Fisheries and Oceans Canada | Pêches et Océans Canada

Canadian Stock Assessment Secretariat
Research Document 98/33

Not to be cited without
permission of the authors[1]

Secrétariat canadien pour l'évaluation des stocks
Document de recherche 98/33

Ne pas citer sans
autorisation des auteurs[1]

STATUS OF ATLANTIC SALMON (*SALMO SALAR*) IN THE BUCTOUCHE RIVER IN 1997

by

Gary Atkinson
Department of Fisheries & Oceans
Science Branch, Maritime Region
P.O. Box 5030
Moncton, New Brunswick, E1C 9B6

and

Vince Leblanc and Sheldon Simon
Buctouche First Nation
RR #2, Site 1, Box 9
Buctouche, New Brunswick, E0A 1G0

and

Serge LeBlanc and Natalie LeBlanc
Southeastern Anglers Association
P.O. Box 628
Buctouche, New Brunswick, E0A 1G0

[1] This series documents the scientific basis for the evaluation of fisheries resources in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

Research documents are produced in the official language in which they are provided to the Secretariat.

[1] La présente série documente les bases scientifiques des évaluations des ressources halieutiques du Canada. Elle traite des problèmes courants selon les échéanciers dictés. Les documents qu'elle contient ne doivent pas être considérés comme des énoncés définitifs sur les sujets traités, mais plutôt comme des rapports d'étape sur les études en cours.

Les documents de recherche sont publiés dans la langue officielle utilisée dans le manuscrit envoyé au secrétariat.

ISSN 1480-4883
Ottawa, 1998
Canada

TABLE OF CONTENTS

ABSTRACT

Angling effort, as determined from a telephone survey, indicated that at least 6 large salmon were released, 4 small salmon were retained, and 1 was released. Aboriginal community harvest was five large and 25 small salmon. A mark-recapture experiment was the basis for estimating returns: tags were applied at two estuarial trapnets and recovered at a counting fence in freshwater. Total large salmon returns were estimated at 200 and total small salmon returns at 97. Respective spawning escapements were 191 and 67. Total egg deposition was 70% of the conservation requirement, representing an increase of 52%, relative to 1996. Juvenile densities at the sites surveyed were generally higher than previous years but still well below optimum, confirming that spawning in recent years has been inadequate. At present, sufficient information on stock status has not been accumulated to forecast returns, but with five consecutive years well below requirements (mean: 56%) it is unlikely that conservation requirements will be met on the Buctouche River in 1998. In this event there will be no harvestable surplus of large or small salmon.

RÉSUMÉ

D'après un sondage sur l'effort de la pêche à la ligne réalisé au téléphone, il semble qu'au moins six gros saumons aient été relâchés, que quatre petits saumons aient été conservés et qu'un petit ait été relâché. Les prises des Autochtones sont de cinq gros saumons et de 25 petits. Une expérience de marquage et recapture a été le fondement pour l'évaluation des retours de salmonidés : des étiquettes ont été posées à deux filets-trappes installés dans un estuaire et les saumons ont été recapturés à une barrière de dénombrement en eau douce. Au total, les estimations des retours de gros saumons étaient de 200, comparativement à 97 pour les petits saumons. L'échappée de géniteurs était respectivement de 191 et de 67. Le total de la ponte était de 70 % de la valeur exigée aux fins de conservation, ce qui correspond à une augmentation de 52 % par rapport à 1996. Dans les sites ayant fait l'objet d'un recensement, la densité des juvéniles était généralement plus élevée que dans les années précédentes, mais elle est encore fortement en deça du niveau optimum, confirmant ainsi l'insuffisance du frai ces dernières années. À l'heure actuelle, nous n'avons pas suffisamment de données accumulées sur l'état du stock pour prévoir les retours. Cependant, comme pendant cinq années consécutives les retours ont été nettement en deçà des exigences pour la conservation (moyenne de 56 %), il est peu probable que l'on satisfera aux exigences pour la conservation dans la rivière Bouctouche en 1998. Il n'y aura donc pas de surplus exploitable de petits ou de gros saumons.

SUMMARY SHEET

STOCK: Buctouche River (SFA 16)
CONSERVATION REQUIREMENT: 1.587 million eggs (281 large salmon, 172 small salmon)

	1992	1993	1994	1995	1996	1997	MIN[1]	MAX[1]	MEAN[1]
Angling catch									
Large (Released)		35	20	0	na(21)	na(6)			
Small (Rel + Kept)		64	7	33	na(21)	na(5)			
Aboriginal Community Harvest									
Large	12	0	12	0	4	5	0	12	7
Small	0	0	11	15	25	25	0	25	15
Broodstock removals									
Large				7	5	4			
Small				8	5	1			
Spawning escapement									
Large		94	212	147	124	191	94	121	144
Small		21	59	67	78	67	21	78	56
Total returns									
Large		95	225	154	134	200	95	225	152
Small		78	77	98	127	97	77	127	95
% Egg Requirement met									
Large		34	72	55	45	69	34	72	52
All spawners		35	72	58	46	70	35	72	53

[1]Angling figures not shown since catches are not estimated on a consistent basis: other categories with respect to figures in the table prior to current year.

Recreational catches: Catch statistics from the New Brunswick Department of Natural Resources and Energy were not available for 1997. A telephone survey indicated that a minimum of 6 large salmon were released, 4 small salmon were retained and 1 was released. These totals appear above in parentheses.

Data and assessment: Returns of large and small salmon to the Buctouche River in 1997 were estimated from tags applied at two estuarial trapnets and recaptured at a counting fence. Spawners were estimated as returns minus known removals.

State of the stock: Spawning escapement was not met for either large or small salmon in 1997. Total egg deposition was estimated at 70% of the conservation requirement.

Forecast for 1998: No quantitative forecast can be made: however, given five consecutive years below required egg depositions (mean: 56%), it is unlikely that the conservation requirement will be met in 1998.

Management Considerations: There will probably not be a harvestable surplus of either large or small salmon from the Buctouche River in 1998. However, the combined Aboriginal community and angling harvest for the past three years has resulted in the removal of less than two percent of total estimated egg deposition.

Introduction

The Buctouche River (also spelled Bouctouche) is situated in Kent County, southeast New Brunswick and flows in an easterly direction to Northumberland Strait in Fisheries Statistical District 77, Salmon Fishing Area 16 (Fig.1). The system is small and has no man-made barriers to ascending fish. A spawning run of Atlantic salmon, composed of approximately two thirds multi-seawinter fish, enters the river during September and October. The resource is harvested for food by Buctouche First Nation and by public recreational angling. Information on stock status is required to manage salmon harvest on the Buctouche, and ensure that adequate spawning escapement occurs on a sustainable basis. This is of particular concern on smaller rivers where the potential to overexploit remaining wild stocks is high.

The stock on this river has been assessed previously from 1993 through 1996 (Atkinson and Claytor MS1994, Atkinson *et al.* MS1995, Atkinson and Chaput MS1996, Atkinson *et al.* MS 1997). Under the Aboriginal Fisheries Strategy (AFS) agreements the Department of Fisheries and Oceans (DFO) provides funding and training to First Nations in the interest of developing a co-management approach to the resource. These assessments were accomplished through mark-recapture experiments in which tags were applied in the estuary at Buctouche First Nation trapnets and recovered in the recreational fishery or at a counting fence upriver. In 1997 returns were estimated from tags applied at two estuary trapnets and recaptured at a counting fence in the freshwater portion of the river operated by the Southeastern Anglers Association.

Results of electroseining at ten sites during the summer of 1997 have been included in the current assessment, along with juvenile density data from previous surveys for purposes of comparison.

Description of Fisheries

Commercial

Commercial harvesting of Atlantic salmon ceased in 1984. The harvest from 1967 to 1983 in SFA 16 was presented in Atkinson and Claytor (MS1994).

First Nation

Beginning in 1992, Buctouche First Nation has harvested salmon from research trapnet(s) in the Buctouche River estuary during September and October. Prior to 1992, this was a sporadic gill net fishery and numbers taken were not recorded. In 1997, five large (63 cm or more) and 25 small (less than 63 cm) salmon were removed for food, and all were males. Allocations to Buctouche First Nation under the AFS agreement in 1997 were 36 large and 56 small salmon (Table 1).

Recreational

The Buctouche is a scheduled river. As of July 15 fly-fishing only is permitted, to conserve trout and salmon stocks. Recreational angling occurs upstream from the head of tide, and there is no leased water on the system. Prior to 1996, black salmon could be angled from April 15 through May 15 and bright salmon from June 8 through the end of the season. The bright season was extended in 1993 from October 15 through the end of the month downstream from the Route 490 bridge. Beginning in 1996, the angling season for black or bright salmon was made continuous from April 15 through October 31. As of 1995 the South Branch has been closed to all angling in an effort to conserve trout stocks. Due to very low water conditions in 1997, the angling season was closed as of October 27. Prior to 1984 all salmon could be retained. In

1984 large black salmon could be kept but all large bright salmon had to be released. Beginning in 1985, regulations have required that all large salmon (brights and blacks) be released and only small salmon be retained. In 1992, the season limit for small salmon was reduced from ten to eight, and this regulation remains in effect to date. Little effort is devoted to angling black salmon, and almost all angling for bright salmon occurs from late September to the end of the season.

Recreational catches have been estimated by the New Brunswick Department of Natural Resources and Energy (DNRE) based on random surveys representing 20 to 40 percent of license purchasers. For small rivers such as the Buctouche, the rate of survey return was usually not high enough to estimate catch accurately (Table 2). The survey was not done in 1996, and results for 1997 were not available at the time of writing.

Beginning in 1995, a telephone survey of anglers was conducted to determine angling impact on returns. The list was compiled from personal contact on the river, from names provided by local angling associations, and from anglers who have returned tags. Only 24 of 38 anglers contacted fished the Buctouche in 1997 and of these, only 5 caught salmon. Results indicated that 6 large salmon were caught and released, 4 small salmon were retained, and 1 was released. The survey represented approximately 183 rod days, for a catch per rod day of 0.06 which was much lower than 1996 (0.27). This was due to very low water throughout the season in 1997, and an early closure. Although it is not known what proportion of all effort this represents, it is thought to include about 75% of the catch. For the purpose of this assessment, removals have been calculated as retained fish plus a 3% mortality on released fish, even though hook-and-release mortality in cold water fisheries is considered to be negligible. It is unlikely that losses due to angling significantly affect large salmon spawning escapement.

Other

Estimates of unrecorded catch are obtained from fishery officers and represent known or suspected removals in the estuary or freshwater due to by-catch in commercial fishing gear or poaching. Poaching in the freshwater portion of the river has been considered a problem in the past, but DFO and DNRE fishery officers felt that it has greatly declined in recent years. Although anecdotal accounts of poaching occur, no apprehensions were made in 1997 and patrols found no evidence of poaching activity. It was suggested that between by-catch in smelt traps and poaching in freshwater, 10 each of large and small bright salmon may have been removed.

An ongoing enhancement project, initiated in 1995 by the the Southeastern Anglers Association, resulted in the collection of 4 large (3 female, 1 male)and 1 small (male) salmon for broodstock production. These fish were removed at the counting fence and returned to the river following artificial spawning at the former DFO Miramichi hatchery. The progeny of these fish will be stocked in the Buctouche as fall fingerlings in 1998.

Summary of Known Removals, 1997

Location	Large	Small
First Nation Food (traps)	5	25
Angling (freshwater)	0	4
Broodstock (counting fence)	4	1
Total	9	30

Conservation Requirement

The calculation of the conservation requirement for the Buctouche River is detailed in Table 3, using Method 2 recommended by Randall (MS1985) for the Miramichi River. The number of spawners needed to meet egg deposition requirements was calculated assuming all egg deposition came from large salmon. The number of small salmon required was calculated assuming that one male spawner was needed for each female large salmon. Fecundity was considered to be equivalent to Miramichi stock, based on river proximity and the fact that the Buctouche was stocked in 1978-79 with 37,000 juvenile salmon from the Miramichi River (Newbould 1983, Atkinson *et al.* 1997). Stock characteristics used were the means of values observed from 1993-95. Sex ratios were derived based on external characteristics. The 2SW component of total large salmon requirements was calculated using the mean proportion from aged samples (1992-94).

Egg Requirement: 1.587 million eggs
Large Spawners: 281 (2SW component: 244)
Small Spawners: 172

Research Data

Mark/Recapture

In co-operation with Buctouche First Nation, two trapnets were operated in the tidal portion of the river to mark and recapture salmon. The lower (mark trap) was located 3 km upriver (west) of the Route 11 bridge in Bouctouche, the upper (recapture trap) was two km upstream from this point (Fig. 1). The box portion of the traps measured 3.7 m (12') wide by 18.3 m (60') long and was constructed with 5.7 cm (2.25") mesh knotless nylon. A single leader of approximately 60 m (200'), extending from shore into a door in the middle of the long side of the box, was made from 11.4 cm (5.5") mesh polypropylene. The traps were configured to fish in an upstream direction. Salmon caught were measured for fork length, sexed using external characters, and scale sampled. They were then marked with small blue Carlin tags attached with a single wire through the back behind the first ray of the dorsal fin, and released. Some salmon were retained for food, as noted above. Because the "recapture" trap was not effective in capturing fish tagged in the "mark" trap, the two together were considered as a single marking site, and the tags pooled.

The mark trap was operated from September 21 to October 27, and the recapture trap from September 9 to October 27. Timing of the run to the estuary, as indicated by the total catch for both traps, shows a fairly even distribution over the period of operation, with a slight peak for both large and small salmon during Week 38 (Sep. 17-23)(Fig. 2). This was similar to 1996 in being earlier by about two weeks than 1994 and 1995. Total catch for both traps combined, exclusive of recaptures, was 53 large and 36 small salmon (Table 4), of which 48 large and 11 small were tagged. Relative to 1996, the catch at the recapture site (the only one operated in 1996) for approximately the same period increased by 20% for both large and small salmon.

A counting fence was installed on the main stem of the river 2.75 km upstream from the head of tide, just below the confluence of the South Branch (Fig. 1). The fence, consisting of a trapnet about 6m (20') long by 3m (9') wide and connected to the shore by two downstream-angled leaders, trapped fish moving upstream only. The trap and leaders were constructed with 5.7 cm (2.25") knotless nylon mesh, held in place with steel rods driven into the stream bed. The fence was operated from October 3 to November 7 by the Southeastern Anglers Association. Each fish was measured, sexed and a scale sample was taken for ageing. All untagged fish released upstream were marked by punching a 5mm (1/4') hole in the caudal fin.

Few fish are thought to have ascended before the fence was installed (an occasional fish was observed by anglers in the Forks pool) and for the first 25 days of operation only one large and one small salmon were caught, due to low water. Consistent rain from October 28 onward raised and maintained the river at levels adequate for fish to run, but not interrupt continuous operation of the fence. Most fish passed through the fence during Week 44 (Oct.29-Nov.4), for a total count of 118 large and 39 small salmon (Fig. 2, Table 4). Timing was one week later for large and two for small salmon, relative to 1996.

Tags were recovered at the counting fence throughout the duration of its operation, and no tags were known to have been lost prior to possible interception at the fence. One tag was also recovered from a large fish angled above the fence. Five tags applied in previous years were recaptured in the current year. Tagging effort and recaptures in 1997 are as follows:

Tags Applied

Location	Large	Small
Mark trap	19	1
Recapture trap	29	10
Both traps	48	11

Tags Recaptured

	Large		Small	
Location	Tags	Catch	Tags	Catch
Counting fence	29	118	6	39
Angling	1	6	0	5

Biological Characteristics

A length-frequency histogram for all adult salmon caught at counting facilities on the Buctouche River for 1997 indicates modal values of 78 cm and 58 cm for large and small fish, respectively (Fig. 3). The mean length of large salmon was 78.4 cm; 77% were females (mean length 78.5 cm) and 23% males. Mean length of small salmon was 56.7 cm; 6% were females (mean length 54.3 cm) and 94% males. The large salmon proportion of the catch, as observed at the counting fence, was 75%. Age determinations from samples taken in 1996 and 1997 are shown in Table 5. Of known-age fish in 1997, 2 and 3 year smolts respectively comprised 70% and 30% of the sample. Of the multi-seawinter (MSW) component, 82% were maiden two-seawinter (2SW) fish and 18% were repeat spawners. Repeat spawning one-seawinter (1SW) fish, or grilse, represented 16% of all repeat spawners and 3% of all MSW fish.

The length-frequency distribution for all juveniles sampled by electroseining shows modal values for fry, small parr and large parr of 50, 105, and 135 mm, respectively (Fig. 4). Mean lengths were 49, 97, and 133 mm. Hatchery parr, all stocked the previous fall as 0+ fry, had modal and mean lengths of 105 and 102 mm respectively.

Electroseining

In August of 1997, 10 sites were electroseined on the Buctouche River (Fig. 1). One site each on the main river (#1) and the South Branch (#3) were barriered sites, initially fished with one upstream sweep followed by three downstream sweeps. The other sites (2, 4-7, 12 on the main, 8, 11 on S. Br.) were open site spot checks fished with one upstream sweep in the same manner as the initial sweep on closed sites, to compare catch per unit effort (CPUE) across all sites. Closed site populations were calculated on the three downstream sweeps using the Zippin procedure (1958), then the initial upstream sweep catch was added before calculating density, except for hatchery parr at site 1 where all four sweeps were needed to obtain a regression (Table 6). Percent Habitat Saturation (PHS) values were derived for juvenile salmonids according to Grant and Kramer (1990). A total (fry + parr) PHS value around 27 is considered a useful reference point, since above this a greater than 50% chance exists that a density dependent response will occur. CPUE for all species in 1997 (Table 7), and comparisons of wild juvenile salmon CPUE (Table 8) and densities determined from data collected in all years (Table 9) are also presented. Densities in years prior to 1996 were calculated using the Zippin procedure, on three to five downstream sweeps of closed sites, except for sites 1 and 3 in 1994-95, which were open. In all cases, parr classes have been combined for calculating density, due to the typically low numbers sampled.

Wild juveniles

Mean CPUE for all sites in 1997 was up slightly from the previous year for both fry and parr and catches showed the same pattern, with highest numbers occurring in the lower main and South Branch sites (Table 7). Densities of fry at both closed sites in 1997 (12.2, 16.2 /100m^2) were more than double those seen in 1996. Wild parr density was more than double the 1996 level at site 1 (15.2 /100m^2), but was less than half the previous year at site 3 (11.1 /100m^2)(Table 9).

Though generally higher than in recent years, densities observed in 1997 were very low with respect to Elson's (1967) "normal" values of 29 fry and 38 parr /100m^2on Miramichi River sites which were unaffected by DDT spraying. Fry densities at main river and South Branch spot check sites were predicted from the regression of density on CPUE for all sites available (fry dens. = 15 min. catch x 0.9427 + 1.1826; N=6, R^2=0.68, P=0.042). Mean densities thus obtained were 6.8 in 1996 and 6.9 in 1997 (Table 8). Multiplying these values by the total units of habitat in the system (6612) and dividing by the calculated egg deposition in the previous year (920,460 in 1995, 730,020 in 1996) provides an estimate of egg to fry survival rate. These values are only 4.9% and 6.2% for 1996 and 1997 respectively, and are probably optimistic for the river as a whole, since the choice of electroseining sites is admittedly biased toward higher quality habitat (riffle and run). Yet these rates are much lower than the 9% value considered by Symons (1979) to represent a "low" survival. Symons considers a medium survival rate as 13%, and Elson's norm of 29 fry per unit is predicated on a 12% survival rate, assuming an optimum egg deposition of 240 per unit. The survival rates calculated may represent anomalous years, but juvenile density data going back 20 years are little different from the present, and at a time when anecdotal accounts claim there were more adults returning. Only at site 3 on the South Branch did juvenile abundance ever approach or exceed the norm, and for fry only, in just two years out of nine (Table 9). It seems likely that survival rate has eroded over time due to land use practices (mainly woodcutting) resulting in lower mean flows which are colder in winter and warmer in summer, and higher susceptibility to extreme runoff events contributing to scouring and silting. Given current survival rates, at least twice the conservation egg deposition would be needed to obtain "normal" fry densities in the Buctouche River. However, quality spawning and rearing habitat on the river appears to be very limited. The proportion of the total habitat surveyed comprising "good" and "fair" riffle, plus run, (excludes pool, bedrock, "poor" riffle) is only 63% (DNRE database). On average, 59% of the substrate in riffle and run habitat is cobble (60-250 mm) or courser, as observed at most electroseining sites. Nevertheless, if the conservation requirement was based on 2.4 eggs/m^2 applied to this smaller area of

quality habitat, it would have been exceeded in two of the past five years (1994, 1997) and only narrowly missed in a third (1995). It is therefore conceivable that the quality habitat available is being used to capacity in most years, and that limited by low egg to fry survival, the productivity of the system is inadequate to achieve the conservation requirement as currently defined.

Hatchery parr

In the autumn of 1996, 38,867 adipose clipped 0+ fingerlings were stocked at six sites in the main Buctouche River (Atkinson *et al.* 1997). These fish were found at all main river sites fished in 1997 including those not stocked the previous year, with CPUE being low (1-5/15 min.) but uniform, suggesting that the fish redistributed themselves relatively uniformly both upstream and down as well as into site 8 on the lower South Branch (Table 7). With respect to the total area of the main stem only, this represented a stocking density of 10.3/100 m^2, and 8.6/100 m^2 if it assumed that tributaries were accessible. At site 1, the only closed site done on the main stem in 1997, hatchery parr density was 8.6/100m^2 (Table 1). Unfortunately, the relationship between CPUE and density for parr is not significant, thus relative catches of hatchery parr cannot be considered proportional, nor can densities be predicted for spot check sites. However, survival of 0+ to 1+ hatchery parr at site 1 appears to be on the order of 83%, and even if the other sites were only two fifths of this (as suggested by the CPUE), it would indicate a survival rate of 33%, which would fall midway between low and medium survival (Symons 1979). Although inconclusive, this suggests that survival at this stage is more within normal bounds than egg to fry survival.

Stocking

In the fall of 1996, 5 large female and 5 small male salmon from the Buctouche River were spawned at the Miramichi hatchery, and subsequently returned to the river. In November 1997, 33,000 adipose-clipped fall fingerlings were released in lots of approximately 3,000 each at sites 2 - 6, 12, 17, and 18, and 10,000 were released at site 1 (Fig. 1). These will be monitored by electroseining, for overwinter survival.

Estimation of Stock Parameters

Returns of large and small salmon past the estuary traps were calculated separately from the pooled tags for each group placed at those sites and recovered at the counting fence, 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. A tag loss rate was not factored into the calculations because it was thought to be negligible over the short period (seven weeks) during which tags were recaptured, and none were known to have been removed prior to possible interception at the fence.

Total returns to the system were obtained by adding removals known to have occurred prior to marking. The corresponding spawning escapement was then computed by subtracting total known removals from total returns. Known removals were First Nation harvest, angling catch and broodstock removals, as detailed above. Because estimates of unrecorded catch (poaching) are unsubstantiated, those alleged to have occurred in the estuary have not been included in the estimates of total returns. The egg deposition rate (2.4/m^2) used to calculate the conservation requirement compensates for in-river losses to poaching and disease. Consequently, in-river poaching estimates have not been subtracted from total returns to calculate spawning escapement.

Assessment Results

Total Returns and Spawning Escapement

The estimate of total returns to the river is 200 for large salmon and 97 for small salmon, with respective spawning escapements of 191 (95% CI: 146-285) and 67 (95% CI: 37-241). The probability of achieving the conservation requirement was only 3% for large and 9% for small salmon (Figs. 5,6).

Based on fecundity values derived from stock characteristics observed in the current year (5771 eggs/large salmon, 199 eggs/small salmon), total egg deposition was estimated at 70% of the conservation requirement for the system, assuming that all fish spawned in the Buctouche River and its tributaries. This represents a 52% increase over the egg deposition in 1996. However, the conservation requirement as currently defined was not met on the Buctouche River in 1997. The Aboriginal community harvested only male fish, and the probability is that anglers did likewise, thereby having no significant affect on egg deposition. The calculated male:female ratio of spawners was 0.71; had all harvested fish escaped to spawn, this would have been 0.93.

The proportion of the total river habitat above the fence is 88%; relative to this, spawning escapement above the fence (total count minus broodstock = 114 large, 38 small) represented 47% of the conservation requirement. This should be considered a minimum, since some fish ascended prior to fence installation, and some "leakage" upstream probably occurred, since several fish were recaptured after passing the fence. It is also likely that some additional fish moved upstream after its removal.

Sources of Uncertainty

It has been assumed that all spawning occurred in the Buctouche River. However, several smaller streams flow into the estuary which have some spawning potential for salmon, since low numbers of juveniles were found there. It cannot be estimated what proportion of the returns may have used these streams, but is thought to be very small.

The conservation requirement for the Buctouche River may be unrealistically high in terms of the proportion of total habitat used or accessible to spawning salmon, and the overall quality of the habitat may be inferior to that assumed in the application of 2.4 eggs/m^2. Juvenile data suggest that the upper reaches of the main stem may be inaccessible or inadequate for rearing, and many of the tributaries are blocked by numerous beaver dams. The gradient of the river is low, creating extensive areas of low flow at normal summer level, and much of the substrate was observed to be large rock or bedrock. The proportion of the total habitat judged to be riffle of fair to good quality, or run, was only 63%.

Ecological Considerations

Water flows in the Buctouche River were generally inadequate for many fish to ascend prior to the installation of the counting fence. They remained that way until rain brought levels up on October 28, and sustained them throughout the uninterrupted operation of the fence. Angling conditions were dismal for the entire season, which was closed five days early due to low water.

Forecast/Prospects

At present there is no reliable method of forecasting returns of Atlantic salmon to the Buctouche River. Given a longer term data set, it may be possible to develop a stock/recruit relationship. However, for the five assessed years 1993 to 1997 the conservation requirement has not been met; the mean level being 56% (range 35% - 72%). Although returns in 1997 were up substantially from 1996, it is considered unlikely that conservation requirements, as currently defined, will be met in 1998.

Management Considerations

There will probably not be a harvestable surplus of either large or small salmon from the Buctouche River in 1998. However, the combined Aboriginal community and angling harvest in each of the past three years has resulted in the removal of less than two percent of total estimated egg deposition.

Research Recommendations

1. Operate at least one marking trap in the estuary from the first week in September through the first week of November, in conjunction with a counting fence upriver from the beginning of October through the first week of November. Both large and small salmon should be marked in the estuary.

2. Continue electroseining to determine the extent of habitat use, validate spawning success, and monitor the survival of stocked juveniles.

Acknowledgments

We thank Buctouche First Nation and the Southeastern Anglers Association for operating the mark-recapture facilities and collecting relevant data. The Southeastern Anglers Association also provided assistance in carrying out the electroseining program. The New Brunswick Department of Fisheries and Aquaculture provided funding to the Southeastern Anglers Association.

Literature Cited

Atkinson, G., and R.R. Claytor. MS1994. Status of Atlantic salmon in the Buctouche River in 1993. DFO Atl. Fish. Res. Doc. 94/15.

Atkinson, G., T. Pettigrew, J. LeBlanc, and G. Cormier. MS1995. Status of Atlantic salmon in the Buctouche River in 1994. DFO Atl. Fish. Res. Doc. 95/14.

Atkinson, G., and G. Chaput. MS1996. Status of Atlantic salmon in the Buctouche River in 1995. DFO Atl. Fish. Res. Doc. 96/43.

Atkinson, G., J. Peters, V. LeBlanc, G. Cormier, and M.-J. Maillet. MS1997. Status of Atlantic salmon (*Salmo salar*) in the Buctouche River in 1996. DFO CSAS Res. Doc. 97/19.

CAFSAC. MS1991. Quantification of conservation for Atlantic salmon. CAFSAC Adv. Doc. 91/16.

Elson, P.F. 1967. Effects on wild young salmon of spraying DDT over New Brunswick forests. J. Fish. Res. Board Can. 24(4): 731-767.

Gazey, W.J., and M.J. Staley. 1986. Population estimation from mark-recapture experiments using a sequential Bayes algorithm. Ecology 67: 941-951.

Grant, J.W.A., and D.L. Kramer. 1990. Territory size as a predictor of the upper limit to population density of juvenile salmonids in streams. Can. J. Fish. Aquat. Sci. 47: 1724-1737.

Newbould, K.A. 1983. Hatchery salmonid production and distribution (1976-82), Nova Scotia, New Brunswick and Prince Edward Island. Can. Data Rep. Fish. Aquat. Sci. 410: ix + 260p.

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

Symons, P. E. K. 1979. Estimated escapement of Atlantic salmon (*Salmo salar*) for maximum smolt production in rivers of different productivity. J. Fish. Res. Board Can. 36: 132-140.

Zippin, C. 1958. The removal method of population estimation. J. Wildl. Man. 22(1): 82-90.

Table 1. First Nation allocation and harvest of Atlantic salmon from the Buctouche River.

	Allocation		Harvest	
Year	Large	Small	Large	Small
1992	-	-	12	0
1993	-	-	0	0
1994	36	56	12	11
1995	36	56	0	15
1996	36	56	4	25
1997	36	56	5	25

Table 2. Atlantic salmon angling catch on the Buctouche River, 1984 - 1995. Estimates provided by New Brunswick Department of Natural Resources and Energy. Small salmon numbers up to 1993 include released fish. Dashes (-) indicate insufficient data to calculate; (na) data not available.

	Bright Salmon						
	Small	Small	Large				
Year	Kept	Rel	Rel	Total	% Large	Rods	CPUE
1984	13		-	13	-	13	1.000
1985	-		-	-	-	-	-
1986	60		34	94	36.2	94	1.000
1987	-		-	-	-	53	-
1988	-		-	-	-	31	-
1989	-		52	52	-	192	0.271
1990	16		47	63	74.6	213	0.296
1991	-		-	-	-	308	-
1992	-		-	-	-	314	-
1993	57	7	35	99	35.4	817	0.121
1994	6	0	31	37	83.8	171	0.216
1995	33	0	0	33	0	50	0.660
1996	na	na	na	na	na	na	na
1997	na	na	na	na	na	na	na

Table 3. Calculation of the conservation requirement for the Buctouche River.

AREAS SURVEYED: Total habitat - sq.m (DNRE database):	
Bouctouche main (above forks)	295493
Bouctouche main (below forks)	82354
Upper North Branch	22377
Richard Brook	6706
Unnamed tributary	4900
Johnson Brook	20645
McLean Brook	9820
Yankee Brook	8420
South Branch	206134
Bailey Brook	4369
Total Area	661218
STOCK CHARACTERISTICS: (mean 1993-95)	
Male proportion of large salmon	0.24
Female proportion of large salmon	0.76
Mean length of large female salmon (cm)	78.1
Eggs per large female (1.4132 x LN(FL) + 2.7560)(Randall 1989)	7441
Eggs per large salmon (eggs / lg female x lg female proportion)	5655
Male proportion of small salmon	0.85
Female proportion of small salmon	0.15
Mean length of small female salmon (cm)	55.6
Eggs per small female (3.1718 x LN(FL) - 4.5636)(Randall 1989)	3573
Eggs per small salmon (eggs / sm female x sm female proportion)	536
SPAWNING REQUIREMENTS:	
Egg deposition rate (no. / sq.m) (CAFSAC MS1991)	2.4
EGG REQUIREMENT (millions) (Total area x deposition rate)	1.587
TOTAL LARGE SALMON (egg target / eggs per lg salmon)	281
Large females (total large x lg female proportion)	213
Large males (total large - large females)	67
Small males needed (large females - large males)	146
TOTAL SMALL SALMON (sm males needed / sm male proportion)	172
2SW COMPONENT:	
Proportion 2SW (of total large salmon: mean 1992-1994)	0.87
TOTAL 2SW (total large x proportion 2SW)	244

Table 4. Salmon catches by day and standard week at Buctouche River counting facilities, 1997. Shaded figures indicate days when facility was not operating.

Standard	Date	Daily catch Mark		Recap		Both		Fence	
Week	Mo/Da	Large	Small	Large	Small	Large	Small	Large	Small
36	909			0	0	0	0		
37	910			0	0	0	0		
37	911			0	2	0	2		
37	912			2	1	2	1		
37	913			0	0	0	0		
37	914			1	1	1	1		
37	915			0	1	0	1		
37	916			0	2	0	2		
38	917			0	0	0	0		
38	918			2	2	2	2		
38	919			0	0	0	0		
38	920			0	0	0	0		
38	921	0	0	5	5	5	5		
38	922	0	0	7	7	7	7		
38	923	0	0	3	1	3	1		
39	924	0	0	0	0	0	0		
39	925	0	0	0	0	0	0		
39	926	0	0	0	0	0	0		
39	927	0	0	0	0	0	0		
39	928	0	2	0	0	0	2		
39	929	3	0	1	3	4	3		
39	930	4	0	0	0	4	0		
40	1001	7	2	1	3	8	5		
40	1002	0	0	1	1	1	1		
40	1003	0	0	4	0	4	0	0	0
40	1004	0	0	0	0	0	0	0	0
40	1005	0	0	1	0	1	0	0	0
40	1006	0	0	0	0	0	0	0	0
40	1007	0	0	1	1	1	1	0	0
41	1008	0	0	0	0	0	0	0	0
41	1009	1	0	0	0	1	0	0	0
41	1010	2	0	3	0	5	0	0	0
41	1011	0	0	0	0	0	0	0	0
41	1012	0	0	0	0	0	0	0	0
41	1013	0	0	0	0	0	0	0	0
41	1014	1	0	0	0	1	0	0	0
42	1015	1	0	0	0	1	0	0	0
42	1016	0	0	0	0	0	0	0	0
42	1017	0	0	0	0	0	0	0	0
42	1018	0	0	0	0	0	0	0	1
42	1019	0	0	0	1	0	1	0	0
42	1020	1	0	0	0	1	0	0	0
42	1021	1	0	0	1	1	1	1	0
43	1022	0	0	0	0	0	0	0	0
43	1023	0	0	0	0	0	0	0	0
43	1024	0	0	0	0	0	0	0	0
43	1025	0	0	0	0	0	0	0	0
43	1026	0	0	0	0	0	0	0	0
43	1027	0	0	0	0	0	0	0	0
43	1028							6	8
44	1029							20	12
44	1030							23	9
44	1031							4	0
44	1101							3	1
44	1102							19	7
44	1103							32	1
44	1104							3	0
45	1105							5	0
45	1106							2	0
45	1107							0	0

Table 4. Continued

Weekly total

Std. Week	Mark Large	Mark Small	Recap Large	Recap Small	Both Large	Both Small	Fence Large	Fence Small
36			0	0	0	0		
37			3	7	3	7		
38	0	0	17	15	17	15		
39	7	2	1	3	8	5		
40	7	2	8	5	15	7	0	0
41	4	0	3	0	7	0	0	0
42	3	0	0	2	3	2	1	1
43	0	0	0	0	0	0	6	8
44							104	30
45							7	0

Weekly cumulative total

Std. Week	Mark Large	Mark Small	Recap Large	Recap Small	Both Large	Both Small	Fence Large	Fence Small
36			0	0	0	0		
37			3	7	3	7		
38	0	0	20	22	20	22		
39	7	2	21	25	28	27		
40	14	4	29	30	43	34	0	0
41	18	4	32	30	50	34	0	0
42	21	4	32	32	53	36	1	1
43	21	4	32	32	53	36	7	9
44							111	39
45							118	39

Standardized weeks

Week	Month	Days
36	September	03-09
37	September	10-16
38	September	17-23
39	September	24-30
40	October	01-07
41	October	08-14
42	October	15-21
43	October	22-28
44	October	29-04
45	November	05-11

Table 5. Age distribution of Buctouche River salmon, 1996 and 1997. SW = sea winter; repeat spawner categories indicate total sea age followed by sea ages at which the fish spawned.

1996

			Repeat Spawners					% of known
Smolt Age	1SW	2SW	2.1	3.1	4.2	5.2.3	Total	smolt age
2	34	43	1	1	3	1	83	81
3	12	6	1	0	0	0	19	18
4	1	0	0	0	0	0	1	1
unknown	3	0	0	0	0	0	3	
Total	50	49	2	1	3	1	106	

Proportion repeat spawners of MSW = 13%
Proportion repeat 1SW of all repeats = 43%
Proportion repeat 1SW of MSW = 5%
Proportion 2SW of MSW = 87%

1997

			Repeat Spawners										% of known
Smolt Age	1SW	2SW	2.1	3.1	3.2	4.2	4.2.3	5.2.3.4	5.2.4	6.2.4	6.2.4.5	Total	smolt age
2	12	80	1	0	2	4	0	2	3	0	1	105	70
3	35	4	1	1	0	1	1	0	1	1	0	45	30
unknown	1	4	0	0	0	0	0	0	0	0	0	5	
Total	48	88	2	1	2	5	1	2	4	1	1	155	

Proportion repeat spawners of MSW = 18%
Proportion repeat 1SW of all repeats = 16%
Proportion repeat 1SW of MSW =3%
Proportion 2SW of MSW = 82%

Table 6. Densities of juvenile salmonids from closed site electroseining on the Buctouche R., 1997; * variances unreliable due to small catch or negative value; w - wild; h - hatchery.

Location	Map Site	Area (m^2)	No.of Sweeps	Life Stage	Sweep Catch	Pop. Estimate	Variance	Upsweep Catch	Total Estimate	Density /100 m^2	Mean FL(cm)	PHS
Main R. (100 m above Forks)	1	260	3	Fry (w)	17	22.8	*298.9	9	31.8	12.2	5.011	1.4
South Branch (below Rte. 490)	3	299	3	Fry (w)	23	28.5	*90.4	20	48.5	16.2	4.853	1.7
Main R. (100 m above Forks)	1	260	3	Parr (w)	21	31.6	*689.2	8	39.6	15.2	11.538	15.5
	1	260	4	Parr (h)	13	22.3	*-1030.7	-	22.3	8.6	10.608	7.0
South Branch (below Rte. 490)	3	299	3	Parr (w)	16	19.2	*89.7	14	33.2	11.1	9.167	6.2

Table 7. Catch per 15 minute upstream sweep at all electroseining sites, Buctouche R., 1997. Shaded figures are for sites stocked in 1997; w - wild; h - hatchery.

			Salmon										
Location	Map Site	Equivalent Area (m^2)	Fry (w)	Small Parr (h)	Small Parr (w)	Large Parr (w)	Chub	Dace	Lamprey	Sculpin	Shiner	Stickle-back	Sucker
Main R. (100 m above Forks)	1	231	8	5	4	4	3	63	1	0	0	0	1
Main R. (below Rte. 490)	2	273	4	2	2	0	13	67	1	3	0	0	3
South Branch (below Rte. 490)	3	218	15	0	9	1	0	30	2	1	0	0	0
Main R. (0.6 km below St. Paul crossroad)	4	226	6	1	6	1	6	48	3	0	0	0	0
Upper N. Br. (below Rte. 510)	5	100	7	1	1	0	30	5	0	0	0	0	1
Main R. (0.3 km below Johnson Brook)	6	242	3	2	4	0	8	43	3	0	0	0	1
Main R. (0.5 km above Coates Mill Bridge	7	299	7	2	26	9	9	49	1	1	5	0	20
South Branch (0.2 km above Forks)	8	203	1	2	10	4	5	75	10	0	0	0	17
South Branch (3.5 km below Rte. 490)	11	283	9	0	12	1	9	69	4	0	1	1	1
Main R. (below Rte. 485)	12	148	1	2	1	0	13	23	0	0	0	9	3

Table 8. Catch of wild juvenile salmon per 15 minute upstream sweep, and predicted fry density, Buctouche R., 1996-97. Fry density = 15 min catch x 0.9427 + 1.1826 (N=6, R^2=0.68, P=0.042)

		Salmon fry		Salmon parr		Predicted fry density/100m^2	
Location	Map Site	1996	1997	1996	1997	1996	1997
Main R. (100 m above Forks)	1	10	8	14	7	10.2	8.7
Main R. (below Rte. 490)	2	4	4	2	2	4.6	5.2
South Branch (below Rte. 490)	3	6	15	10	10	6.8	14.9
Main R. (0.6 km below St. Paul crossroad)	4	0	6	2	7	1.2	7.2
Upper N. Br. (below Rte. 510)	5	0	7	2	1	1.2	8.2
Main R. (0.3 km below Johnson Brook)	6	2	3	7	4	3.0	4.2
Main R. (0.5 km above Coates Mill Bridge	7	20	7	23	35	20.0	7.7
South Branch (0.2 km above Forks)	8	2	1	8	14	2.6	1.9
South Branch (3.5 km below Rte. 490)	11	17	9	15	13	17.5	9.4
Main R. (below Rte. 485)	12	0	1	0	1	1.2	1.9
Mean		6	6	8	9	6.8	6.9

Table 9. Comparison of wild juvenile salmon densities on the Buctouche R., 1977-97; *denotes minimum value = sweep catch/area.

FRY

Location	Map Site	1977	1978	1979	1980	1982	1994	1995	1996	1997
Main R. (100 m above Forks)	1	-	-	-	-	-	0.0	2.6	5.0	12.2
Main R. (below Rte. 490)	2	0.0	*1.4	0.0	2.0	0.0	-	-	5.1	-
South Branch (below Rte. 490)	3	0.0	77.5	29.5	6.1	3.3	0.0	0.0	7.2	16.2
Main R. (0.6 km below St. Paul crossroad)	4	0.0	8.7	13.7	6.5	*0.5	-	-	-	-
Main R. (0.3 km below Johnson Brook)	6	-	-	-	-	-	-	-	2.6	-
South Branch (0.2 km above Forks)	8	0.5	11.9	0.0	-	0.0	-	-	-	-
Johnson Br. (Rte. 510)	13	0.0	4.1		-	-	-	-	-	-
Yankee Br. (Rte. 490)	14	0.0	9.6	0.0	-	2.6	-	-	-	-
Main R. (1 km above Forks)	15	*1.4	17.6	*1.0	-	-	-	-	-	-
Bailey Br.	16	-	-	-	-	-	-	-	-	-

PARR

Main R. (100 m above Forks)	1	-	-	-	-	-	2.7	1.5	5.9	15.2
Main R. (below Rte. 490)	2	1.2	*0.5	10.0	3.5	*0.3	-	-	*2.4	-
South Branch (below Rte. 490)	3	24.8	10.5	25.8	11.5	10.6	0.0	1.4	26.0	11.1
Main R. (0.6 km below St. Paul crossroad)	4	5.6	*0.7	7.2	2.9	5.1	-	-	-	-
Main R. (0.3 km below Johnson Brook)	6	-	-	-	-	-	-	-	8.8	-
South Branch (0.2 km above Forks)	8	3.1	1.5	5.6	-	9.0	-	-	-	-
Johnson Br. (Rte. 510)	13	*0.3	*0.5	-	-	-	-	-	-	-
Yankee Br. (Rte. 490)	14	0.7	0.0	5.9	-	2.0	-	-	-	-
Main R. (1 km above Forks)	15	*0.5	2.1	13.3	-	-	-	-	-	-
Bailey Br.	16	-	-	-	-	-	-	-	-	-

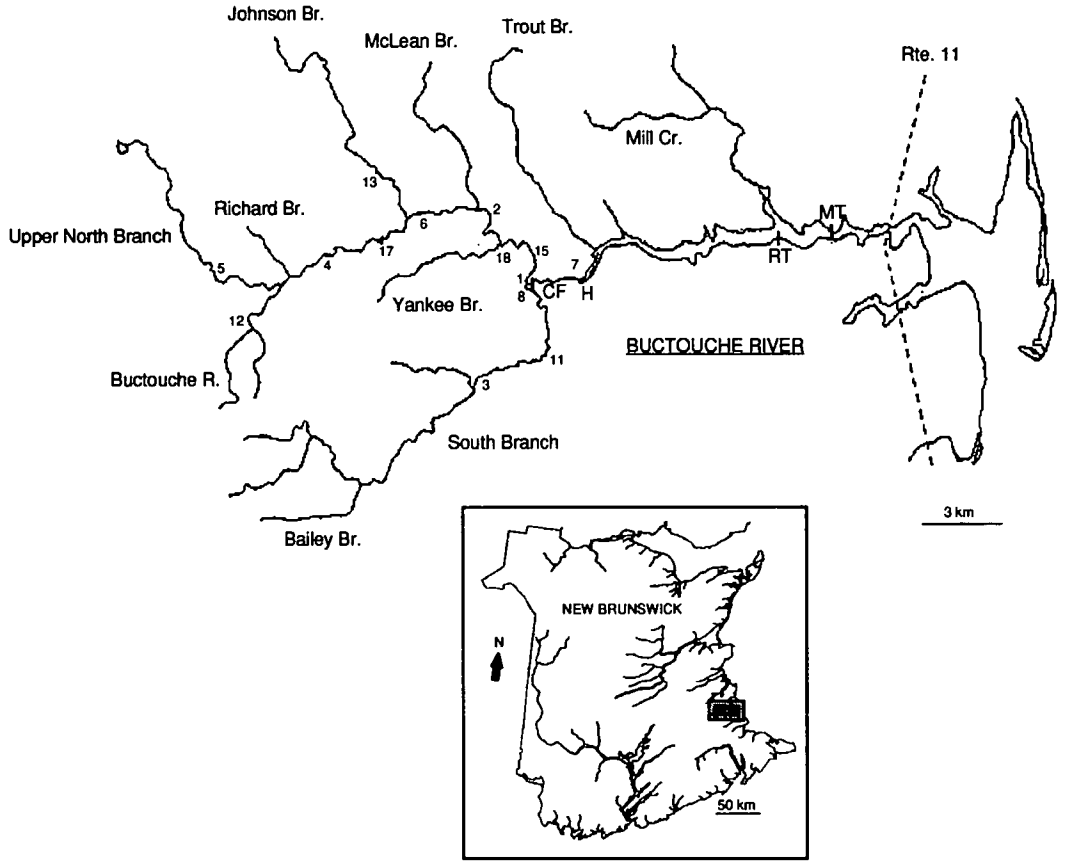

Figure 1. Location of mark and recapture traps (MT, RT), head of tide (H), counting fence (CF), and electroseining/stocking sites (1 - 18) on the Buctouche River.

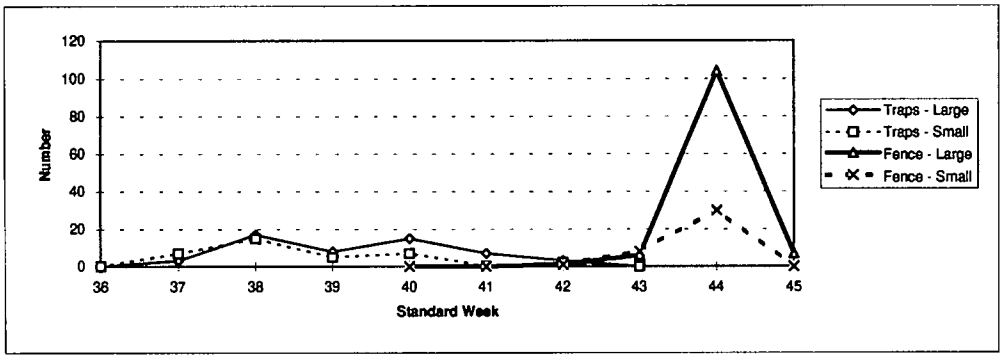

Figure 2. Salmon catches by standard week in the estuary traps and counting fence, Buctouche R., 1997.

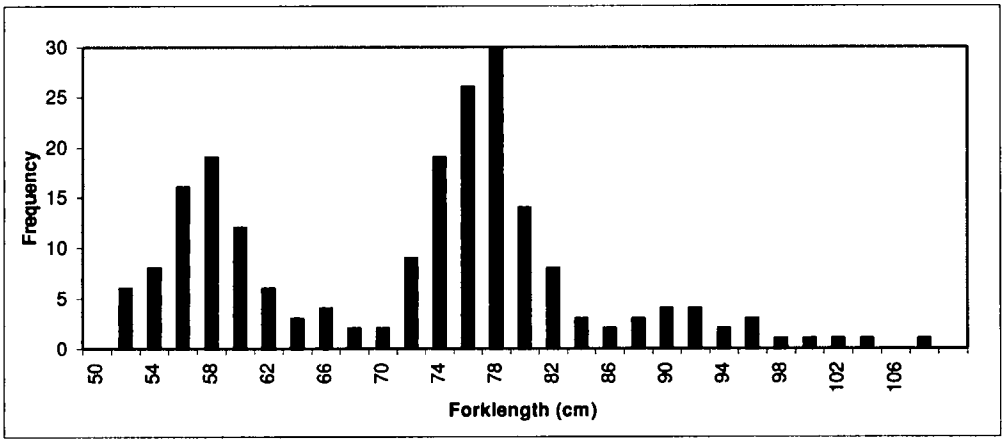

Figure 3. Length-frequencies of salmon caught in Buctouche R. counting facilities, 1997. Recaptures have been excluded (N=211).

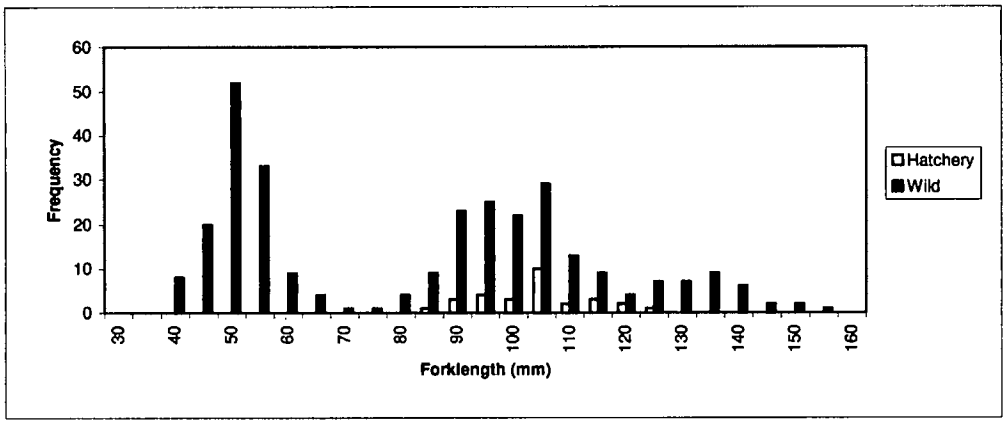

Figure 4. Length-frequencies of juvenile Atlantic salmon caught at electroseining sites on the Buctouche R., 1997; (N=300 wild, 22 hatchery).

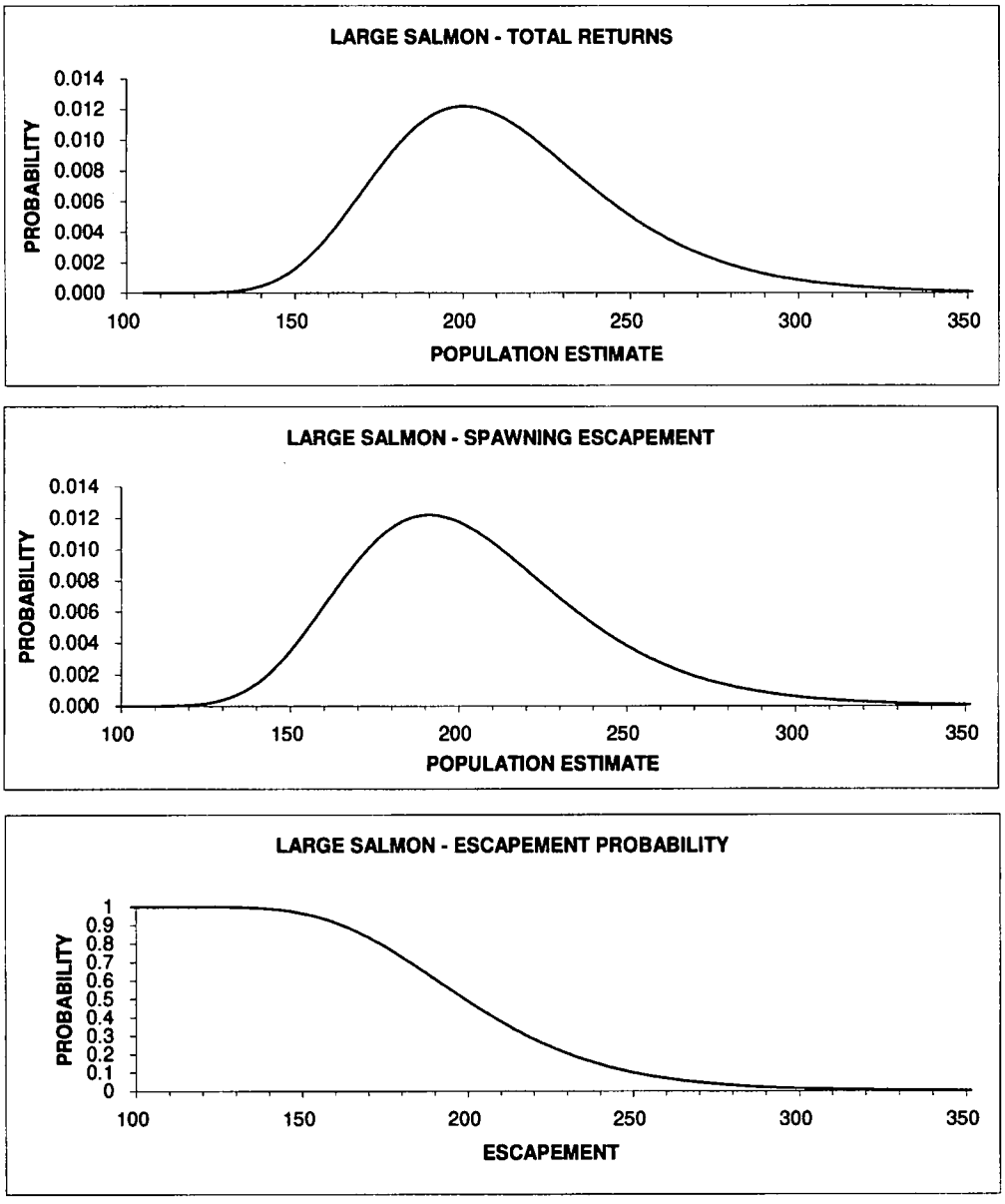

Figure 5. Bayesian estimates of large salmon total returns (200), spawning escapement (191) and probability (0.03) of achieving conservation spawning escapement (281) for the Buctouche R., 1997.

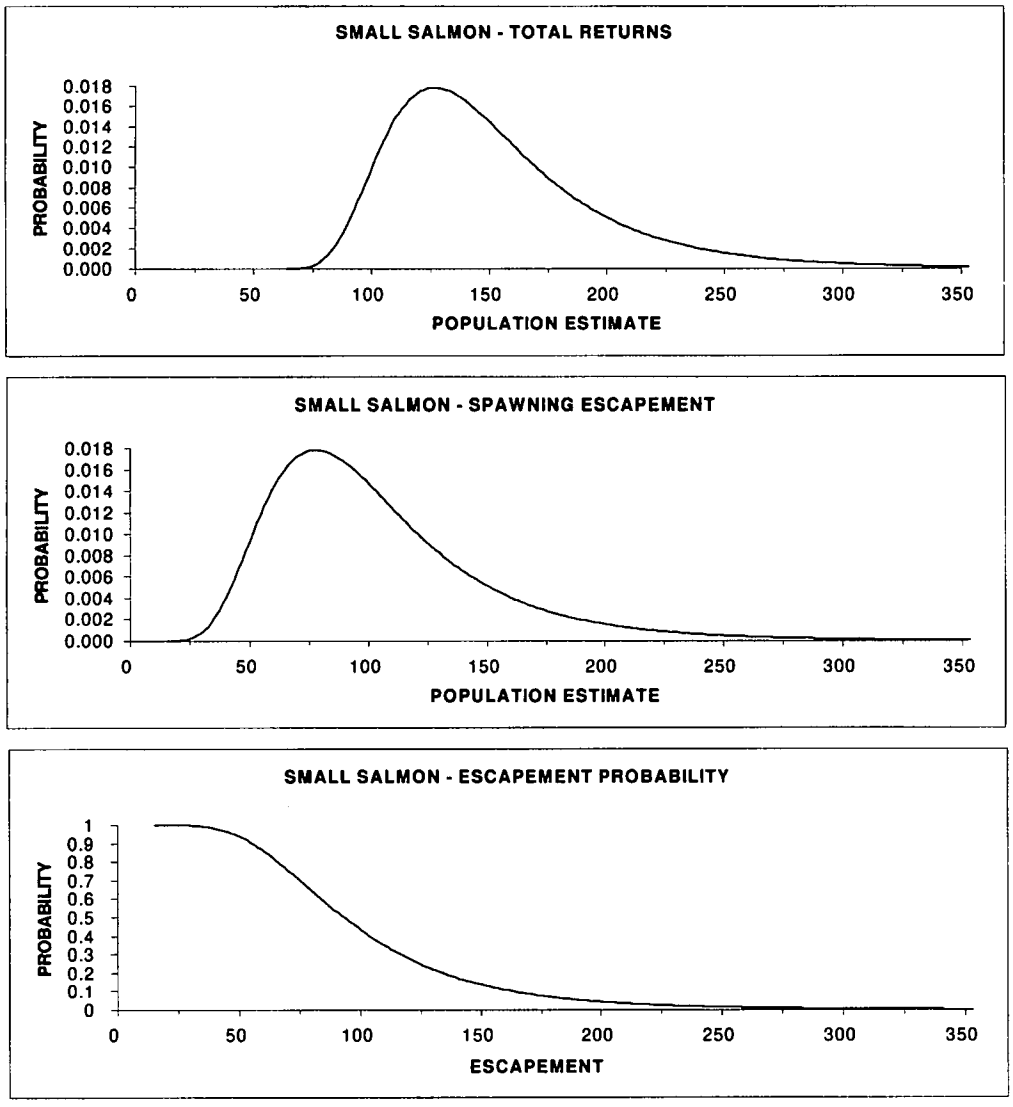

Figure 6. Bayesian estimates of small salmon total returns (97), spawning escapement (67) and probability (0.09) of achieving conservation spawning escapement (172) for the Buctouche R., 1997.