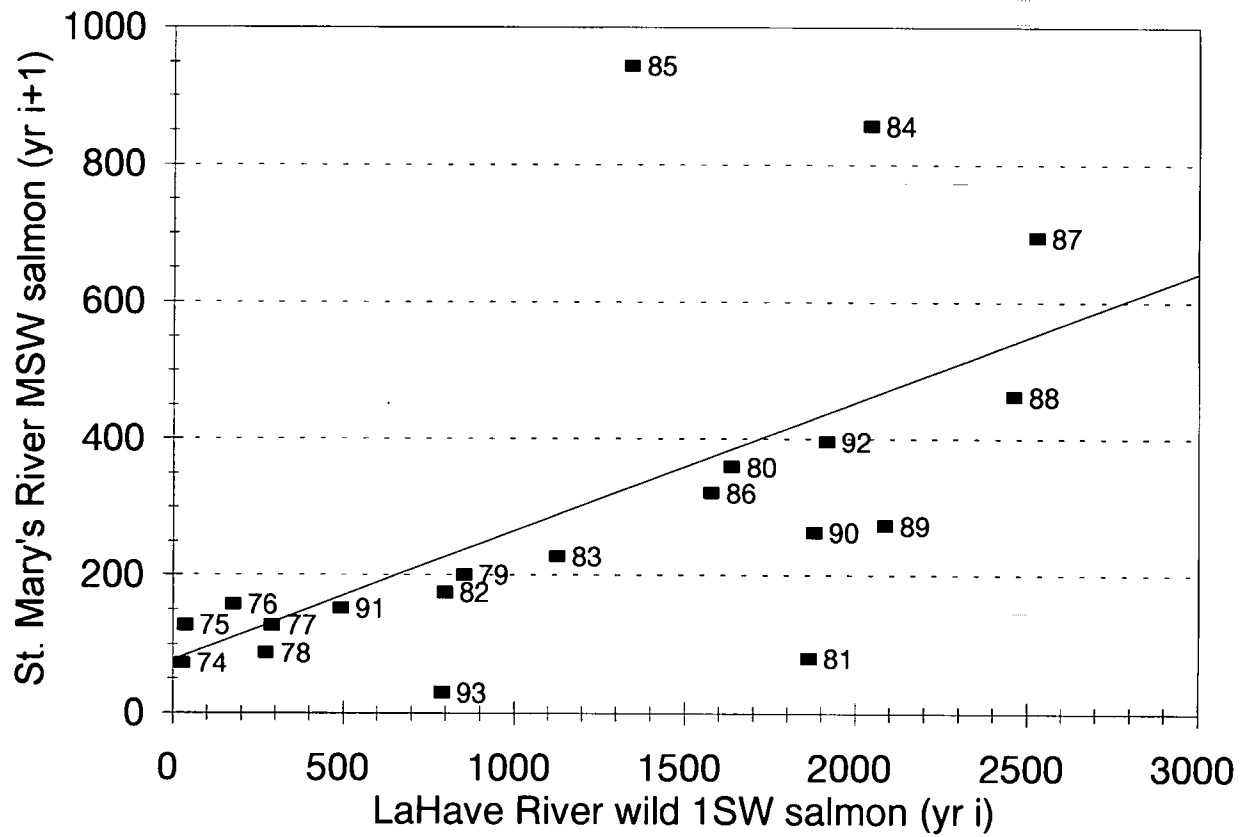


Figure 4 . St. Mary's River MSW salmon sport catch related to the LaHave River at Morgan Falls wild 1SW fish counts, 1974-93.



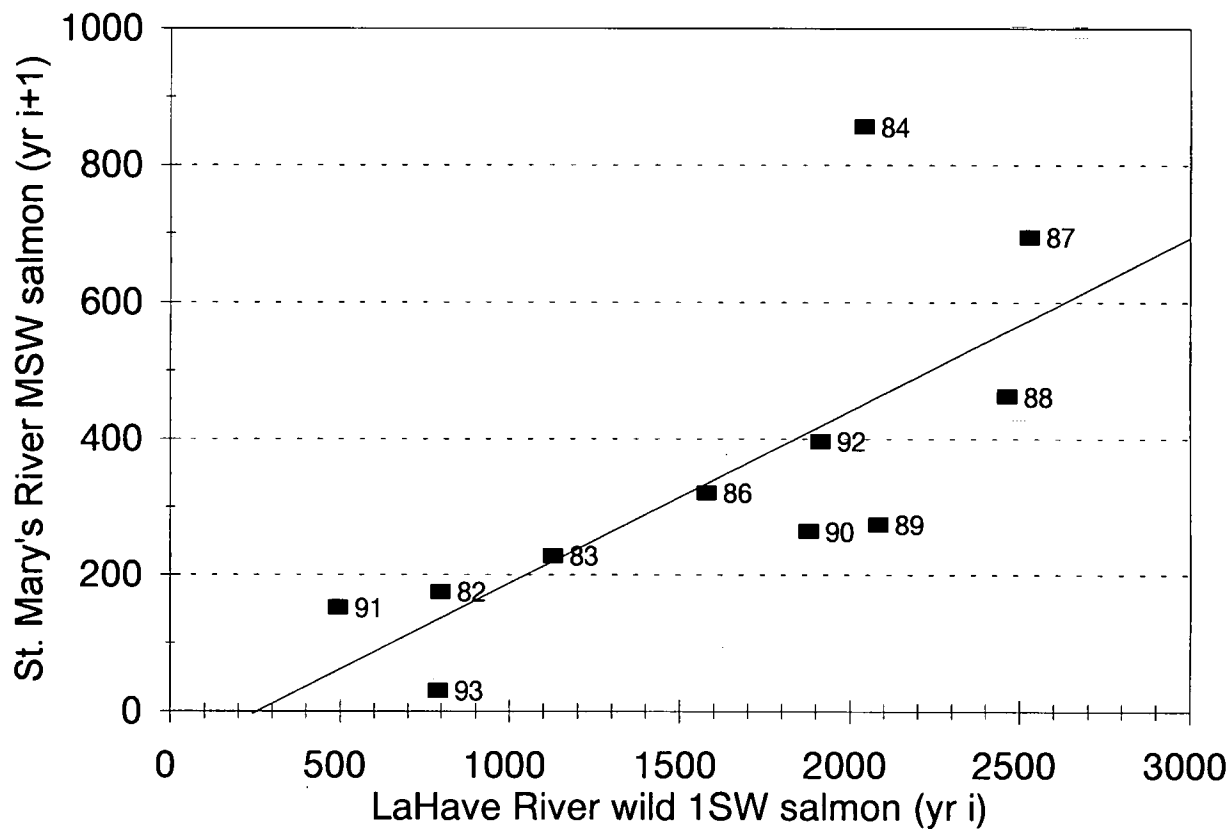


Figure 5. St. Mary's River MSW salmon sport catch related to the wild 1SW salmon returns to Morgan Falls on the LaHave River, 1982-93, exclusive of the 1985 point which was an outlier (refer to text). The 1982-93 period encompasses the years when the license stub generated the angler catch data.

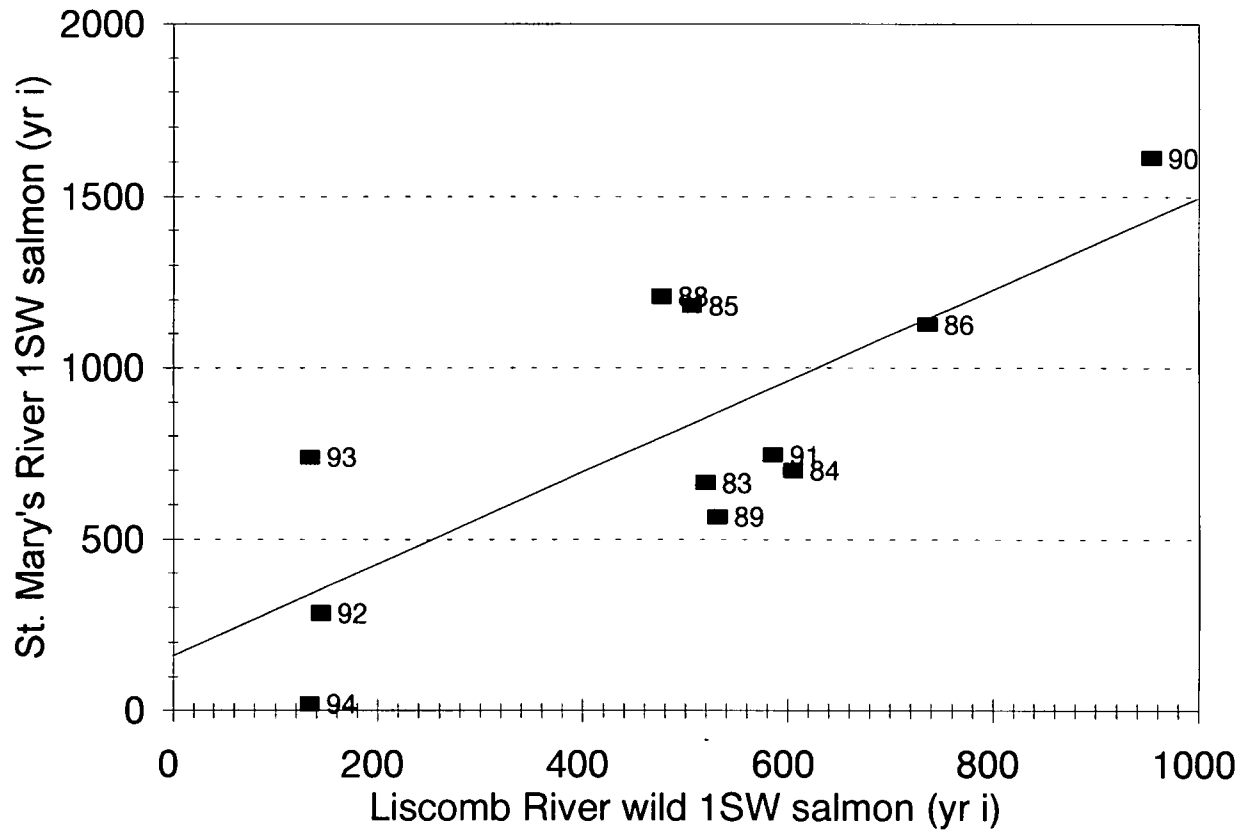


Figure 6. Sport catch of 1SW salmon on the St. Mary's River related to the wild 1SW salmon counts at the Liscomb River trap, 1983-94 exclusive of the 1987 drought year.

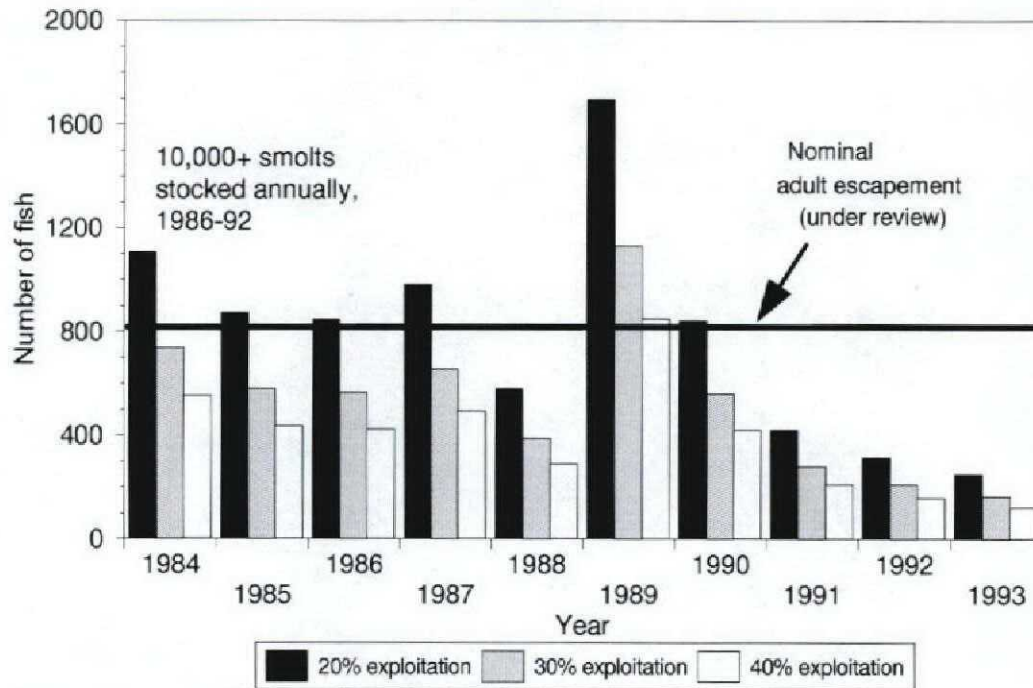


Figure 7. Estimates of Atlantic salmon escapements to the West River, Sheet Harbour, based on a range of exploitation rates and reference to a nominal conservation requirement.

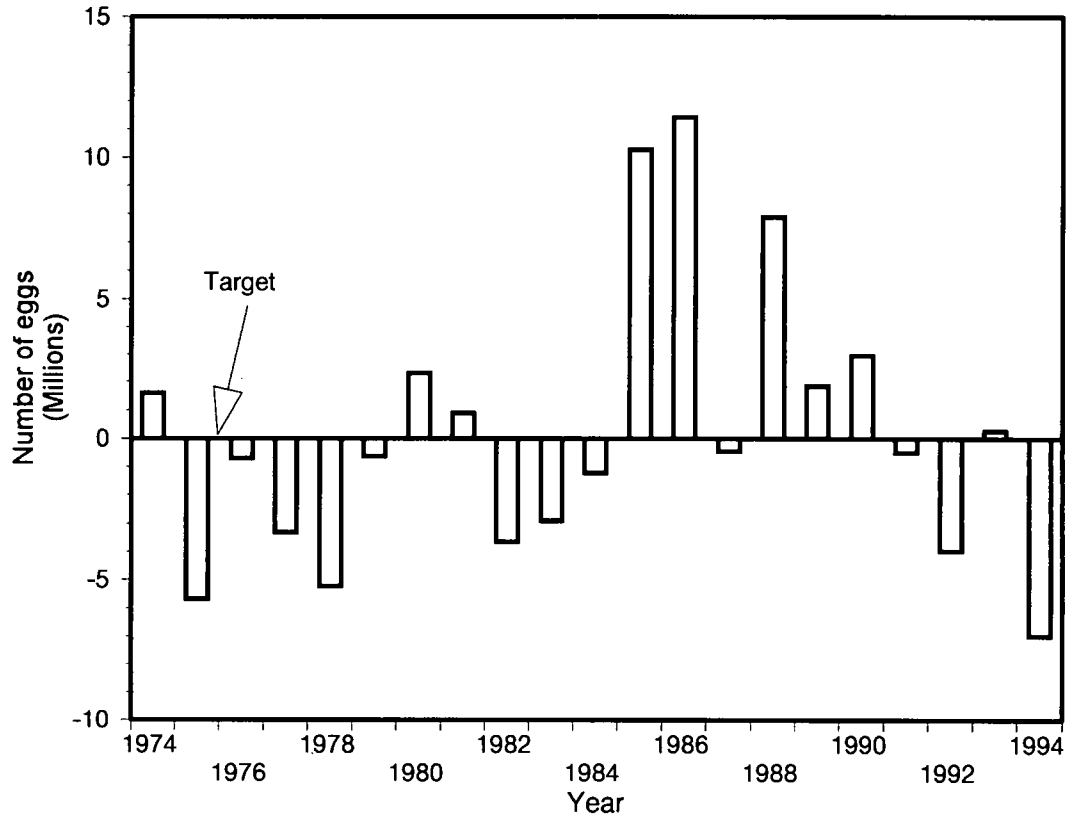


Figure 8. Estimated egg deposition relative to conservation target ("0" line) for the St. Mary's River based on escapement after a 30% exploitation rate for angling.