ASSESSMENT OF ATLANTIC SALMON IN THE MARGAREE RIVER, NOVA SCOTIA, 1992

by

G. Chaput, R. Jones, L. Forsyth, and P. LeBlanc
Science Branch, Gulf Region
Department of Fisheries and Oceans
P.O. Box 5030
Moncton, New Brunswick
E1C 9B6

ABSTRACT

The recreational catches of Atlantic salmon (*Salmo salar*) from the Margaree River between June 1 and Oct. 15, 1992, were estimated by creel survey to be at 747 1SW salmon (<63 cm fork length) harvested and 609 MSW salmon released. The recreational fishery exploitation rate estimates, based on recaptures of salmon tagged and released at the estuary, were 0.25 for 1SW salmon and 0.11 for MSW salmon. About 31% of the 1SW salmon tagged before Sept. 1 (summer-marked fish) were recaptured during the angling season, in contrast to 12% of the fall-marked fish. For MSW salmon, 8% of the summer-marked fish were recaptured in contrast to 7% of the fall-marked salmon. The estimated returns of Atlantic salmon to the Margaree River in 1992, based on angling catches, were 2562 (90% C.I. 1302 to 4803) 1SW salmon and 5182 (90% C.I. 3073 to 9001) MSW salmon, resulting in potential egg depositions by MSW salmon of 493% (90% C.I. 290% to 860%) of target requirements (502% of target by 1SW and MSW salmon). A second estimate of returns, based on the recapture trap and independent of angling catch and exploitation rate estimated 1018 1SW salmon and 3941 MSW salmon returned to the river, resulting in egg depositions of 378% of target. Potential egg depositions have exceeded target requirements since 1985 (137% in 1985 to 1063% in 1990). The high densities of juvenile salmon (6.3 to 58.7 parr/100 m^2) in the Margaree River in 1992 are a reflection of the high spawning escapements achieved in recent years.

RESUME

Les captures de Saumon atlantique (*Salmo salar*) de la pêche récréative de la rivière Margaree, pour la période du 1e juin au 15 octobre, 1992 ont été estimées par enquête à 747 saumons unibermarins (1SW) (longueur à la fourche < 63 cm) récoltés et 609 saumons pluribermarins (MSW) relâchés. Les taux d'exploitation de la pêche récréative, estimés par la méthode de marquages-captures des poissons marqués dans l'estuaire de la rivière, s'élevaient à 0,25 pour les 1SW et 0,11 pour les MSW. Environ 31% des saumons 1SW marqués avant le 1e septembre (remontée estivale) ont été capturés dans la pêche récréative tandis que 12% de ceux marqués après le 1e septembre ont été capturés par après. Pour les saumons MSW, seulement 8% de la remontée estivale et 7% de la remontée d'automne ont été capturés durant la saison de pêche récréative. La remontée de saumon en 1992 dans la rivière Margaree, estimée des captures de la pêche récréative et les taux d'exploitation de cette pêche, a été environ 2562 saumons 1SW (intervalle de confiance (I.-C.) à 90%, 1302 à 4803) et 5182 saumons MSW (I.-C. à 90%, 3073 à 9001). Les survivants de cette remontée de saumons MSW auraient contribué un dépôt d'oeufs équivalent à 493% du niveau cible (I.-C. à 90%, 290% à 860%). Les saumons 1SW ne contribuent que faiblement au dépôt d'oeufs; ensemble les saumons MSW et 1SW auraient contribué à 502% du niveau cible d'oeufs. Un deuxième estimé de la remontée a été possible en 1992 en se servant du rapport des saumons marqués et non-marqués dans les captures au deuxième filet dans l'estuaire. La remontée aurait atteint 3941 saumons MSW (I.-C. à 95%, 2865 à 5639)et 1018 saumons 1SW (I.-C. à 95%, 740 à 1456), dont 378% du niveau cible d'oeufs. Les dépôts d'oeufs ont excédé au niveau cible depuis 1985 (137% en 1985 à 1067% en 1990). Les hautes densités des juvéniles dans la rivière en 1992 (6,3 à 58,7 tacons/100m^2) sont dues aux niveaux élevés de géniteurs atteints récemment.

INTRODUCTION

This is the 9th assessment of the Margaree River Atlantic salmon (*Salmo salar*) resource. Previous assessments have been presented for 1983, and 1985 to 1991. Gray and Chadwick MS 1984); Claytor and Chadwick MS 1985; Claytor and Léger MS 1986; Claytor et al. MS 1987; Claytor and Chaput MS 1988; Claytor and Jones MS 1990; (Chaput and Jones MS 1991a; Chaput et al. MS 1992.

The Margaree River is situated in Cape Breton Island, Inverness County, Nova Scotia (Statistical District 2, Salmon Fishing Area 18) (Fig. 1). The two principal branches, the Southwest Margaree and the Northeast Margaree, meet at Margaree Forks to form the Margaree River which flows into the Gulf of St. Lawrence. Most of the recreational fishery takes place in the Northeast Margaree and the Margaree River proper, although the Southwest Margaree is fished in the fall. The Margaree River salmon has traditionally been considered as having two run components, the summer run which for statistical purposes ends on August 31, and the fall run occurring from Sept. 1 onwards.

Since 1979, numerous regulatory restrictions have been imposed to increase the summer component of the salmon run (Chaput and Claytor 1988). Mandatory release of multi-sea-winter (MSW) salmon ($\geq$ 63 cm fork length) angled before Sept. 1 has been in place since 1979. Since 1985, all MSW salmon have been released regardless of date of capture. The angling season in 1992 was the same as in 1991; the angling season extended from June 1 to Oct. 31, rather than closing on Oct. 15, as was the case prior to 1990. The season retention limit for 1SW salmon (<63 cm fork length) per license was reduced from 10 to 8 in 1992, while the regulations requiring that all 1SW salmon kept be tagged, as well as mandatory hook and release regulations for all multi-sea-winter salmon (MSW) (fork length >= 63 cm) were maintained. The commercial fishery of Salmon Fishing Area 18 remained closed, as it has been since 1985. Commercial landings prior to 1985 are summarized in Claytor and Jones (MS 1990).

This document summarizes the recreational catch for the Margaree River which, combined with a derived exploitation rate, is used to estimate the returns, spawning escapement and egg depositions of 1SW and MSW salmon in 1992. An independent population estimate of the returns of salmon, based on a recapture trap in the estuary is compared to the estimate obtained using angling catches. The contribution by hatchery-origin salmon to the total returns and to the angling catches are presented. Juvenile densities at five standard sites are compared to those from previous years.

MATERIALS AND METHODS

Estimates of harvests and catches

Recreational catch estimates were obtained from three sources.

1. Fisheries officers from the Dept. of Fisheries and Oceans (DFO) at Margaree Forks, Nova Scotia, have provided estimates of angling catch for the period 1947 to 1992. MSW salmon hook and release estimates were not provided in 1992.

2. Recreational catches, since 1984, have been estimated from license stub returns (LIC) (O'Neil et al. 1985, 1986, 1987, 1989, 1991). Catch estimates for 1989 to 1991, and preliminary estimates for 1992 were obtained from S. O'Neil, DFO Halifax, Nova Scotia. The estimation procedures for the LIC data are outlined in O'Neil et al. (1991). Anglers are only required to report the number of MSW hooked and released from a given river for the entire season, therefore, seasonal breakdowns are not possible.

3. Angling catch was estimated by creel survey for 1987 to 1992. The creel survey method used in 1992 was identical to the one used in 1990 and 1991; a "bus route" access point survey (Robson and Jones 1989) combined with lattice sampling (Chaput and Jones MS 1991a). The 10 index pools were surveyed for the period June 1 to Oct. 15. The recent two week season extension, Oct. 16 to Oct. 31, was not surveyed. A total of 4 strata, each of 23 days duration, were used for the time period between June 1 and Aug. 31, 1992. Five strata, each of nine days duration, were constructed for the fall period, Sept. 1 to Oct. 15. The sampling intensity in the strata was 12/23 days for the June 1-23 stratum and 16/23 days for the remaining three strata. Fall sampling intensity was 6/9 days in each stratum. The sampling day was divided into AM and PM periods. Each sampling period lasted 7.5 hours with the AM period commencing at 600 or sunrise depending on season and the PM period finishing at 2100 or sunset depending on season. Both the AM and PM periods were sampled on the same day, twice in each stratum for the summer and once in each stratum for the fall. The Horvitz-Thompson unweighted matrices were used to estimate total catch and effort by stratum (Robson 1990). Variance estimates of effort (hours) and angling catch by size group (1SW and MSW salmon) for the summer (June 1 to Aug. 30) and fall (Aug. 31 to Oct. 15) were obtained using the Yates-Grundy variance estimator (Robson 1990). The 95% confidence intervals for the estimates were calculated using $\pm$ 2 standard deviations as in the previous assessment. The creel survey field methods for Margaree River are described in Appendix A.

The estimates of total river catch were obtained using logbook reports. Creel catch at index pools was expanded to total river catch using the proportion of the logbook catch originating at index pools. The distributions of the river catch estimates for 1SW and MSW salmon by season were generated using 5000 replications and bootstrap estimates of individual parameter uncertainty (Chaput MS 1992).

Volunteer angler logbook reports which detailed the daily catch by size, release method, effort (hours) and pools fished were received and processed as in previous assessments (Claytor and Jones MS 1990). Logbook data were used to expand creel catch estimates to total river catch and to provide estimates of reporting rates of tagged fish recaptured in the recreational fishery.

Salmon Check-In Program (SCIP)

A volunteer catch declaration program, initiated in 1991, was continued in 1992. Anglers were asked to report the 1SW salmon catches to one of 5 stations where the angled fish could be sampled for biological characteristics, date of capture, location captured, etc. The declaration stations included four local business establishments and the Margaree Fish Culture Station (DFO). The program was a cooperative initiative between DFO and the Margaree Salmon Association.

Estimation of Exploitation Rate (ER)

The exploitation rate (ER) was estimated using mark/recapture methods, similar to those used since 1988, and the following formula:

ER = Tags Recaptured / Tags Available.

Two trapnets, identical in construction and installation to those of the previous assessments (Claytor and Chaput 1988), were fished within tidal waters between June 14 and Oct. 20, 1992. Each trap was not fished for the same time period and these fishing periods are summarized below:

Trap	Start Date	Finish Date
Marking Trap (Lower Trap)	September 1	October 20
Recapture Trap (Upper Trap)	June 15	October 14

All salmon captured in the trapnets were marked using blue, individually numbered Carlin tags secured with a double stainless steel wire attachment directly under the dorsal fin. In 1992, small lengths of fluorescent flagging tape were twisted into the stainless steel wire to make the tags more visible during snorkel and streamside censuses. Different colours were used for June, July, August and Sept./Oct. tagging periods. Tag recaptures in the angling fishery were reported in logbooks, at SCIP stations and by mail.

Estimation of Tags Available

Losses of tagged fish due to emigration and mortality were considered minimal and were not considered further. Losses due to tag shedding by marked fish were estimated by marking, with Carlin tags prior to confinement in the holding tanks at the Margaree Fish Culture Station, a total of 32 1SW and MSW salmon collected for broodstock from Hatchery Pool on Aug. 25. The tagging method was similar to that used at the estuarine trapnets. Fish were examined for tags when spawned in late October, early November. The tag shedding rate (tags lost per day) was calculated as the ratio of the number of tags lost to the number of tags initially placed divided by the number of days since tagging (taken as 65 days in 1992). The number of tags available to anglers was estimated from the number of marked fish released multiplied by the proportion of tags retained,

where the proportion retained equalled (1 - tag shedding rate times median days to recapture in the angling fishery) (Table 1).

Estimation of Tags Recaptured

The tags returned voluntarily were adjusted to account for the reporting rate. The reporting rate of tag recaptures from the angling fishery was estimated for 1SW and MSW separately. The proportion of logbook tag recaptures to logbook catch was assumed to represent 100% reporting. The proportion of tags recaptured at index pools to estimated catch at index pools represented the partial reports. The ratio of creel catch proportions to logbook catch proportions equalled the reporting rate.

Estimation of Returns

Method 1:

The estimate of returns based on angling catch in 1992 was obtained using the formula:

Returns = Angling Catch / ER   (see Table 1).

The confidence around the returns estimate was quantified using simulation techniques. The returns equation was solved a total of 5000 times with the angling catch and exploitation rate allowed to vary for each replication. Variation in angling catch and exploitation rate was simulated using bootstrap techniques as described in Table 1.

Method 2:

This method is based on catches at the recapture trap (upper trap) and a derived catch efficiency. The following three statistical methods were used to estimate the fall population.

1.   Adjusted Peterson Estimate.

This population estimate is described in Ricker (1975).

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

M = Salmon tagged at Lower Trap.
C = Total Catch at Upper Trap.
R = Tagged Salmon at Upper Trap.

2.   Bayesian Population Estimate.

An estimate of the population was obtained using a bayesian estimator as described by Gazey and Staley (1986). The most probable population size given R recaptures out of M marks placed in a sampled catch of C was calculated over a range of possible population sizes. The probabilities were calculated assuming that the sampling for marks was performed with replacement for one recapture interval.

$$P(N_i \mid R_1, R_2 \ldots R_\tau) = \frac{\prod\limits_{t=1}^{\tau} P(R_t \mid N_i)}{\sum\limits_{i=1}^{K} \prod\limits_{t=1}^{\tau} P(R_t \mid N_i)}$$

3.   Schaefer Method for Stratified Populations.

Similar to the Peterson estimate but where the time of marking and time of recovery are divided into periods (Ricker 1975). The marking and recapture periods were the following:

1.   September 1   -   September 15
2.   September 16   -   September 30
3.   October 1   -   October 14

$$N = \sum N_{ij} = \sum \left(R_{ij} \times \frac{M_i}{R_i} \times \frac{C_j}{R_j} \right)$$

The total returns of 1SW and MSW were estimated using the proportion of 1SW salmon and MSW salmon from the upper trap catch.

Estimation of Spawning Requirements and Spawning Escapements

The conservation spawning requirements based on 2.4 eggs/m^2 of spawning and rearing area for the Margaree River were calculated using the formula and biological characteristics summarized in Table 2. The MSW salmon spawner requirement is 1,036 fish.

Estimates of spawning requirements were also derived from a stock-recruit relationship for MSW salmon. The MSW spawner requirement for maximum surplus production was estimated at 1,352 fish and 1,974 MSW salmon spawners are required for generating maximum recruitment back to the river (Chaput and Jones MS 1992).

The spawning escapement to the Margaree River was calculated using the following formula (Claytor and Jones MS 1990):

$$\text{Spawners} = \frac{\text{Sport Catch X (1 - ER)}}{\text{ER}}$$

For the years 1947 to 1986, DFO estimates of catch were used. For 1987 to 1992, creel survey estimates of sport catch were used. Prior to 1987, the exploitation rate for both 1SW and MSW salmon was assumed to be uniformly distributed between 0.206 and 0.379 for both summer and fall angled fish (Claytor and Chaput MS 1987). The returns for 1987 to 1989 were estimated using an assumed exploitation rate for the summer (uniform distribution between 0.206 and 0.379) and derived exploitation rates for the fall varying from 0.11 to 0.35 for 1SW salmon and 0.09 to 0.26 for MSW salmon (Chaput and Jones MS 1991b). The returns and escapements in 1991 and 1992 were determined using the simulation and bootstrapping techniques. Since 1979, summer MSW sport catch and since 1985, all MSW sport catch regardless of date of capture was added back to the spawners formula, less 5% for hook and release mortality. The estimate of the percent of egg target met by MSW spawners excludes eggs collected by the DFO hatchery.

Hatchery Releases and Returns

Releases of hatchery reared fish, by life stage, to the Margaree River were updated for 1992. The proportions of hatchery and wild salmon returning to the Margaree River were determined from angler logbooks, creel survey, SCIP reports, broodstock collections, trapnet catches, and counting fence data at Lake O'Law Brook.

Electrofishing Surveys

A total of five electrofishing stations were sampled in July 1992. The methods were similar to those described by Chaput and Claytor (1989). Estimates of wild Atlantic salmon juvenile population numbers, densities, and mean size by size group were obtained for each station. Population estimates were calculated using the Zippin method (Zippin 1956). The percent habitat saturation index (PHS) was calculated according to the method proposed by Grant and Kramer (1990):

$$PHS = 100 \text{ X} \sum D_i \text{ X } T_i \text{ X } 1.19$$

where D_i is the density (per m^2) of size class $_i$

T_i is the territory size (m^2) for size class $_i$ predicted from the territory size-body size regression (Grant and Kramer 1990).

The index was calculated for the 1992 stations and compared to values for previous years.

RESULTS

Recreational Catches and Catch Rates

The DFO estimated catch of 1SW salmon from the Margaree River between June 1 and Oct. 31, 1992 was 236 fish, 83% of the previous 5 year mean value (Table 3). MSW salmon catch estimates were not obtained by field personnel in 1992.

Preliminary license stub estimates of catch from the Margaree River for 1992 were 693 1SW salmon and 1973 MSW salmon (Table 4). The previous 5 year mean license stub catch from the Margaree River was 764 1SW salmon and 1725 MSW salmon. The angling catch and effort for the Margaree River represented 55% of the 1SW salmon catch, 60% of the MSW salmon catch and 77% of declared effort (rod-days) for SFA 18 in 1992 (Locke et al. MS 1993).

Creel catch estimates of MSW salmon from the index pools in 1992 were almost identical to the 1991 catches for both the summer and fall periods. The MSW salmon catch in 1992, up to Oct. 15, was 88% of the 1991 catch. The 1992 1SW salmon catch estimate up to Oct. 15 was 149% of the 1991 catch estimate (Table 5). The effort estimate (hours of fishing effort) was 107% of the 1991 effort value and identical to the 1990 effort value.

The 1SW and MSW salmon catch proportions from the index pools, estimated using logbook catches versus tag recapture distributions, were different for both the 1SW and MSW salmon but the confidence intervals of the proportions obtained by bootstrapping were completely overlapping (Table 6), except for summer MSW salmon. Logbook proportions were used for expanding the index pool catches to total river catch in 1992.

The 1992 estimated catch of 1SW salmon, up to Oct. 15, from the Margaree River was 747, 191% of the 1991 estimated catch and 202% of the previous 5 year mean (Table 7). The MSW salmon catch up to Oct. 15, 1992 was 609 fish, similar to the 1991 value and 77% of the previous 5 year mean (Table 7).

The logbook reports for 1992 (Table 8), show that angler success rate was higher during the fall fishing period compared to the summer. Summer angling success peaked during the month of July, while the greatest fall catch rate occurred in the final two weeks of October.

Distribution of Tagging Effort and Recaptures

A total of 224 1SW salmon and 845 MSW salmon were marked and released from the estuarine trapnets between June 14 and Oct. 20, 1992 (Table 9). The largest portion of the catch occurred in the first two weeks of October for both 1SW and MSW salmon (Fig. 2). The modal length of 1SW salmon was 56 cm whereas MSW salmon had a modal length of 76 cm (Fig. 2).

About 21% of the 1SW salmon tags and 10% of the MSW salmon tags were returned by anglers (Table 9). Of the 21 1SW salmon marked and released during the broodstock seining on

Aug. 25, 1992, 29% were recaptured by anglers whereas none of the 10 MSW salmon marked and released were subsequently recaptured (Table 9).

The median days to recapture for salmon marked in the fall was comparable to that of salmon marked in the summer and recaptured in the summer:

	Days to Recapture		
	Median	Min.	Max.
1SW Marked before Sept. 1			
Recaptured before Sept. 1	16	4	37
Recaptured before Oct. 31	27	4	117
1SW Marked after Aug. 31			
Recaptured before Oct. 31	10	1	37
MSW Marked before Sept. 1			
Recaptured before Sept. 1	10	5	52
Recaptured before Oct. 31	45	5	107
MSW Marked after Aug. 31			
Recaptured before Oct. 31	9	1	38

Summer marked fish were recaptured throughout the fall in decreasing proportion as the fall season progressed. Of the tags reported captured during September, 50% of the 1SW salmon recaptures were of summer origin (4/5 of these summer recaptures were August marks), while the proportion fell to 16% in the first half of October and no summer tags were reported in the second half of October (Table 10). The fall catch of MSW salmon was composed primarily of fall marked salmon; the September recaptures were 31% summer origin (2/4 of the these summer-tagged recaptures were August marks), while the proportion of summer tags in the October recaptures was about 3% (Table 10).

Exploitation of June and July marked salmon was very high compared to the other groups, especially for 1SW salmon. The exploitation on the salmon marked during the last two weeks of Sept. was also high relative to the other tagging groups; 37% of 1SW salmon marks and 16% of MSW salmon marks placed were returned by anglers.

Summer fish, defined as salmon which were present at least in the estuary by the end of August are harvested as intensively in the fall season as in the summer. The proportions of fish marked before Sept. 1 and subsequently recaptured and reported before Sept. 1 were 0.15 for 1SW salmon and 0.04 for MSW salmon (Table 11). The proportions of these marked fish which were subsequently recaptured and reported over the entire angling season were more than double these values; 0.31 for 1SW and 0.09 for MSW salmon. Similar results were obtained during the 1991 tagging program; exploitation rates for 1SW passed from 0.08 to 0.15 whereas MSW exploitation passed from 0.03 to 0.12 (Table 11).

Fall exploitation rates, using only fish marked and released after August 31 were as high as those on summer fish recaptured during the summer period (Table 11). The MSW salmon rate, up to Oct. 15, was 0.07 which is almost identical to the values obtained during the 1988 to 1990 tagging programs (Table 11). The 1SW rates have been more variable, fluctuating between 0.07 and 0.12. The integrated rate for the entire season of marking and recapture was estimated at 0.10 for MSW salmon and 0.21 for 1SW salmon (Table 11). The exploitation rate derived for the entire season was less than that derived using only summer marked fish but the difference in 1992 was minor for MSW salmon. The difference was much greater for 1SW salmon (33% less than summer derived rate) (Table 11).

Estimation of Returns Equation Parameters

The angling catch data used in the estimation of returns for 1947 to 1992 are summarized in Table 7. The parameters which made up the returns equation in 1992 are presented in Tables 1 and 12.

In 1992, salmon were marked and released during the entire period of June 14 to Oct. 20. For comparison, exploitation rates were derived using the 1991 assessment method which used only tags released up to August 31 as well as exploitation rates derived using the marks placed for the entire season (Table 12). Prior to 1991, the summer ER was assumed to be between 0.206 and 0.379 and ER's had been derived for fall marked fish for the years 1988 to 1990.

The returns in 1992, based on angling catches up to Oct. 15, are presented using both exploitation rate values; summer tagged exploitation rate and overall summer and fall exploitation rate (Table 12). Using the overall exploitation rates for 1SW and MSW salmon, the returns in 1992 were estimated at 5,182 MSW (90% C.I. 3,073 to 9,001) and 2,562 1SW salmon (90% C.I. 1,302 to 4,803) (Table 12; Fig. 3). Using the exploitation rates derived for summer marked fish only provided estimated returns of 3,638 MSW and 1,484 1SW salmon (Table 12), a value for the MSW salmon return estimate identical to the 1991 MSW return estimate (Table 12). The integrated exploitation rate value is the more appropriate value to use.

The escapements in 1992 were estimated at 1,832 1SW salmon (90% C.I. 720 to 3,596) and 5,151 MSW salmon (90% C.I. 3,053 to 8,953) (Table 13). These escapements resulted in an estimated egg deposition by MSW salmon equal to 493% of the conservation target (90% C.I. 290% to 860%) or 502% by both 1SW and MSW salmon (Table 13). Potential egg depositions by MSW salmon have exceeded the conservation target egg depositions since 1985, even at the lower confidence limit (Table 13). The estimated MSW escapements exceeded the target MSW spawners for maximum surplus production (1,352) by a factor of 3.8 and the target for maximum recruitment (1,974 MSW) by a factor of 2.6. The maximum surplus target has been exceeded every year since 1985 and the maximum recruitment target has been exceeded in 6 of the eight years since 1985 (Table 13).

Independent Trapnet Estimates of Returns

Catches at the trapnet are summarized in Fig. 2. Out of a total of 46 1SW and 164 MSW salmon marked and released from the lower trapnet between Sept. 1 and Oct. 13, 1992, 29 MSW and 5 1SW salmon were recaptured at the upper trapnet. The range of recapture times for lower to upper was 1 to 31 days with a median lag time of 1 day. Population estimates derived using the Peterson, Schaefer and Bayesian methods were identical and the most probable population size for salmon in the fall of 1992 was 3848 fish (95% C.I. 2798 to 5507) (Fig. 3). This provides a trap efficiency value of 16% (22% to 11%; 95% C.I.) from which the returns of 1SW and MSW salmon were estimated at 1018 and 3941 respectively (Table 14). These estimates are about 25% lower than the MSW estimate derived using the angling catches and 60% lower for 1SW salmon.

Electrofishing Surveys

The densities of fry in 1992 at the five sites were on average similar to 1991, and ranged from 20 to 336 fry per 100m^2 (Table 15). Parr densities were slightly lower in 1992, and ranged from 6 parr per 100m^2 at the Trout Brook site (Lake Ainslie tributary) to 59 parr per 100m^2 at three of the other sites (Table 15). The 1992 PHS index values for the Margaree River ranged from 4% to 45%, lower than the 1991 values but above values recorded in the 1970's (Table 15) (Chaput et al MS 1992).

Hatchery Contributions

Releases of hatchery progeny to the Margaree River by life stage are summarized in Table 16. The proportions of hatchery and wild 1SW and MSW salmon by collection method are summarized in Table 17. The trapnets provide the best indication of the proportion of wild salmon in the runs because of the larger sample size and the estuarine location from which samples were obtained. Prior to Aug. 31, the 1SW salmon run was 57% wild origin and the MSW salmon run was 88% wild origin (Table 17). Using the trapnet catches and the estimated efficiency, the hatchery contributions to the summer run in 1992 were 99 MSW fish and 142 1SW fish. These proportions are higher than the 1991 proportions of 9% for MSW and 19% for 1SW but the absolute numbers in 1991 are just slightly higher than in 1992; 117 MSW salmon and 197 1SW fish (assuming a catch efficiency similar to the 1992 estimate). Fall returns of hatchery fish in 1992 were estimated to have been 160 MSW and 160 1SW fish, representing 4% and 15% of the fall returns, respectively (Table 17). Overall contributions of hatchery origin salmon to total returns in 1992 were 5% for MSW and 21% for 1SW salmon.

Marine Exploitation of the Margaree River Atlantic Salmon

The Margaree River Atlantic salmon kelts, as well as returning previous spawners, are regularly intercepted in the Newfoundland and Quebec north shore commercial fisheries (Table 18). Three salmon from the 1991 spawning migration, were recaptured in the 1992 commercial fishery, two in Labrador and the other from the Quebec northshore.

DISCUSSION

The initiatives undertaken in 1992 have addressed two particular gaps in the assessment of the returns of Atlantic salmon to the Margaree River: 1) conducting a tagging study which covered the entire season to provide an estimate of the relative proportions of summer and fall run fish in the summer and fall angling catches and 2) obtain an estimate of population size, independent of angling recaptures.

The returns of MSW salmon to the Margaree River in 1992 were estimated using two methods: 1) on the basis of angling catches weighted by derived exploitation rates as in recent assessments for the Margaree and 2) using catches at a recovery trapnet in the lower section of the river for which the catch efficiency was derived. The returns estimates using both methods indicated that the returns in 1992 of MSW salmon were greater than 3500 fish although the estimate obtained using the angling catch method was 25% higher than the recovery trap estimate. The distributions of the returns estimates (Bayesian vs angling) for MSW salmon had a large overlap and the difference in the two estimates is not considered serious given the large uncertainty in the derivation of the exploitation rates in the angling fishery. In 1991 and 1992, the reporting rate of marked fish captured in the angling fishery was estimated to have been 100% using the method described in the text. The reporting rate is undoubtedly less than that since anglers mentioned that they had caught tagged MSW salmon but had not removed the tag because they did not want to stress the fish further or they were not aware that they should remove the tags. A reporting rate of 50% would be required to generate an estimate of returns using the angling data which is similar to the estimate obtained using the recovery trap. Such a low reporting rate value has been estimated from the Miramichi River angling fishery (Randall et a. 1991), but the present method of estimating the reporting rate does not support such a low value. Previously, estimates of returns based on angling catches and independently using trapnets were different. In 1988, the estimates based on angling catches were 13% higher for MSW and 25% higher for 1SW than those based on trapnet recaptures whereas, in 1989, the estimates based on angling catches were 35% less for MSW salmon and 46% less for 1SW salmon than the trapnet estimated returns (Claytor and Jones MS 1990). Trapnet estimates should preferentially be used over angling data because fewer of the variables have error: recaptures are reported without error, catch is reported without error. The only variable common to both which has uncertainty is the number of tags available.

Reliable angling statistics are difficult to obtain. Based on the population estimate from the trapnet and the exploitation rate on 1SW and MSW salmon derived with the mark-recapture data, the recreational catch on the Margaree River in 1992 was estimated at 255 1SW and 434 MSW salmon, values which are significantly lower than the estimates of angling catch from creel and from license stubs.

The exploitation rate on 1SW salmon in 1992 was the highest value derived since 1988 and for fish tagged prior to Sept. 1, the exploitation rate was estimated at 0.46; nearly half the 1SW salmon released from the trapnet in the summer period were subsequently harvested by the end of October. The exploitation rate on summer MSW salmon was significantly lower, but nearly 17% of these salmon were subsequently recaptured by the end of October.

The estimated exploitation rate on fall marked MSW salmon has been very constant and low (<0.10) over the last five years. Summer exploitation rate values for MSW also appear fairly constant over the two years collected so far. The exploitation rate on 1SW salmon is much more variable. The integrated ER calculated in 1991 overestimated the overall exploitation rate resulting in an underestimate of the total returns because a similar calculation applied to the 1992 summer tagged fish resulted in estimates of MSW salmon returns which were slightly less than the recovery trap estimates.

Estimating the returns of salmon during the summer versus the fall, using the angling catch values for each season, is complicated by the mixture of both summer and fall entrants in the fall angling catch. The proportion of fall catch which is summer salmon is not very high, about 8% for MSW salmon and 21% for 1SW salmon. In previous assessments, the angling catches from the summer and fall were treated as two distinct components representing the respective sizes of the runs. The mark/recapture data from 1991 and 1992 have shown this to be incorrect. Since some of the fall recreational catch consisted of fish which had been marked and released in the summer, the fall returns of MSW salmon are slightly inflated but the summer returns have been seriously underestimated, especially when using assumed exploitation rates of 0.202 to 0.379 as in the previous assessments (Chaput et al. MS 1992). The true exploitation rate which should be used for the summer catch has been more in the order of 0.04% in 1991 and 1992. The exploitation rates derived in 1988 to 1990 for fall angled fish actually correspond to exploitation rates for fish entering and angled in the fall. This overestimated the fall returns while underestimating the summer returns but the bias for the fall returns is not large because the fall catch, at least in 1992, was composed primarily of fall fish (92% for MSW, 79% for 1SW salmon).

The return of MSW Atlantic salmon to the Margaree River in 1992 was similar to the 1991 value. The spawning escapement in 1992 was four times the conservation target spawning requirement, and two times the maximum recruitment target. The increased returns to the Margaree River since 1985 have resulted in high densities of Atlantic salmon juveniles at the sampled sites in the Margaree River.

The Atlantic salmon resource of the Margaree River has increased in abundance since 1985 to the point where surpluses of fish to presently designated spawning requirements are occurring every year. A forecast for 1993 can be obtained from the stock-recruit function which has been derived for the Margaree River (Chaput and Jones 1992). Given the estimated spawning escapement of 1,670 MSW salmon achieved in 1988, the expected recruitment of MSW salmon in 1993 is 4,491 (90% C.I. 3833 to 5079) (Fig. 4).

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Table 1. Formulation for the estimation of the returns of Atlantic salmon to the Margaree River, 1992. Italics indicate parameters which changed value for every repetition.

_____

$$RETURNS\ (1SW;\ MSW) = \frac{CATCH\ (1SW;\ MSW)}{EXPLOITATION\ RATE\ (1SW;\ MSW)}$$

CATCH *(1SW; MSW)* = Catch Summer + Catch Fall

$$Catch\ (summer;\ fall) = \frac{Est.\ Creel\ Catch\ from\ Index\ Pools\ (CCI)}{Proportion\ of\ Catch\ from\ Index\ Pools\ (PCI)}$$

CCI ---> 1SW summer assumed distribution N(128, 2583)
         1SW fall assumed distribution   N(110, 1551)
         MSW summer assumed distribution N(67, 637)
         MSW fall assumed distribution   N(150, 1742)

PCI ---> variability simulated using bootstrapping.
         Using logbooks:
         summer   N = 30   1SW prop.   11/41 = 0.27
                            MSW prop.   23/61 = 0.38
         fall   N = 47   1SW prop.   13/30 = 0.43
                            MSW prop.   31/87 = 0.36

         Using tag returns from angling fishery:
         summer   1SW prop.   3/8 = 0.38
                            MSW prop.   1/5 = 0.20
         fall   1SW prop.   13/29 = 0.45
                            MSW prop.   24/51 = 0.47

EXPLOITATION RATE *(1SW; MSW)* = *Tags Recaptured / Tags Available*

Estimated for both seasons combined.

$$Tags\ Recaptured = \frac{Tags\ Returned\ Voluntarily\ (1SW;\ MSW)}{Reporting\ Rate\ (RR)\ (1SW;\ MSW)}$$

Bootstrap estimates of RR for 1991 estimated from:

$$RR = \frac{\dfrac{Tag\ Recaptures\ from\ Index\ Pools\ (1SW;\ MSW)}{Creel\ Catch\ Estimate\ at\ Index\ Pools\ (1SW;\ MSW)}}{\dfrac{Tag\ Recaptures\ by\ Logbook\ Anglers\ (1SW;\ MSW)}{Logbook\ Catch\ (1SW;\ MSW)}}$$

Nonbootstrap value: 1SW = (16/238)/(5/87)   = 1.17
                      MSW = (26/217)/(22/202) = 1.10

Note: If RR > 1 then RR = 1.

Table 1 (cont'd).

Tags Available (1SW; MSW) = Tags Placed X *Proportion Retained(PR)*

Tags Placed in 1992:	1SW	=	221
(June 14 –Oct 15)	MSW	=	831

PR = 1 - (*Tag Loss Rate*) X *Median Days to Recapture*

Tag Loss Rate is Bootstrapped.
Of 32 MSW and 1SW salmon marked and retained for 65 days in 1992,
19 had shed their tags. Tag loss rate = 0.009 tags/day.

Recapture data is bootstrapped to obtain median days to recapture.

1SW Recaptures: N = 47, Range 1 to 117 days, Median = 13 days
MSW Recaptures: N = 79, Range 1 to 107 days, Median = 10 days

SUMMARY EQUATION

$$RETURNS\ (1SW;\ MSW) = \left[\frac{CCI\ (Summer)}{PCI\ (Summer)} + \frac{CCI\ (Fall)}{PCI\ (Fall)} \right] X \frac{Tags\ Placed\ X\ PR\ X\ RR}{Tags\ Returned\ Voluntarily}$$

Solve *RETURNS* a large number of times to generate the distribution from
which the Confidence Limits can be determined.

Table 2. Estimation of spawner requirements for the Margaree River.

MARGAREE RIVER

Rearing Units	27,976 (100 sq. m)	(Elson 1975)
Optimal Egg Deposition	240 per rearing unit	(Marshall 1982)

Total Egg Requirements =   6,714,240

Biological characteristics

Fecundity		1764 eggs/kg	(Elson 1975)
1SW	% female	11	(Marshall 1982)
	mean wt	1.7	(Marshall 1982)
MSW	% female	75	(Marshall 1982)
	mean wt	4.9 kg	(Marshall 1982)

Eggs per spawner   1SW = eggs/kg * mean wt(kg) * %female
                        = 1764 * 1.7 * 11%
                        =   330

                    MSW = eggs/kg * mean wt(kg) * %female
                        = 1764 * 4.9 * 75%
                        =   6483

Required number of   MSW = egg requirements / eggs per MSW
                         = 6,714,240 / 6483

                         =   1036 --->>   777 females
                                                   259 males

Deficit males =   777 - 259 =   518

1SW spawners to obtain 518 males   =   518 / 89%
                                      =   582

MSW spawners to obtain 518 males   =   518 / 25%
                                      =   2072

Spawning Requirements   Minimum   MSW =   1036
                                         1SW =   582

                           Maximum   MSW =   3108
                           All 1SW surplus

Table 3. Salmon angling catch on Margaree River (1947-1992) as compiled by Department of Fisheries and Oceans fisheries officers (DFO statistics).

Year	1SW	MSW Retained	MSW Released	MSW Total	Unsized	Total
1947	36	363			1	400
1948	106	704			.	810
1949	41	332			9	382
1950	111	320			8	439
1951	21	424			25	470
1952	83	204			4	291
1953	49	291			. 8	348
1954	68	298			10	376
1955	53	258			.	311
1956	28	90			1	119
1957	36	136			.	172
1958 *	N/A	N/A			.	334
1959 *	N/A	N/A			.	235
1960 *	N/A	N/A			.	140
1961	29	49			11	89
1962	46	410			.	456
1963	87	212			.	299
1964	120	289			.	409
1965	86	254			.	340
1966	92	165			.	257
1967	98	265			8	371
1968	64	198			6	268
1969	214	139			6	359
1970	85	215			3	303
1971	21	94			.	115
1972	42	105			.	147
1973	166	117			.	283
1974	60	107			.	167
1975	36	64			.	100
1976	96	82			.	178
1977	69	140			1	210
1978	25	158			.	183
1979	597	62	19	81	8	686
1980	167	138	2	140	11	318
1981	899	105	34	139	11	1049
1982	691	103	76	179	1	871
1983	68	107	42	149	4	221
1984	148	12	109	121	.	269
1985	223	0	312	312	1	536
1986	295	0	754	754	.	1049
1987	353	0	408	408	.	761
1988	435	0	580	580	.	1015
1989	179	0	244	244	.	423
1990 @	208	0	314	314	.	522
1991 @	246	0	-	-	.	246
1992 @	236	0	-	-	.	236

*   Information regarding 1SW and MSW salmon for 1958-1960 are not available.
@   Note: Season was extended from October 15 to October 31.

Table 4. Annual summaries of catch and effort for the Margaree river from 1984-92 using license stub returns. +/- Mean = (1992-Mean)/Mean.

Year	River	No. Angler	1SW Obs.	1SW Est.	MSW Obs.	MSW Est.	Unk. Obs.	Total Obs.	Total Est.	Rods Obs.	Rods Est.	CPUE	% MSW
	Margaree												
1984		678	233	242	293	305	4	530	551	5952	6665	0.089	55.7
1985		793	473	509	1130	1215	3	1606	1724	7324	7824	0.219	70.5
1986		1131	748	782	2522	2636	2	3272	3420	9724	10232	0.336	77.1
1987		1441	925	977	1757	1857	0	2682	2834	12165	12887	0.220	65.5
1988		1455	749	879	1647	1932	0	2396	2810	11582	14042	0.207	68.7
1989		1486	464	561	1298	1570	0	1762	2132	10594	13234	0.166	73.7
1990		1382	514	649	1193	1507	0	1707	2156	10789	14072	0.158	69.9
1991		1236	586	752	1370	1757	0	1956	2509	10142	13432	0.193	70.0
1992		1315	512	693	1458	1973	0	1970	2666	10746	15018	0.183	74.0
	Mean(87-91)	1400	648	764	1453	1725	0	2101	2488	11054	13533	0.189	69.6
	+/- Mean	-6%	-21%	-9%	0%	14%	.	-6%	7%	-3%	11%	-3%	6%

Table 5. Estimation of angling catch and effort (hours) from the index pools on the Margaree River, June 1 to Oct. 15, 1992.

		Estimate of Total	Std. Dev.	C.I. 95% Lower	C.I. 95% Upper	Inaccuracy +/- %
Summer	1SW	128	50.8	26	230	79.4%
(June 1 to Aug. 31)	MSW	67	25.2	17	117	75.3%
	EFFORT	11465	519.9	10425	12505	9.1%
Fall	1SW	110	39.4	31	189	71.6%
(Aug. 31 to Oct. 15)	MSW	150	41.7	67	233	55.6%
	EFFORT	11190	616.7	9957	12423	11.0%
	1SW	238	64.3	109	367	54.0%
TOTAL	MSW	217	48.8	119	315	45.0%
	EFFORT	22655	806.6	21042	24268	7.1%

Table 6. Proportion of catch at index pools based on logbook data and tag recapture data, 1992.

	Catch	Logbooks Median	Logbooks Percentiles 5%	Logbooks Percentiles 95%	Tag Recaptures Median	Tag Recaptures Percentiles 5%	Tag Recaptures Percentiles 95%
Summer	1SW	0.27	0.15	0.40	0.38	0.13	0.63
(June 1 to Aug. 28)	MSW	0.43	0.29	0.58	0.20	0.00	0.60
Fall	1SW	0.38	0.23	0.57	0.45	0.31	0.59
(Aug. 29 to Oct. 15)	MSW	0.35	0.20	0.52	0.47	0.35	0.59

Table 7. Angling catches used for estimating returns and escapements to the Margaree River, 1947-1992. Catches by season for 1SW and MSW salmon are adjusted for the unsized catches in Table 3.

Year	1SW Salmon June 1 to Aug. 31	Sept. 1 to Oct. 15	Oct. 16 to Oct. 31	Total*	MSW Salmon June 1 to Aug. 31	Sept. 1 to Oct. 15	Oct. 16 to Oct. 31	Total*
1947	16	20		36	156	208		364
1948	64	42		106	276	428		704
1949	26	16		42	77	263		340
1950	49	64		113	79	247		326
1951	14	8		22	187	261		448
1952	37	47		84	86	121		207
1953	28	22		50	124	174		298
1954	38	32		70	170	137		306
1955	30	23		53	100	158		258
1956	16	12		28	67	24		91
1957	15	21		36	38	98		136
1958								0
1959								0
1960								0
1961	20	13		33	35	21		56
1962	25	21		46	273	137		410
1963	23	64		87	49	163		212
1964	77	43		120	135	154		289
1965	43	43		86	89	165		254
1966	48	44		92	22	143		165
1967	48	52		100	117	154		271
1968	30	35		65	54	148		203
1969	108	110		218	77	64		141
1970	48	38		86	55	163		217
1971	13	8		21	40	54		94
1972	22	20		42	53	52		105
1973	97	69		166	69	48		117
1974	34	26		60	30	77		107
1975	14	22		36	4	60		64
1976	43	53		96	9	73		82
1977	37	32		69	53	87		141
1978	9	16		25	20	138		158
1979	538	66		604	21	62		83
1980	104	69		173	2	143		145
1981	737	172		909	29	11		140
1982	603	89		692	65	114		179
1983	38	31		69	46	106		152
1984	81	67		148	27	94		121
1985	116	107		223	144	168		313
1986	196	99		295	297	457		754
1987	306	97		403	242	561		803
1988	367	222		589	190	178		368
1989	151	57		208	152	311		463
1990 Median	203	51		256	359	1307		1699
Perc. 5	78	0		120	156	630		959
Perc. 95	383	114		449	705	2369		2821
1991 Median	221	148	0	391	78	514	292	596
Perc. 5	44	0	–	146	6	262	91	331
Perc. 95	611	407	–	842	161	830	1089	917
1992 Median	479	256	–	747	171	423	–	609
Perc. 5	153	99	–	365	59	205	–	346
Perc. 95	1056	474	–	1365	353	842	–	1060

* Totals up to and including October 15.

Table 8. Summary of monthly effort, catch and CPUE from logbook anglers on Margaree River in 1992.

Season	Month	Rods	Effort Hours	1SW Salmon Kept	1SW Salmon Rel'd	1SW Salmon Total	MSW Rel'd	Total Fish	Catch/Unit Effort Rods	Catch/Unit Effort Hours
Summer	June	96	396	4	0	4	3	7	0.073	0.018
	July	166	805	18	5	23	39	62	0.373	0.077
	Aug.	125	754	8	1	9	16	25	0.200	0.033
Sub-Total		387	1955	30	6	36	58	94	0.243	0.048
Fall	Sept.	148	889	11	1	12	20	32	0.216	0.036
	Oct. 1-15	107	656	6	4	10	23	33	0.308	0.050
	Oct. 16-31	103	587	5	3	8	57	65	0.631	0.111
	Oct. 1-31	210	1243	11	7	18	80	98	0.467	0.079
Sub-Total		358	2132	22	8	30	100	130	0.363	0.061
Total Season		745	4087	52	14	66	158	224	0.301	0.055

Table 9. Distribution of recaptures at index pools vs other pools in the angling fishery for 1992.

Gear	Month	Tagged	Index Pools	Other Pools	Total:	Prop. Recap
	1SW SALMON					
Trap	June	10	3	3	6	0.60
	July	24	1	5	6	0.25
	August	18	3	1	4	0.22
	Sept. 1-15	29	3	2	5	0.17
	Sept. 16-30	27	2	8	10	0.37
	Oct. 1-15	113	5	10	15	0.13
	Oct. 16-31	3	0	1	1	0.33
	Sub-total:	224	17	30	47	0.21
Seine	August 25	21	5	1	6	0.29
	Total:	245	22	31	53	0.22
	MSW SALMON					
Trap	June *	17	1	2	3	0.18
	July *	55	2	5	7	0.13
	August	56	1	1	2	0.04
	Sept. 1-15	109	3	7	10	0.09
	Sept. 16-30	102	5	11	16	0.16
	Oct. 1-15	492	19	23	42	0.09
	Oct. 16-31	14	0	1	1	0.07
	Sub-total:	845	31	50	81	0.10
Seine	August 25	10	0	0	0	0.00
	Total:	855	31	50	81	0.09

* - 2 salmon were caught and kept for broodstock on August 25.

Table 10. Distribution of recaptures in the angling fishery for 1SW and MSW for 1992.

Gear	Month	No. Tagged	June	July	Aug.	Sept. 1-15	Sept. 16-30	Oct. 1-15	Oct. 16-31	Unk	Total	Prop.
	1SW SALMON											
Trap	June	10	.	4	1	.	.	1	.	.	6	0.60
	July	24	.	3	.	1	.	2	.	.	6	0.25
	August	18	.	.	.	2	2	.	.	.	4	0.22
	Sept. 1-15	29	.	.	.	.	3	2	.	.	5	0.17
	Sept. 16-30	27	.	.	.	.	2	4	4	.	10	0.37
	Oct. 1-15	113	.	.	.	.	.	10	5	.	15	0.13
	Oct. 16-31	3	.	.	.	.	.	.	1	.	1	0.33
	Sub-total:	224	0	7	1	3	7	19	10	0	47	0.21
Seine	August 25	22	.	.	1	3	1	1	.	.	6	0.27
	Total:	246	0	7	2	6	8	20	10	0	53	0.22
	MSW SALMON											
Trap	June *	17	.	2	1	.	.	.	.	.	3	0.18
	July *	55	.	2	.	1	1	1	1	1	7	0.13
	August	56	.	.	.	.	2	.	.	.	2	0.04
	Sept. 1-15	109	.	.	.	.	4	4	2	.	10	0.09
	Sept. 16-30	102	.	.	.	.	5	10	1	.	16	0.16
	Oct. 1-15	492	.	.	.	.	.	23	18	1	42	0.09
	Oct. 16-31	14	.	.	.	.	.	.	1	.	1	0.07
	Sub-total:	845	0	4	1	1	12	38	23	2	81	0.10
Seine	August 25	11	.	.	.	.	.	.	.	.	0	0.00
	Total:	856	0	4	1	1	12	38	23	2	81	0.09

* - 2 salmon were caught and kept for broodstock on August 25.

Table 11. Exploitation rates, by tagging group, of salmon recaptured during various angling intervals. #/## represents the number of tags returned relative to the number of tags available.

Life Stage	Year	Fish Marked up to Aug. 31 and recaptured			Fish Marked after Sept. 1 and recaptured		Total Fish Marked and recaptured	
		pre Sept. 1	pre Oct. 15	pre Oct. 31	pre Oct. 15	pre Oct. 31	pre Oct. 15	pre Oct. 31
1SW	1992	8/52 0.154	16/52 0.308	16/52 0.308	21/169 0.124	30/169 0.178	37/221 0.167	46/221 0.208
	1991	13/164 0.079	25/164 0.152	25/164 0.152				
	1990				13/153 0.085	13/153 0.085		
	1989				6/87 0.069			
	1988				21/173 0.121			
MSW	1992	5/128 0.039	10/128 0.078	12/128 0.094	46/703 0.065	68/703 0.097	56/831 0.067	80/831 0.096
	1991	7/203 0.034	22/203 0.108	24/203 0.118				
	1990				18/282 0.064	18/282 0.064		
	1989				19/347 0.055			
	1988				9/155 0.058			

Table 12. Summary statistics of various parameters used in the assessment of the recreational catch and returns of Atlantic salmon to the Margaree River in 1991 and 1992 using only marks placed up to Aug. 31 and all marks placed up to Oct. 15. The 1992 formulation is described in Table 1.

	1991			1992 *			1992 @		
		Percentiles			Percentiles			Percentiles	
	Median	5	95	Median	5	95	Median	5	95
Adjusted Reporting Rate									
1SW	1	0.61	1	0.96	0.46	1	0.96	0.46	1
MSW	1	0.84	1	1	0.63	1	1	0.63	1
Adjusted Tags Recaptured									
1SW	25	25	40	17	16	34	49	47	102
MSW	23	23	27	12	12	19	81	81	129
Tags Available									
1SW	139	123	146	39	32	44	199	189	206
MSW	139	107	174	78	56	113	765	742	783
Exploitation Rate									
1SW Summer Tagged Fish	0.19	0.17	0.30	0.46	0.37	0.91	-	-	-
Fall & Summer Combined	-	-	-	-	-	-	0.25	0.23	0.51
MSW Summer Tagged Fish	0.17	0.13	0.23	0.17	0.11	0.27	-	-	-
Fall & Summer Combined	-	-	-	-	-	-	0.11	0.10	0.17
Estimated Angling Catch									
1SW Summer	221	44	611	479	153	1,056	479	153	1,056
Fall (Sept. 1 to Oct. 15)	148	0	407	256	99	474	256	99	474
Subtotal	391	146	842	747	365	1365	747	365	1365
Fall (Oct. 16 to 31)	0	0	0	not estimated			not estimated		
Total	391	146	842	not estimated			not estimated		
MSW Summer	78	6	161	171	59	353	171	59	353
Fall (Sept. 1 to Oct. 15)	514	262	830	423	205	842	423	205	842
Subtotal	596	331	917	609	346	1,060	609	346	1,060
Fall (Oct. 16 to 31)	292	91	1,089	not estimated			not estimated		
Total	924	546	1,778	not estimated			not estimated		
Estimated Returns									
1SW Summer	1,085	236	2,781	939	333	2,094	1,626	575	3,653
Fall (Sept. 1 to Oct. 15)	728	0	1,962	498	192	1,011	881	343	1,701
Subtotal	1,909	794	3,891	1,484	750	2,776	2,562	1,302	4,803
Fall (Oct. 16 to 31)	-	-	-	-	-	-	-	-	-
Total	1,909	794	3,891	-	-	-	-	-	-
MSW Summer	454	39	986	1,002	352	2,278	1,467	535	3,034
Fall (Sept. 1 to Oct. 15)	3,013	1,476	5,228	2,526	1,153	5,290	3,606	1,800	7,143
Subtotal	3,484	1,853	5,785	3,638	1,894	6,775	5,182	3,073	9,001
Fall (Oct. 16 to 31)	1,753	524	6,859	-	-	-	-	-	-
Total	5,512	3,001	11,106	-	-	-	-	-	-

* - Using only marks placed up to August 31.
@ - Using all marks placed up to October 15.

Table 13. Estimates of returns, escapements, and percent of egg target met for Atlantic salmon from the Margaree River, 1947 to 1992. Eggs collected for the hatchery are removed from escapement estimates before the calculation of the percent target met.

Year	1SW Returns Median	Percentiles 5	95	1SW Escapement Median	Percentiles 5	95	MSW Returns Median	Percentiles 5	95	MSW Escapement Median	Percentiles 5	95	Egg Target Met by MSW Median	Percentiles 5	95	Collected for Hatchery (eggs)*
1947	123	97	167	87	61	131	1236	981	1688	873	618	1325	9.8%	-14.8%	53.5%	5.00
1948	361	286	493	255	180	387	2397	1902	3274	1693	1198	2570	96.4%	48.6%	181.2%	4.50
1949	140	111	191	99	70	150	1130	897	1544	798	565	1212	35.4%	12.8%	75.3%	2.80
1950	378	300	516	267	189	405	1090	864	1488	770	544	1168	74.3%	52.6%	112.8%	0.00
1951	72	57	98	51	36	77	1444	1145	1972	1020	721	1548	98.5%	69.6%	149.5%	0.00
1952	283	224	386	200	141	303	695	551	949	491	347	745	47.4%	33.5%	71.9%	0.00
1953	167	132	228	118	83	179	991	786	1353	700	495	1062	67.6%	47.8%	102.6%	0.00
1954	232	184	316	164	116	248	1015	805	1386	717	507	1088	69.2%	49.0%	105.1%	0.00
1955	180	143	247	127	90	194	878	697	1200	620	439	942	52.5%	34.9%	83.5%	0.50
1956	95	76	130	67	48	102	306	243	419	216	153	329	-31.2%	-37.3%	-20.4%	3.50
1957	123	97	167	87	61	131	463	367	633	327	231	497	18.2%	8.9%	34.5%	0.90
1958																1.00
1959																0.50
1960																1.50
1961	99	78	135	70	49	106	167	132	228	118	83	179	-18.4%	-21.7%	-12.5%	2.00
1962	157	124	214	111	78	168	1396	1108	1907	986	698	1497	90.7%	62.9%	140.1%	0.30
1963	296	235	405	209	148	318	722	573	986	510	361	774	32.8%	18.4%	58.4%	1.10
1964	409	324	558	289	204	438	984	781	1344	695	492	1055	61.1%	41.5%	95.9%	0.40
1965	293	232	400	207	146	314	865	686	1181	611	432	927	50.0%	32.8%	80.6%	0.60
1966	313	249	428	221	157	336	562	446	767	397	281	602	32.4%	21.1%	52.2%	0.40
1967	334	265	456	236	167	358	902	716	1233	637	451	968	58.6%	40.6%	90.4%	0.20
1968	218	173	298	154	109	234	674	535	921	476	337	723	40.0%	26.6%	63.8%	0.40
1969	729	578	995	515	364	781	473	375	647	334	236	508	27.1%	17.6%	43.8%	0.35
1970	289	230	395	204	145	310	732	581	1000	517	366	785	46.9%	32.3%	72.8%	0.20
1971	72	57	98	51	36	77	320	254	437	226	160	343	21.1%	14.7%	32.4%	0.05
1972	143	113	195	101	71	153	358	284	488	253	179	383	22.9%	15.8%	35.5%	0.10
1973	565	448	772	399	282	606	398	316	544	281	199	427	25.7%	17.7%	39.8%	0.10
1974	204	162	279	144	102	219	364	289	498	257	182	391	24.8%	17.6%	37.7%	0.00
1975	123	97	167	87	61	131	218	173	298	154	109	234	14.1%	9.8%	21.8%	0.05
1976	327	259	447	231	163	351	279	222	381	197	140	299	19.0%	13.5%	28.9%	0.00
1977	235	186	321	166	117	252	477	378	651	337	238	511	32.5%	23.0%	49.4%	0.00
1978	85	68	116	60	43	91	538	427	735	380	269	577	35.2%	24.5%	54.2%	0.10
1979	2033	1613	2777	1436	1016	2180	276	219	377	195	138	296	18.8%	13.3%	28.6%	0.10
1980	569	451	777	402	284	610	477	378	651	337	238	511	31.0%	21.5%	47.9%	0.10
1981	3061	2428	4181	2162	1529	3282	473	375	647	334	236	508	31.5%	22.1%	48.3%	0.05
1982	2353	1867	3214	1662	1176	2523	609	484	833	430	305	654	38.6%	26.4%	60.1%	0.20
1983	232	184	316	164	116	248	507	402	693	358	253	544	33.1%	23.0%	51.0%	0.10
1984	504	400	688	356	252	540	412	327	563	291	206	442	26.6%	18.4%	41.2%	0.10
1985	838	634	1167	615	411	944	1462	1109	2217	1446	1093	2201	137.4%	103.3%	210.3%	0.15
1986	1096	838	1420	801	543	1125	3616	2738	5680	3578	2700	5642	343.3%	258.5%	542.6%	0.15
1987	1478	1143	1865	1075	740	1462	4015	2976	6540	3975	2936	6500	381.6%	281.2%	625.4%	0.15
1988	2209	1674	2911	1620	1085	2322	1688	1286	2494	1670	1268	2476	156.7%	117.9%	234.6%	0.30
1989	768	591	977	560	383	769	2289	1708	3693	2266	1685	3670	214.3%	158.2%	349.9%	0.30
1990	997	443	1880	730	315	1457	11144	8073	16606	11067	8022	16497	1062.9%	768.9%	1587.2%	0.38
1991	1909	794	3891	1507	644	3116	3484	1853	5785	3453	1836	5740	326.4%	170.2%	547.2%	0.47
1992 angling	2562	1302	4803	1832	720	3596	5182	3073	9001	5151	3053	8953	492.9%	290.3%	860.0%	0.30
1992 trapnet	1018	740	1456	271	375	91	3941	2865	5639	3911	2847	5586	377.5%	274.8%	539.2%	

* Eggs are in millions.
1992 angling = estimate based on angling catches; 1992 trapnet = estimate based on recapture trapnet in estuary.

Table 14. Independent population estimates derived using the Peterson, Bayesian and Schaefer methods.

Description:	Peterson Estimate	Bayesian Estimate	Schaefer Estimate
M = Salmon tagged @ lower trap	210	210	210
C = Total Catch @ upper trap	624	624	624
R = Tagged Salmon @ upper trap	34	34	34
N = Estimate	3767	3848	4059
5%	2718	2798	.
95%	5382	5507	.
UPPER TRAP Efficiency	16.56%	16.22%	15.37%
5%	22.96%	22.30%	.
95%	11.59%	11.33%	.
UPPER TRAP 1SW Salmon Catch	165	165	165
UPPER TRAP MSW Salmon Catch	639	639	639
1SW Salmon Estimate	996	1018	1073
5%	719	740	.
95%	1423	1456	.
MSW Salmon Estimate	3858	3941	4157
5%	2783	2865	.
95%	5511	5639	.
TOTAL RETURNS:	4854	4959	5230

Table 15. Results of electrofishing surveys at barrier net sites in the Margaree River, July, 1992.

Tributary	Site #	Area sq. m.	# of Sweeps	Life Stage	Lgth (cm) Boundaries	Catch	Est. Population N	Var.	90% Conf. Int. Lower	Upper	Prob. Capture	Density	Mean Lgth (cm)	Total PHS
Trout Brook	98	190.7	3	Fry	< 5.0	35	38	14.8			0.57	19.9	3.6	
				Parr	>= 5.0	12	12	0.4			0.71	6.3	8.3	3.84
MacFarlane's Brook	96	134.5	4	Fry	< 5.8	49	50	1.7			0.67	37.2	4.3	
				Parr	>= 5.8	76	79	8.9	73	85	0.55	58.7	9.9	44.97
Big Brook	15	209.1	4	Fry	< 6.8	66	89	299.3	54	124	0.29	42.6	4.3	
				Parr	>= 6.8	60	65	19.6	56	74	0.47	31.1	9.3	22.28
Forest Glen Brook	45	170.5	4	Fry	< 5.8	472	573	619.2	524	623	0.35	336.1	3.6	
				Sm. Parr	5.8 to 9.2	75	76	3.6	73	80	0.63	44.6		
				Lg. Parr	>= 9.3	23	23	0.2			0.68	13.5		
				Parr	>= 5.8	98	100	3.8	96	104	0.64	58.7	8.3	43.37
	40	128.0	4	Fry	< 5.8	149	156	17.8	148	165	0.54	121.9	3.8	
				Sm. Parr	5.8 to 9.2	51	53	5.6	48	57	0.57	41.4		
				Lg. Parr	>= 9.3	19	28	594.0			0.24	21.9		
				Parr	>= 5.8	70	75	18.1	67	84	0.49	58.6	8.5	35.17
All Sites Mean 1992				Fry								111.5		
				Parr								42.7		29.9
1991				Fry								99.2		
				Parr								48.6		38.5

Table 16. Numbers of salmon smolt and parr released to Margaree River since 1976 by parent stock origin (MAR = Margaree River, RB = Rocky Brook or Miramichi River). Rearing locations are: MAR, Margaree; COB, Cobequid; MER, Mersey.

Year	Rearing Location	Smolt 2+ MAR	Smolt 2+ RB	Smolt 1+ MAR	Smolt 1+ RB	Smolt Total	Parr 1+ MAR	Parr 1+ RB	Parr 0+ MAR	Parr 0+ RB	Total
1976	MAR	8,971				8,971					
1977	MAR						5,022				5,022
1978	COB		15,250			15,250					
1979	COB		15,927 ?			15,927					
1980	COB		14,960			14,960					
1981	COB		15,950			15,950					
1982	MER			8,481		8,481	1,098				1,098
1983	COB	13,486							9,853		9,853
	MAR	3,783				17,269					
1984	MAR				10,195 @						
	MER			14,483							
	COB	11,210				35,888					
1985	MAR			2,669	1,303		5,882	834			
	COB	13,660				17,632	7,820	5,860			20,396
1986	MAR			2,105			8,754		25,000		
	COB	8,820	9,684			20,609			6,750		40,504
1987	MAR	6,369		8,599			5,400		40,000		
	COB	18,337				33,305			12,429		57,829
1988	MAR	4,136		22,313			2,201		40,000		
	COB	12,785				39,234			6,300		48,501
1989	MAR	2,600 *		13,000			10,000		150,000		
	COB	18,500				34,100			6,000		166,000
1990	MAR	4,119 *		14,200			21,425		60,500		
	COB	15,976				34,295					81,925
1991	MAR	12,100 *		20,000			22,000		110,000		
	COB	10,200				42,300	4,000				136,000
1992	MAR	21,800 *		20,000			33,600		92,500		
	COB	16,900				58,700	3,500		9,800		139,400

* Reared in the Lake O'Law cages.
@ MSW hatchery return broodstock collected from Margaree River and crossed with wild Margaree River salmon. The hatchery return broodstock would have been 2SW fish originating from Rocky Brook 2+ smolts released in 1981.
? Millbank broodstock.

Table 17. Numbers of wild and hatchery salmon from summer and fall sampling on Margaree River in 1992.

Season	1SW Salmon			MSW Salmon		Percent	Salmon
	Wild	Hatchery	% Wild	Wild	Hatchery	% Wild	
Summer (June 1 - Aug. 31)							
Logbook	22	18	55.0	39	9	81.3	54.5
Trapnets	31	23	57.4	117	16	88.0	71.1
SCIP/Creel	29	34	46.0	0	1	0.0	1.6
Broodstock	12	25	32.4	45	32	58.4	67.5
Sub-Total	94	100	48.5	201	58	77.6	57.2
Fall (Sept. 1 - Oct. 31)							
Logbook	29	6	82.9	110	10	91.7	77.4
Trapnets	148	26	85.1	724	26	96.5	81.2
SCIP/Creel	27	15	64.3	3	1	75.0	8.7
Lake O'Law	14	1	93.3	48	10	82.8	79.5
Sub-Total	218	48	82.0	885	47	95.0	77.8
Total Season	312	148	67.8	1086	105	91.2	72.1

Table 18. Summary of tag recaptures from smolt and adult releases in the Margaree River 1986 to 1992.

Release Year	Stock	Stage	No. Tag Applied	Tag Type	Series	Greenland 1A	1B	1C	1D	1E	1F	NF 1	NF 2	NF 3	NF 4	NF 8	NF 13	NF 14	Quebec Q9	Total Returns
1986	Rocky Brook	2+ smolt	7311	CWT	55 0/0		2		2	3	1	1			2					11
1986	Rocky Brook	2+ smolt	3376	CWT	62 2/23															0
1986	Rocky Brook	2+ smolt	1992	CWT	62 2/25			1				1								2
1987	Lake O'Law	1+ smolt	995	CWT	55 16/7															0
1987	Lake O'Law	1+ smolt	1107	CWT	55 16/8															0
1987	Margaree River	2+ smolt	10000	CWT	55 16/16 [a]									1						1
1987	Margaree River	1+ smolt	8599	CWT	55 16/16 [a]															0
1987	Lake O'Law	1+ smolt	3080	CWT	55 16/17 [a]										2					2
1987	Margaree River	2+ smolt	933	Carlin	P22200-P22299															0
					P22500-P23199															
					P23300-P23499	1	1	1												3
1987	Margaree River	1SW/MSW	138	Carlin	zz23000-zz23137								1					1	2	4
1988	Margaree River	2+ smolt	4116	CWT	55 16/12								2		2				1	5
1988	Margaree River	1SW/MSW	340	Carlin	zz23138-zz23299 zz23401-zz23581															
1989	Margaree River	1SW/MSW	425	Carlin	zz23583-zz23999 zz23300-zz23309 [b]					1		1		3		1				6
1990	Margaree River	1SW/MSW	576	Carlin	zz23310-zz23399 zz24000-zz24489 [c]									1			1	1	2	5
1991	Margaree River	1SW/MSW	494	Carlin	zz24490-zz24799 zz24900-zz24999 zz35000-zz35087 [d]								2						1	3
1992	Margaree River	1SW/MSW	1175	Carlin	zz35088-zz35991 zz36000-zz36280 [e]															

a – May also be Nepisiguit River origin as same series used for those released.
b – Excluding tags 23950 and 23951.
c – Excluding tags 24287, 24443, and 24482.
d – Excluding tags 24510, 24713, 24719, and 24763.
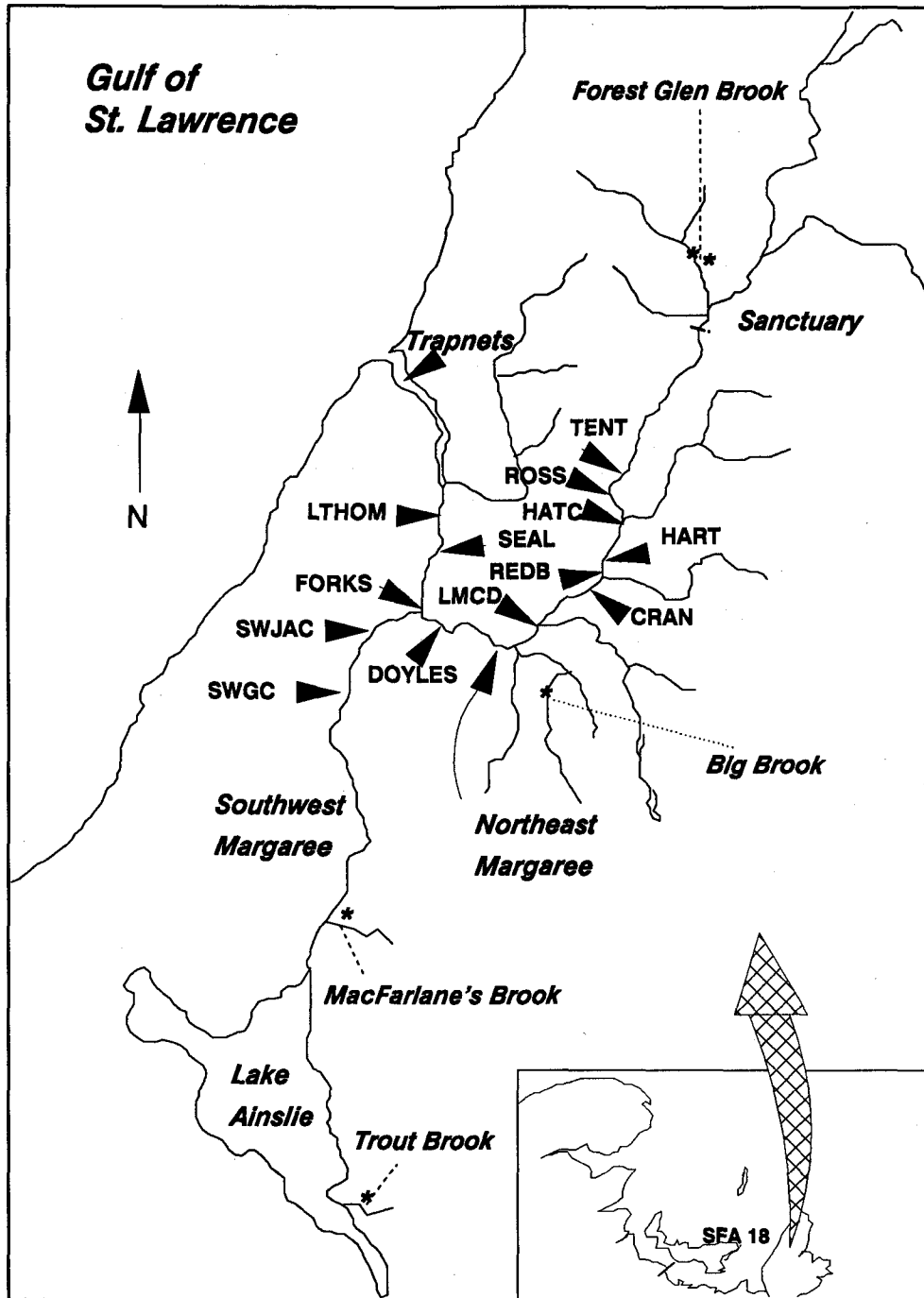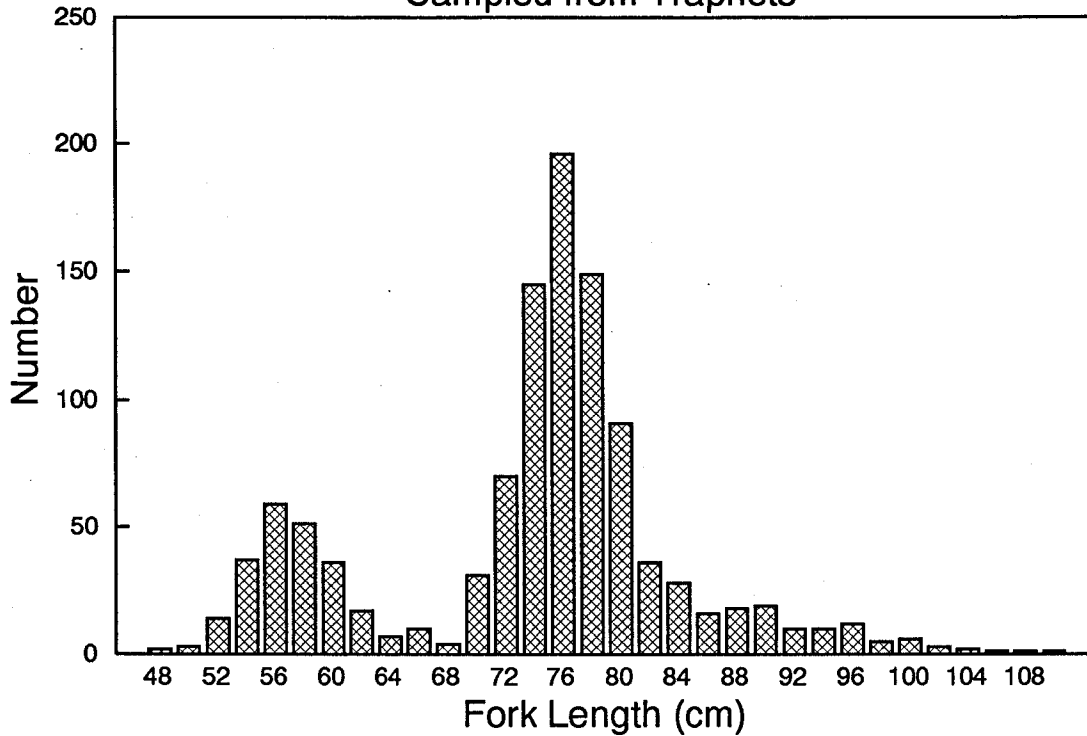e – Excluding tags 35124, 35213, 35563, 35569, 35576, 35787, 36018, 36019, 36079, and 36213.

Figure 1. Margaree River, NS, showing index pool locations for 1992 creel survey, trapnet location, and electrofishing stations (*---).

Length Frequency of Atlantic Salmon
Sampled from Trapnets

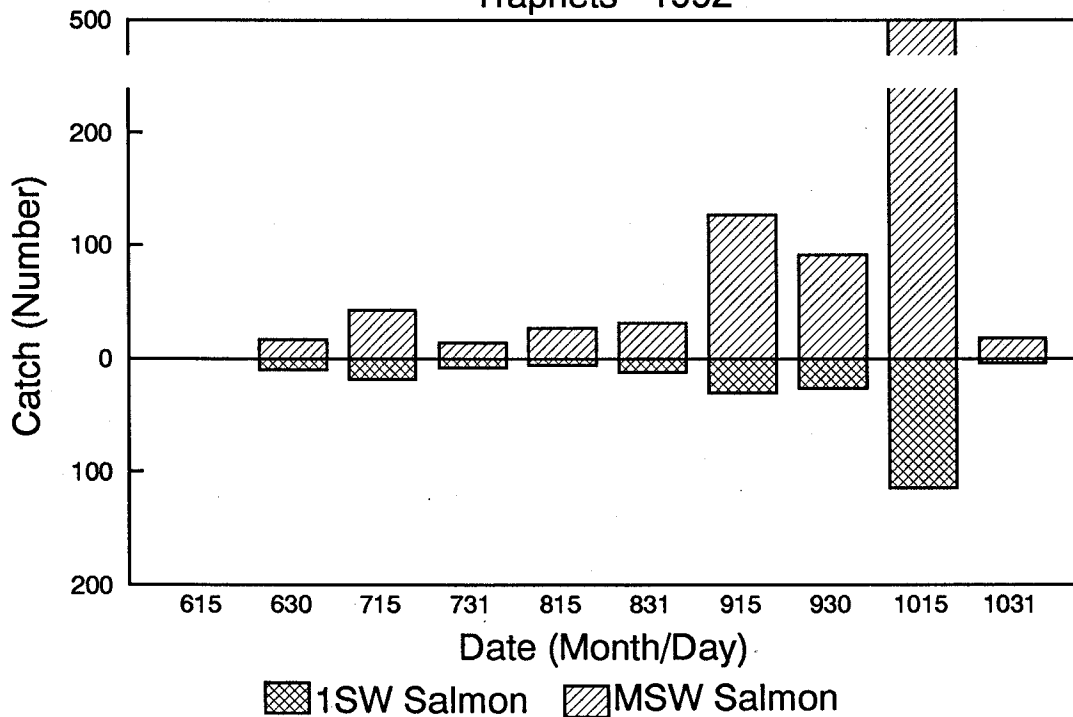# Timing of Salmon Catch
Trapnets - 1992

Figure 2. Length frequency distribution and timing of catches of Atlantic salmon at the trapnets on the Margaree River, 1992.
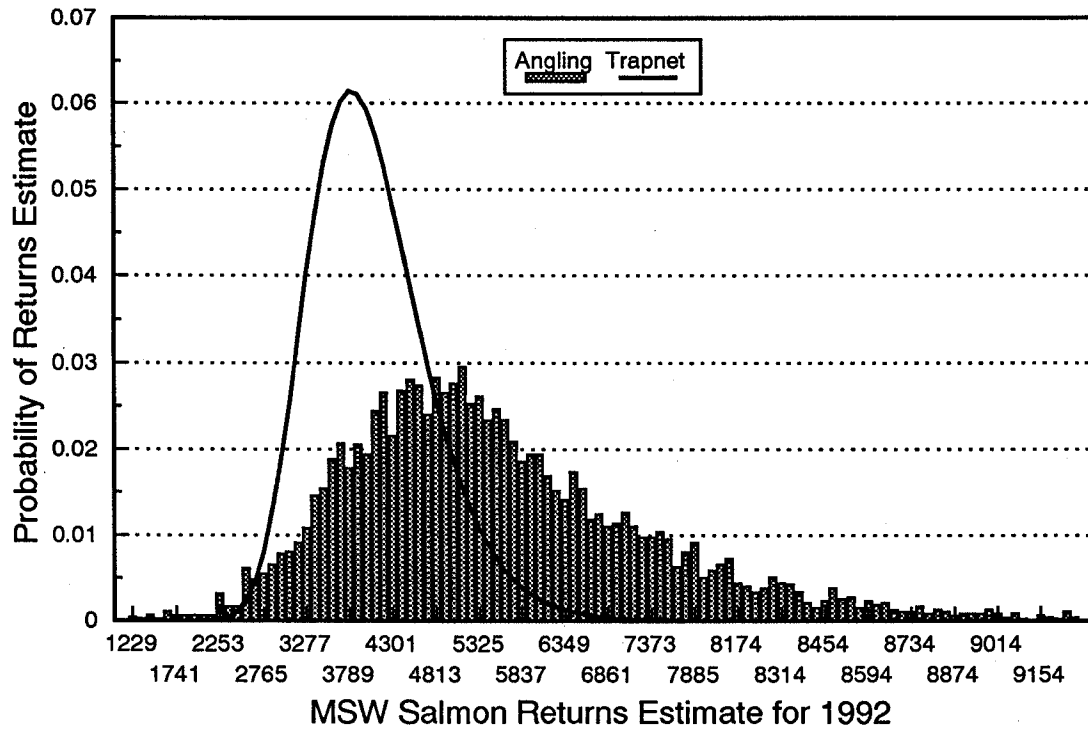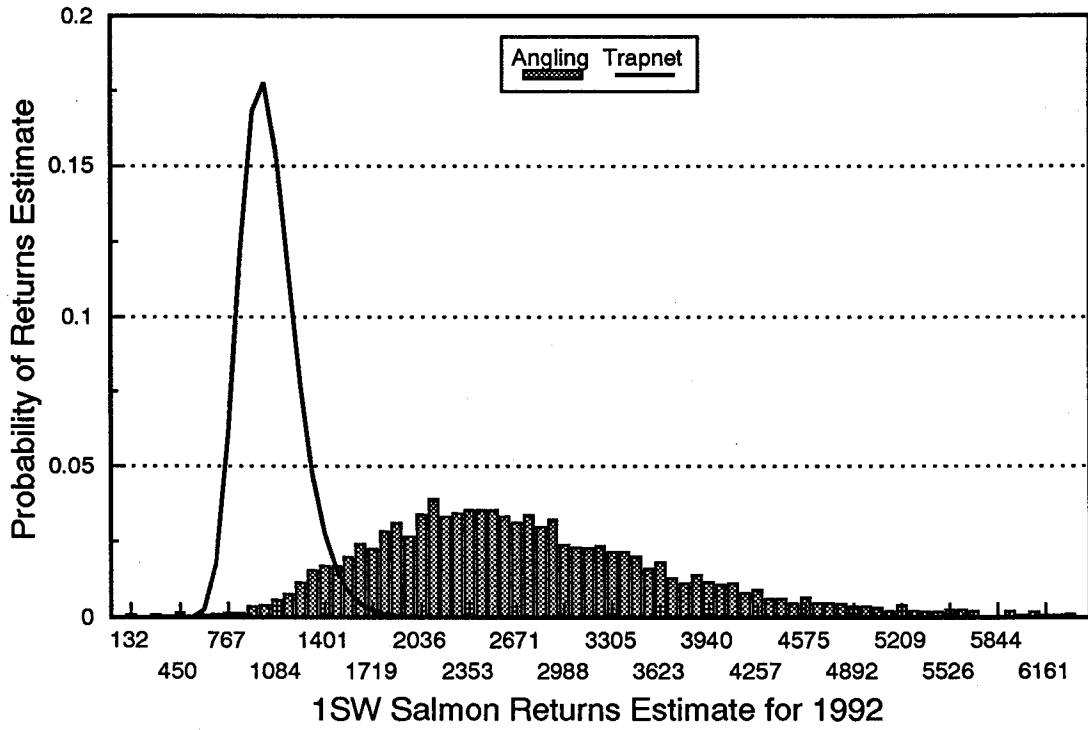
Figure 3. Probability distribution of the returns estimates of 1SW and MSW salmon returns to the Margaree River in 1992, based on angling catch as compared to recapture trapnet methods.
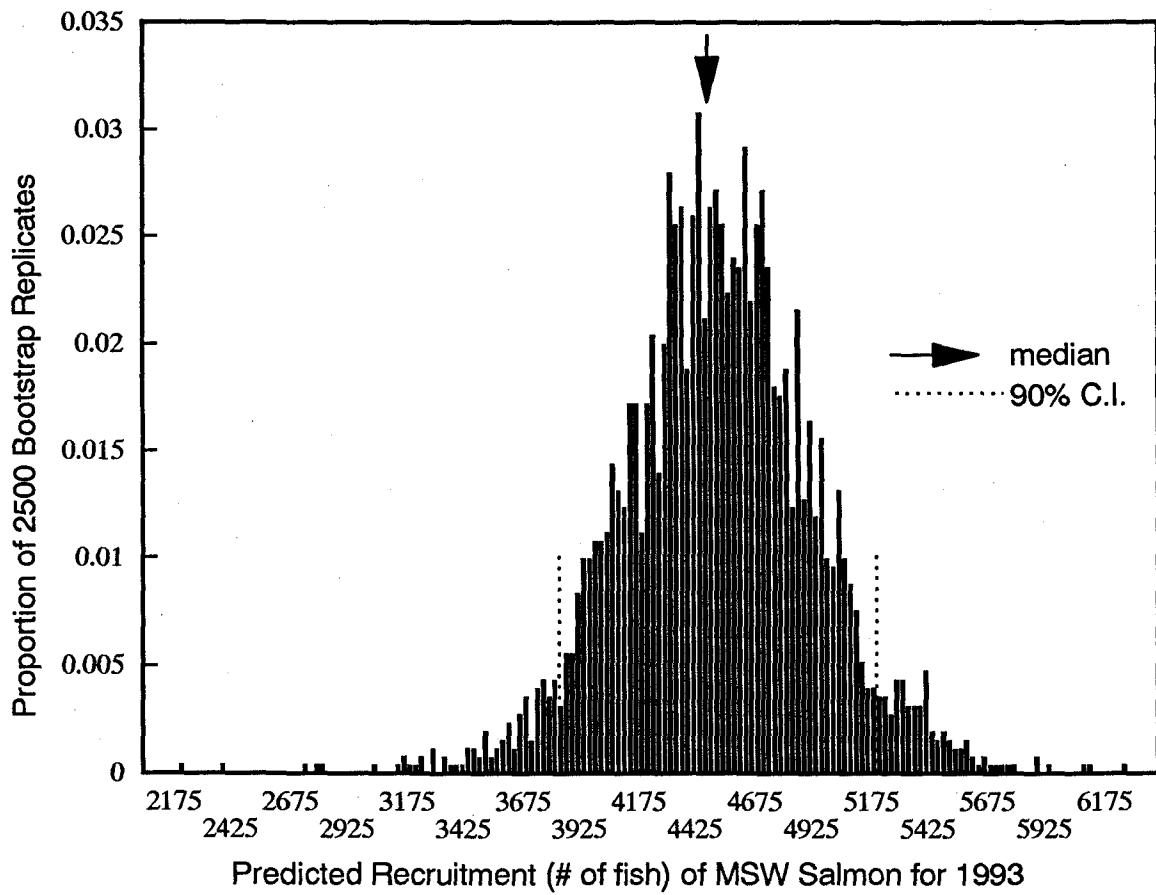
Figure 4. Frequency distribution of the predicted recruitment of MSW salmon to the Margaree River in 1993 based on "bootstrap" estimates of the parameters of a stock-recruit function.

APPENDIX A. Instructions for conducting the creel survey of the Margaree River Atlantic salmon recreational fishery, 1992.

The creel survey is designed as a bus route where the clerk travels along a predetermined route with prescribed stops of fixed duration at several points on the route. The direction of travel for Margaree River is in an upstream direction. There are ten (10) designated stops of fixed duration along the route:

Lower Thompkins Pool (LTHOM)	- 60 minutes
Seal Pool (SEAL)	- 60
Forks Pool (FORKS)	- 120
Doyles Bridge Pool (DOYLES)	- 60
Little McDaniel Pool (LMCD)	- 60
Cranton Bridge Pool (CRAN)	- 60
Hart Pool (HART)	- 60
Hatchery Pool (HATC)	- 60
Ross Bridge Pool (ROSS)	- 60
Tent Pool (TENT)	- 60

After Tent Pool, Lower Thompkins Pool should be sampled, etc.

The day is divided into two sampling periods (AM and PM) starting at 600 and 1330 hours and lasting 7.5 hours each. The actual start time may vary somewhat on the schedule and these start times should be respected. The clerk starts at the pool selected for that day, and stays at that pool for the indicated period of time. The actual observation of angling activity should begin at the pool exactly at the time indicated, not get out of vehicle at that time. After the required observation time for the first pool is completed, the clerk walks back to the vehicle and moves to the next pool in the sequence, in an upstream direction. The actual creel period begins when the clerk arrives at the pool where angling can be directly observed. The creel period for that pool corresponds to the creel durations indicated above.

The clerk moves through the sequence of pools until the sampling period is completed (up to 1330 for AM creels and 2100 for PM creels). The last pool sampled may only be for 15 minutes but even this period of observation should be completed.

Data to be collected at each pool:

On arrival, the clerk counts the number of anglers actually fishing and records this number with the start time on the form. As changes occur in the number of anglers, the clerk records with the corresponding change (for example, +1 or -2 designating one more angler or 2 less anglers fishing) and the time the change occurred. At the same time, fish which are hooked, lost, kept, released, etc. are recorded. The following designations should be used:

LOST - fish is hooked but unsuccessfully landed. This category includes fish which are on for 5 seconds and fish which are on for 15 minutes if the intent of the angler was to land the fish but fish broke away. This type may have a size category, 1SW or MSW salmon but more often does not.

1SW SALMON - KEPT - 1SW Salmon which is landed and kept by the angler. Attempts should be made to look at the fish to determine if it is a wild or adipose clipped fish, if it has an external tag or if a tagging mark is present, to get length and a scale sample if possible.

1SW SALMON - REMOVED HOOK - 1SW Salmon which is released from the hand by the angler. Should note if it is wild or adipose clipped, if external tag is present or if tagging mark is present.
APPENDIX A (Cont'd).

1SW SALMON - CUT LINE - 1SW Salmon which is released by snapping the line, not handled on shore. Wild or probably be unknown. Tag or untagged may also be unknown.

MSW - REMOVED HOOK - Large salmon which is released by hand. Attempts should be made to determine if the fish is wild or hatchery origin, if it has an external tag or if tagging mark is present. **No scales** should be collected.

MSW - CUT LINE - Large salmon which is intentionally released by cutting or snapping the line. Wild or hatchery origin may not be evident. Presence of tag may also be unknown.

All the above activities should be noted if they occur.

APPENDIX A (cont'd).

At the end of the creel period for the pool, the number of active anglers and the time the observation period ends are recorded.

Anglers which leave the pool while the clerk is on site should be interviewed if possible. The following data should be obtained for each angler:

- time started fishing at given pool
- time finished fishing at given pool
- numbers of fish by size category lost, hooked and released, kept.
- fish which are kept should be sampled for length, scales and sex if fish is or was cleaned. Look for external tags, adipose fin clips, tagging scars below the dorsal fin, etc.
- for sampled fish, obtain angler name and address if the individual would like information of the kept fish and angling success in general on the river, to be sent at the end of the year.