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STATUS OF ATLANTIC SALMON (*SALMO SALAR*) IN THE BUCTOUCHE RIVER IN 1998

by

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

and

Gary Sanipass and Vince Leblanc
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

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ABSTRACT

Due to egg depositions well below conservation requirements in recent years, the angling season was closed and there was no First Nation allocation of salmon on the Buctouche River in 1998. 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 102 and total small salmon returns at 92. Respective spawning escapements were 101 and 91. Total egg deposition was only 33% of the conservation requirement, representing a decrease of 52% relative to 1997. 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 an analysis of various management scenarios indicates that even with all fisheries closed, there is only a 1% probability that conservation requirements will be met on the Buctouche River in 1999.

RÉSUMÉ

Étant donné que la ponte a été bien en deçà des impératifs de conservation au cours des dernières années, la pêche du saumon à la ligne a été interdite et aucune Première nation n'a eu droit à une allocation de pêche du saumon dans la rivière Bouctouche en 1998. L'estimation des montaisons a été basée sur un projet de marquage et recapture : des étiquettes ont été posées sur les saumons à deux filets-trappes mouillés en estuaire et elles ont été récupérées à une barrière de dénombrement installée en eau douce. La montaison globale de grands saumons a été estimée à 102 et celle des petits saumons a été évaluée à 92. L'échappée de géniteurs a été de 101 et de 91 respectivement. L'objectif en matière de ponte globale ne représentait que 33 % des impératifs de conservation, soit une baisse de 52 % par rapport aux résultats de 1997. Les densités de juvéniles aux lieux ayant fait l'objet d'un relevé étaient généralement plus élevées que celles notées au cours des années antérieures, mais elles étaient encore en dessous des niveaux optimums, ce qui confirme que le frai est inadéquat depuis quelques années. Présentement, on n'a pas compilé suffisamment d'information sur l'état des stocks pour prévoir les montaisons, mais une analyse des diverses options de gestion indique que malgré la fermeture de toutes les pêches, il n'y a que 1 % de probabilité que les impératifs de conservation soient atteints dans la rivière Bouctouche en 1999.

SUMMARY SHEET

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

	1993	1994	1995	1996	1997	1998	MIN[1]	MAX[1]	MEAN[1]
Angling catch									
Large (Released)	35	20	0	na (21)	9 (6)	0			
Small (Rel + Kept)	64	7	33	na (21)	9 (5)	0			
Aboriginal Community Harvest									
Large	0	12	0	4	5	0	0	12	4
Small	0	11	15	25	25	0	0	25	15
Broodstock removals									
Large	0	0	7	5	4	0	0	7	3
Small	0	0	8	5	1	0	0	8	3
Other known removals (mort. etc.)									
Large	0	0	0	0	0	1	0	0	0
Small	0	0	0	0	0	1	0	0	0
Spawning escapement									
Large	94	212	147	124	191	101	94	212	154
Small	21	59	67	78	67	91	21	78	58
Total returns									
Large	95	225	154	134	200	102	95	225	162
Small	78	77	98	127	97	92	77	127	95
% Egg Requirement met									
Large	34	72	55	45	69	33	34	72	55
All spawners	35	72	58	46	70	33	35	72	56

[1] Min, max, mean relative to 5 year period prior to current year. Angling figures not shown since catch estimates are inconsistent.

Recreational catches: The angling season was closed for salmon on the Buctouche River in 1998. Figures in parentheses from telephone surveys, others provided by New Brunswick Department of Natural Resources and Energy (NBDNRE).

Aboriginal community harvest: There was no allocation of salmon in 1998.

Data and assessment: Returns of large and small salmon to the Buctouche River in 1998 were estimated from tags applied at two estuarial trapnets and recaptured at a counting fence. Spawners were estimated as returns minus known removals; egg deposition was calculated from fecundity based on stock characteristics observed in the current year.

State of the stock: Spawning escapement was not met for either large or small salmon in 1998. Total egg deposition was estimated at 33% of the conservation requirement.

Forecast for 1999: No quantitative forecast can be made: however, given six consecutive years below required egg deposition (mean: 52%), it is highly unlikely that the conservation requirement will be met in 1999.

Management Considerations: An analysis of various management scenarios indicates that even with all fisheries closed, the probability of meeting the spawning requirement for the Buctouche River in 1999 is only 1%.

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-sea-winter 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 1997 (Atkinson and Claytor MS1994, Atkinson *et al.* MS1995, Atkinson and Chaput MS1996, Atkinson *et al.* MS 1997, Atkinson *et al.* MS 1998). 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 1998 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 1998 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. Due to insufficient spawning escapement to the river in recent years, harvesting was curtailed in 1998. There was consequently no First Nation allocation of salmon and no large (63 cm or more) or small (less than 63 cm) salmon were removed for food (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 insufficient spawning escapement in recent years, the angling season for salmon was closed on the Buctouche River for 1998.

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 remained in effect until closure of the current season. 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). There was no catch in 1998.

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. No apprehensions were made in 1998 and patrols found no evidence of poaching activity. It was suggested that in the estuary, a small number of salmon may have been removed as by-catch in smelt traps.

Two mortalities occurred at the counting fence; one large female and one small male salmon. Reproductive products were removed from these fish, combined, and the eggs sent to the Miramichi hatchery for incubation. The fry will be placed in aquaria in Bouctouche regional schools as part of ongoing educational programs, and released into the Buctouche River probably as unmarked fry in the spring of 1999.

Summary of Known Removals, 1998

Location	Large	Small
First Nation Food (traps)	0	0
Angling (freshwater)	0	0
Mortalities (counting fence)	1	1
Total	1	1

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. 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 15 to November 4, and the recapture trap from September 10 to November 5. Timing of the run to the estuary, as indicated by the total catch for both traps, peaked for large salmon during Week 38 (Sep. 17-23) and probably at least one week earlier for small salmon (Fig. 2). This was the same for large but earlier for small salmon, relative to 1997. Total catch for both traps combined, exclusive of recaptures, was 18 large and 8 small salmon (Table 4), all of which were tagged. Relative to 1997, the catch at the recapture site (the most effective trap) for approximately the same period decreased by 50% for large and 78% for 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 7 to October 23 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. Due to elevated water levels from late September onward, it is known that fish ascended prior to fence

installation, during periods of inoperation due to high water, and most probably after removal following a washout in late October. Most fish passed through the fence during Week 41 (Oct.8-14), for a total count of 17 large and 20 small salmon (Fig. 2, Table 4). Run timing was probably more uniformly distributed, due to water conditions, than is suggested by the relatively short operation of the fence. Since a total count was precluded, the fence served only as a tag recapture site.

Tags were recaptured from only three large and one small salmon. Tagging effort and recaptures in 1998 are as follows:

Tags Applied

Location	Large	Small
Mark trap	2	1
Recapture trap	16	7
Both traps	18	8

Tags Recaptured

	Large		Small	
Location	Tags	Catch	Tags	Catch
Counting fence	3	17	1	20

Biological Characteristics

A length-frequency histogram for all adult salmon caught at counting facilities on the Buctouche River for 1998 indicates modal values of 90 cm and 58 cm for large and small fish, respectively (Fig. 3). The mean length of large salmon was 84 cm; 62% were females (mean length 84 cm) and 38% males. Mean length of small salmon was 56 cm; and all were identified as males. The large salmon proportion of the catch, as a weighted average of catches at all facilities, was 56 %. Age determinations from samples taken in 1998 show that of known-age fish, 2 and 3 year smolts respectively comprised 51% and 49% of the sample. Of the multi-seawinter (MSW) component, 33% were maiden two-sea-winter (2SW) fish and 67% were repeat spawners. Repeat spawning one-seawinter (1SW) fish, or grilse, represented 20% of all repeat spawners and 13% of all MSW fish (Table 5).

Although the sample size is small (N=56), it is notable that the proportion of 2SW maiden fish has dropped considerably (from about 87% to 33%), which is reflected in the increased proportion of repeat spawners (about 13% to 67%) and an increase in mean length (78 cm to 84 cm). The low proportion of 2SW maiden fish was to some extent expected, since returns of large salmon in 1993 were very low.

The length-frequency distribution for all juveniles sampled by electroseining shows modal values for wild fry, small parr and large parr of 55, 105, and 130 mm, respectively (Fig. 4). Mean lengths were 50, 100, and 132 mm. Hatchery parr, all stocked the previous fall as 0+ fry, had modal and mean lengths of 105 and 100 mm respectively.

Electroseining

In August of 1998, 10 sites were electroseined on the Buctouche River (Fig. 1). Two sites on the main river (1,2) and one on the South Branch (3) were barriered sites, initially fished with one upstream sweep followed by three downstream sweeps. The other sites (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 (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 1998 (Table 7), comparisons of juvenile salmon CPUE and predicted density (Table 8), estimates of egg to fry survival (Table 9), and densities determined from data collected in all years (Table 10) 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

Densities of fry (4.2 - 47.4/unit = $100m^2$) and parr (16.0 - 20.9/unit) observed at closed sites in 1998 were generally higher than those in 1997, with the exception of fry at site 1, which was only about one third the previous year's level (Tables 1, 10). Interpretation of fry densities is problematical, however, because of the stocking of unmarked fry in June 1998 at various main river sites (see below). At site 3 on the South Branch, where no stocking occurred, fry density was nearly three times that in the previous year, which supports the estimate of increased spawning in 1997. Fry densities at main river and South Branch spot check sites were predicted from the regression of density on CPUE for all sites available for 1996 to 1998 (fry dens. = 15 min. catch x 0.9302 + 2.0790; N=9, R^2=0.94, P<0.001). These values ranged from 2.1 to 67.2/unit, the highest densities occurring in the main river where fry were stocked. Mean densities (observed or predicted) were 20.6/unit for main river sites and 21.1/unit for South Branch sites (Table 8). Unmarked fry were stocked at a mean density of 14.6/unit in the main river, and if it is assumed that all survived, the density of wild fry could be as low as 6.0/unit. The mean of the two extremes, representing 50% survival, is 13.3/unit, which is nearly twice the 1997 level. Similarly, mean fry density for South Branch sites, where stocked fry were presumed not to occur, was just over twice the 1997 level. A significant relationship between CPUE and parr density was not obtained.

Though generally higher than in recent years, mean densities in 1998 were low with respect to Elson's (1967) "normal" values of 29 fry and 38 parr /unit on Miramichi River sites which were unaffected by DDT spraying. Estimates of egg to fry survival rates (1996-98) were calculated by multiplying these values by the total units of habitat and dividing by the egg deposition in the previous year. For 1998 this rate is 12.3% assuming that all stocked fry perished and those caught were wild, and 6.4% assuming that all stocked fry survived, and the main river mean density was reduced proportionally. The mean of the two extremes is thus 9.4%, which is an improvement over the 1997 (7.3%) and 1996 (4.9%) values (Table 9). These 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), but are generally 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. 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 six 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 at least some 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 1997, 30,000 adipose clipped 0+ fingerlings were stocked at six sites in the main Buctouche River and one in the South Branch (Atkinson *et al.* 1998). These fish were found at all but one site on each of the two streams with CPUE being low (1-11/15 min.) but fairly uniform (Table 7). With respect to the area of the main stem only, this represented a stocking density of 7.9/unit. At closed sites 1 and 2 the density of hatchery parr was 9.9 and 14.1/unit, respectively (Table 1), both of which exceed the stocking density. On the South Branch, hatchery parr were stocked only at site 3, and if it is assumed that they spread throughout the branch, would represent a stocking density of 4.9/unit, which was lower than that observed at site 3 (6.7/unit). This may not be a valid assumption, however, since no hatchery parr were found at site 11 downstream, and those from site 8, the lowest on the branch, may have migrated up from the main stem. 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. Nonetheless, observed densities of hatchery parr relative to stocking density argue favourably for good overwinter survival rates at this stage; certainly more within normal bounds than egg to fry survival.

Stocking

In the fall of 1997, 3 large female and 1 large and 1 small male salmon from the Buctouche River were spawned at the Miramichi hatchery, and subsequently returned to the river. Due to lack of funds to raise the progeny to the 0+ fall fingerling stage, they were released as unmarked, unfed fry in June 1998. A total of 55,000 fry were released in the main stem in lots of 5,000 each at sites 2-5, and 35,000 at site 1 (Fig. 1). Unfortunately, it will be impossible to track these fish either for in-river survival or potential contribution to future returns.

Estimation of Stock Parameters

Returns of large salmon past the estuary traps were calculated from the pooled tags 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 (one month) during which tags were recaptured, and none were known to have been removed prior to possible interception at the fence. Returns of small salmon were computed as a proportion of all salmon returns, from the binomial distribution of probabilities of the large/small ratio from combined catches at all facilities.

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 only counting fence mortalities, as mentioned above. Because estimates of unrecorded catch by-catch in the estuary are unsubstantiated, those alleged to have occurred

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 102 for large salmon and 92 for small salmon, with respective spawning escapements of 101 (95% CI: 55-310) and 91 (95% CI: 39-279). The probability of achieving the conservation requirement was only 7% for large and 24% for small salmon (Fig. 5).

Based on fecundity values derived from stock characteristics observed in the current year (5167 eggs/large salmon, o eggs/small salmon), total egg deposition was estimated at only 33% of the conservation requirement for the system, assuming that all fish spawned in the Buctouche River and its tributaries. This represents a 53% decrease over the egg deposition in 1997, and is well below the average for the previous five years (56% of requirement). The most obvious deficit was in 2SW maiden returns, which, as noted above, was to some extent anticipated from low returns in 1993.

Sources of Uncertainty

Low numbers of tags placed and recaptured put wide confidence limits on estimated returns.

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 have been found there in past electrofishing surveys. It cannot be estimated what proportion of the returns may have used these streams, but is thought to be negligible.

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 adequate for fish to ascend from late September onward. This, combined with unusually high water throughout the latter half of October, precluded obtaining a complete count at the fence, but was undoubtedly beneficial to salmon by ensuring access to most areas of suitable spawning habitat and deterring efforts at poaching.

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. Although returns in 1994 were the highest observed to date and may be expected to influence MSW returns in 1999, the mean level of egg deposition achieved for the six assessed years 1993 to 1998 has only been 52% of the conservation requirement (range, 33%-72%). Coupled with an apparent downward trend in sea survival, it is therefore considered unlikely that requirements will be met in 1999.

Management Considerations

An analysis of various management scenarios indicates that a full First Nation fishery (current allocations) and a grilse retension recreational fishery in 1999 would result in the loss of 25% of the potential egg deposition, with less than a 0.1% probability of achieving the conservation egg requirement. Even with all fisheries closed, the probability of meeting the requirement is only 1%.

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 and validate spawning success.

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Table 1. First Nation allocation and harvest of Atlantic salmon from the Buctouche R., 1992-98.

	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
1998	0	0	0	0

Table 2. Atlantic salmon angling catch on the Buctouche R., 1984 - 1998. 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	0	9	9	18	50	281	0.060
1998 (closed)	0	0	0	0	0	0	-

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

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 R. counting facilities, 1998.

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

Table 4. Continued

Weekly total

	Mark		Recap		Both		Fence	
Std. Week	Large	Small	Large	Small	Large	Small	Large	Small
37	0	0	3	6	3	6		
38	0	0	6	0	6	0		
39	2	0	3	0	5	0		
40	0	0	1	0	1	0	2	1
41	0	0	0	1	0	1	10	14
42	0	1	1	0	1	1	2	3
43	0	0	2	0	2	0	3	2
44	0	0	0	0	0	0		
45	0	0	0	0	0	0		

Weekly cumulative total

	Mark		Recap		Both		Fence	
Std. Week	Large	Small	Large	Small	Large	Small	Large	Small
37	0	0	3	6	3	6		
38	0	0	9	6	9	6		
39	2	0	12	6	14	6		
40	2	0	13	6	15	6	2	1
41	2	0	13	7	15	7	12	15
42	2	1	14	7	16	8	14	18
43	2	1	16	7	18	8	17	20
44	2	1	16	7	18	8		
45	2	1	16	7	18	8		

Standardized weeks

Week	Month	Days
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 R. salmon, 1998. SW = sea winter; repeat spawner categories indicate total sea age followed by sea ages at which the fish spawned.

			Repeat Spawners							% of known
Smolt Age	1SW	2SW	2.1	3.1	3.2	4.2	4.2.3	5.2.3.4	Total	smolt age
2	7	4	1	2	2	10	1	1	28	51
3	19	5	0	1	0	2	0	0	27	49
unknown	0	1	0	0	0	0	0	0	1	
Total	26	10	1	3	2	12	1	1	56	

Proportion repeat spawners of MSW:	67%
Proportion repeat 1SW of all repeats:	20%
Proportion repeat 1SW of MSW:	13%
Proportion 2SW of MSW:	33%

Table 6. Densities of juvenile salmonids from closed site electroseining on the Buctouche R., 1998; * variances unreliable due to small catch or negative value; w - wild; h - hatchery.

Location	Map Site	Area (m2)	No.of Sweeps	Life Stage	Sweep Catch	Pop. Estimate	Variance	Upsweep Catch	Total Estimate	Density /100 m2	Mean FL(cm)	PHS
Main R. (100 m above Forks)	1	320	3	Fry	8	8.3	*0.3	5	13.3	4.2	5.1	0.5
Main R. (below Rte. 490)	2	163	3	Fry	17	17.3	*0.7	4	21.3	13.1	5.2	1.7
South Branch (below Rte. 490)	3	219	3	Fry	48	50.7	10.6	53	103.7	47.4	5.2	6.1
Main R. (100 m above Forks)	1	320	3	Parr (w)	24	32.3	*210.7	19	51.3	16.0	11.1	14.7
Main R. (100 m above Forks)	1	320	3	Parr (h)	20	21.8	*17.8	10	31.8	9.9	10.4	7.7
Main R. (below Rte. 490)	2	163	3	Parr (w)	12	17.5	*-439.1	20	37.5	23.0	10.6	18.8
Main R. (below Rte. 490)	2	163	3	Parr (h)	16	16.9	*12.5	6	22.9	14.1	10.3	10.7
South Branch (below Rte. 490)	3	219	3	Parr (w)	11	11.7	*32.5	34	45.7	20.9	9.3	12.1
South Branch (below Rte. 490)	3	219	3	Parr (h)	6	7.6	*-14.7	7	14.6	6.7	9.2	3.8

Table 7. Catch per 15 minute upstream sweep at all electroseining sites, Buctouche R., 1998. Shaded figures are for sites stocked in fall 1997 (fingerlings) and spring 1998 (fry); w - wild; h - hatchery.

		Salmon												
			Small	Small	Large	Large								
	Map Site	Fry	Parr (h)	Parr (w)	Parr (h)	Parr (w)	Chub	Dace	Eel	Lamprey	Shiner	Stickleback	Sucker	Trout
Main R. (100 m above Forks)	1	4	8	14	0	2	1	62	0	0	0	0	3	0
Main R. (below Rte. 490)	2	5	7	20	0	5	44	269	0	2	0	0	21	0
South Branch (below Rte. 490)	3	48	6	30	0	1	7	122	0	2	0	5	5	2
Main R. (0.6 km below St. Paul crossroad)	4	18	8	5	0	0	2	78	0	0	0	0	3	0
Upper N. Br. (below Rte. 515)	5	72	0	1	0	1	29	2	0	1	1	3	7	2
Main R. (0.3 km below Johnson Brook)	6	20	11	5	1	2	13	158	0	1	0	0	8	0
Main R. (0.5 km above Coates Mill Bridge	7	18	6	21	0	12	1	32	0	4	0	1	7	0
South Branch (0.2 km above Forks)	8	2	2	6	0	2	6	85	1	0	0	0	15	0
South Branch (3.5 km below Rte. 490)	11	11	0	9	0	2	12	88	0	9	1	1	4	0
Main R. (below Rte. 485)	12	0	1	0	0	0	3	6	0	0	0	11	2	0

Table 8. Catch per 15 minute upstream sweep, and density of juvenile salmon, Buctouche R., 1996-98. Predicted fry density for spot check sites (shaded figures) = 15 min catch x 0.9302 + 2.0790 (N=6, R^2=0.94, P<0.001). Catches and predicted densities of fry for 1998 have an indeterminate hatchery component.

FRY

		Catch/15 min			Observed or predicted density		
Location	Map Site	1996	1997	1998	1996	1997	1998
Main R. (100 m above Forks)	1	9.6	8.0	4.1	5.0	12.2	4.2
Main R. (below Rte. 490)	2	3.6	4.3	4.9	5.1	6.0	13.1
South Branch (below Rte. 490)	3	5.9	14.6	48.5	7.2	16.2	47.4
Main R. (0.6 km below St. Paul crossroad)	4	0.0	6.4	18.4	2.1	7.8	18.7
Upper N. Br. (below Rte. 515)	5	0.0	7.4	72.2	2.1	8.8	67.2
Main R. (0.3 km below Johnson Brook)	6	2.0	3.2	20.4	2.6	5.0	20.4
Main R. (0.5 km above Coates Mill Bridge	7	20.0	6.9	18.4	20.1	8.3	18.7
South Branch (0.2 km above Forks)	8	1.5	0.8	2.4	3.5	2.8	4.3
South Branch (3.5 km below Rte. 490)	11	17.3	8.7	10.6	17.7	9.9	11.7
Main R. (below Rte. 485)	12	0.0	0.8	0.0	2.1	2.8	2.1
Mean	Main R.	5.0	5.3	19.8	5.6	7.3	20.6
Mean	South Br.	8.2	8.0	20.5	9.4	9.6	21.1

PARR

		Catch/15 min			Observed density		
Location	Map Site	1996	1997	1998	1996	1997	1998
Main R. (100 m above Forks)	1	13.9	7.1	15.7	5.9	15.2	16.0
Main R. (below Rte. 490)	2	2.2	1.7	24.6	4.6	-	23.0
South Branch (below Rte. 490)	3	9.9	10.2	31.1	26.0	11.1	20.9
Main R. (0.6 km below St. Paul crossroad)	4	1.6	7.0	4.8	-	-	-
Upper N. Br. (below Rte. 515)	5	2.5	1.5	1.8	-	-	-
Main R. (0.3 km below Johnson Brook)	6	7.3	4.3	7.1	8.8	-	-
Main R. (0.5 km above Coates Mill Bridge	7	22.8	35.2	32.4	-	-	-
South Branch (0.2 km above Forks)	8	7.6	13.8	7.3	-	-	-
South Branch (3.5 km below Rte. 490)	11	15.1	13.0	11.5	-	-	-
Main R. (below Rte. 485)	12	0.0	0.8	0.0	-	-	-
Mean	Main R.	7.2	8.2	12.3	-	-	-
Mean	South Br.	10.9	12.3	16.6	-	-	-

Table 9. Estimates of egg to fry survival, Buctouche R., 1996-98. Calculation for 1998a assumes all stocked fry perished and those caught were wild; for 1998b that all stocked fry survived, and were subtracted from mean density (main stem).

		1996	1997	1998a	1998b
Mean fry density	Main R.	5.6	7.3	20.6	6.0
	South Br.	9.4	9.6	21.1	21.1
Units of habitat	Main R.	4507	4507	4507	4507
	South Br.	2105	2105	2105	2105
Number of fry	Main R.	25158	32755	93007	27205
	South Br.	19874	20294	44451	44451
Total fry	System	45032	53048	137458	71656
Egg deposition in previous year	System	920460	730020	1115550	1115550
Percent egg to fry survival	System	4.9%	7.3%	12.3%	6.4%

Table 10. Comparison of wild juvenile salmon densities on the Buctouche R., 1977-98; *denotes minimum value = sweep catch/area. Shading denotes predicted density (see text). Predicted fry densities for 1998 contain an indeterminate hatchery component.

FRY

Location	Map Site	1977	1978	1979	1980	1982	1994	1995	1996	1997	1998
Main R. (100 m above Forks)	1	-	-	-	-	-	0.0	2.6	5.0	12.2	4.2
Main R. (below Rte. 490)	2	0.0	*1.4	0.0	2.0	0.0	-	-	5.1	6.0	13.1
South Branch (below Rte. 490)	3	0.0	77.5	29.5	6.1	3.3	0.0	0.0	7.2	16.2	47.4
Main R. (0.6 km below St. Paul crossroad)	4	0.0	8.7	13.7	6.5	*0.5	-	-	2.1	7.8	18.7
Upper N. Br. (below Rte. 515)	5	-	-	-	-	-	-	-	2.1	8.8	67.2
Main R. (0.3 km below Johnson Brook)	6	-	-	-	-	-	-	-	2.6	5.0	20.4
Main R. (0.5 km above Coates Mill Bridge	7	-	-	-	-	-	-	-	20.1	8.3	18.7
South Branch (0.2 km above Forks)	8	0.5	11.9	0.0	-	0.0	-	-	3.5	2.8	4.3
South Branch (3.5 km below Rte. 490)	11	-	-	-	-	-	-	-	17.7	9.9	11.7
Main R. (below Rte. 485)	12	-	-	-	-	-	-	-	2.1	2.8	2.1
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	-	-	-	-	-	-	-

PARR

Main R. (100 m above Forks)	1	-	-	-	-	-	2.7	1.5	5.9	15.2	16.0
Main R. (below Rte. 490)	2	1.2	*0.5	10.0	3.5	*0.3	-	-	*4.6	-	23.0
South Branch (below Rte. 490)	3	24.8	10.5	25.8	11.5	10.6	0.0	1.4	26.0	11.1	20.9
Main R. (0.6 km below St. Paul crossroad)	4	5.6	*0.7	7.2	2.9	5.1	-	-	-	-	-
Upper N. Br. (below Rte. 515)	5	-	-	-	-	-	-	-	-	-	-
Main R. (0.3 km below Johnson Brook)	6	-	-	-	-	-	-	-	8.8	-	-
Main R. (0.5 km above Coates Mill Bridge	7	-	-	-	-	-	-	-	-	-	-
South Branch (0.2 km above Forks)	8	3.1	1.5	5.6	-	9.0	-	-	-	-	-
South Branch (3.5 km below Rte. 490)	11	-	-	-	-	-	-	-	-	-	-
Main R. (below Rte. 485)	12	-	-	-	-	-	-	-	-	-	-
Johnson Br. (Rte. 515)	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	-	-	-	-	-	-	-

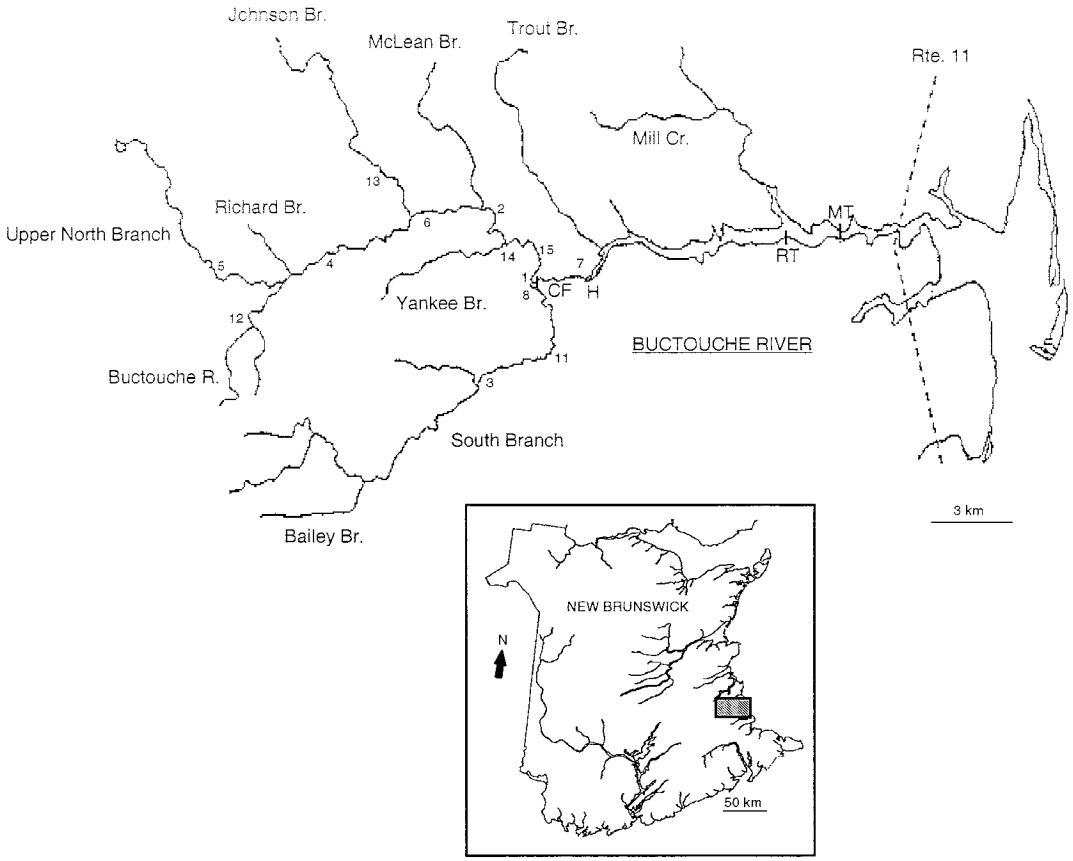

Figure 1. Location of mark and recapture traps (MT, RT), head of tide (H), counting fence (CF), and electroseining/stocking sites (numbered) on the Buctouche River.

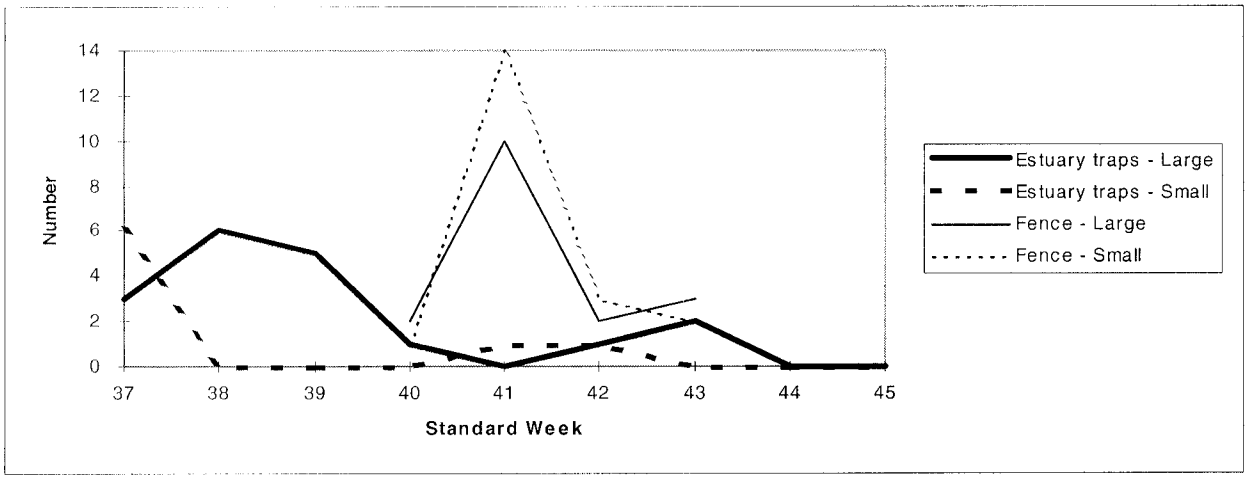

Figure 2. Salmon catches by standard week in the estuary traps and counting fence, Buctouche R., 1998.

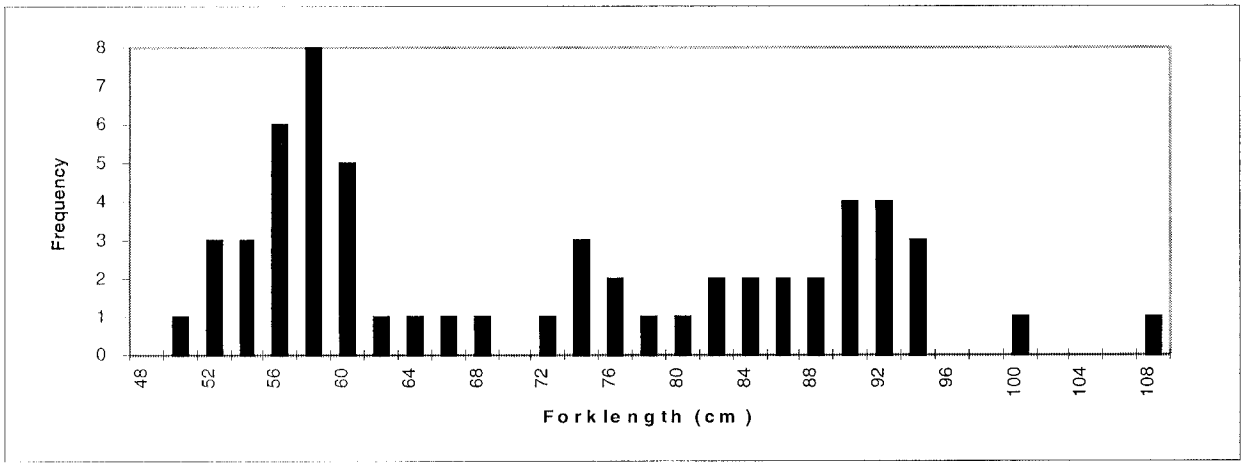

Figure 3. Length-frequencies of salmon caught in Buctouche R. counting facilities, 1998. Recaptures have been excluded (N=59).

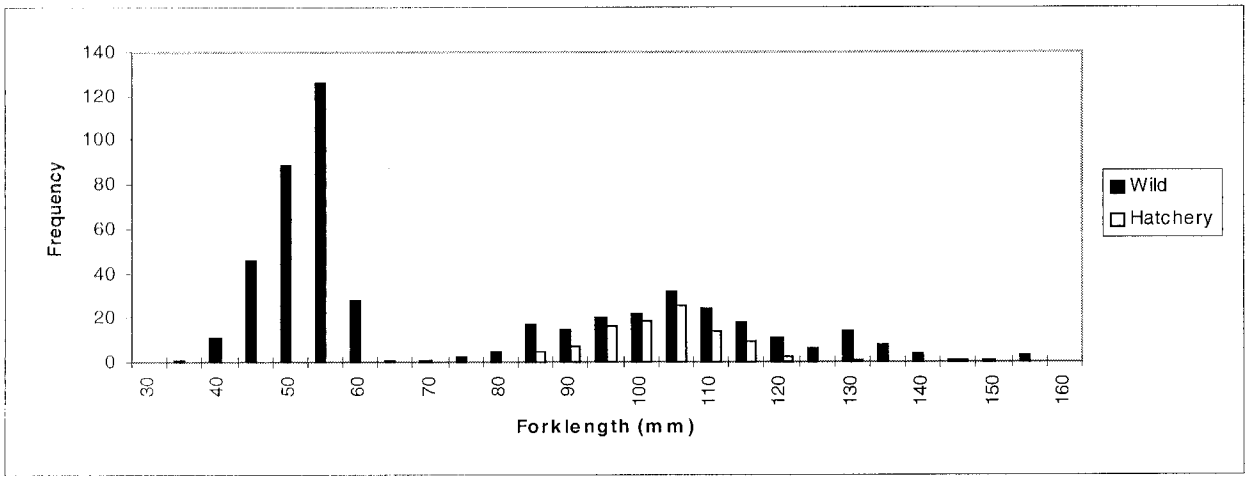

Figure 4. Length-frequencies of juvenile Atlantic salmon caught at electroseining sites on the Buctouche R., 1998; (N=506 wild, 100 hatchery).

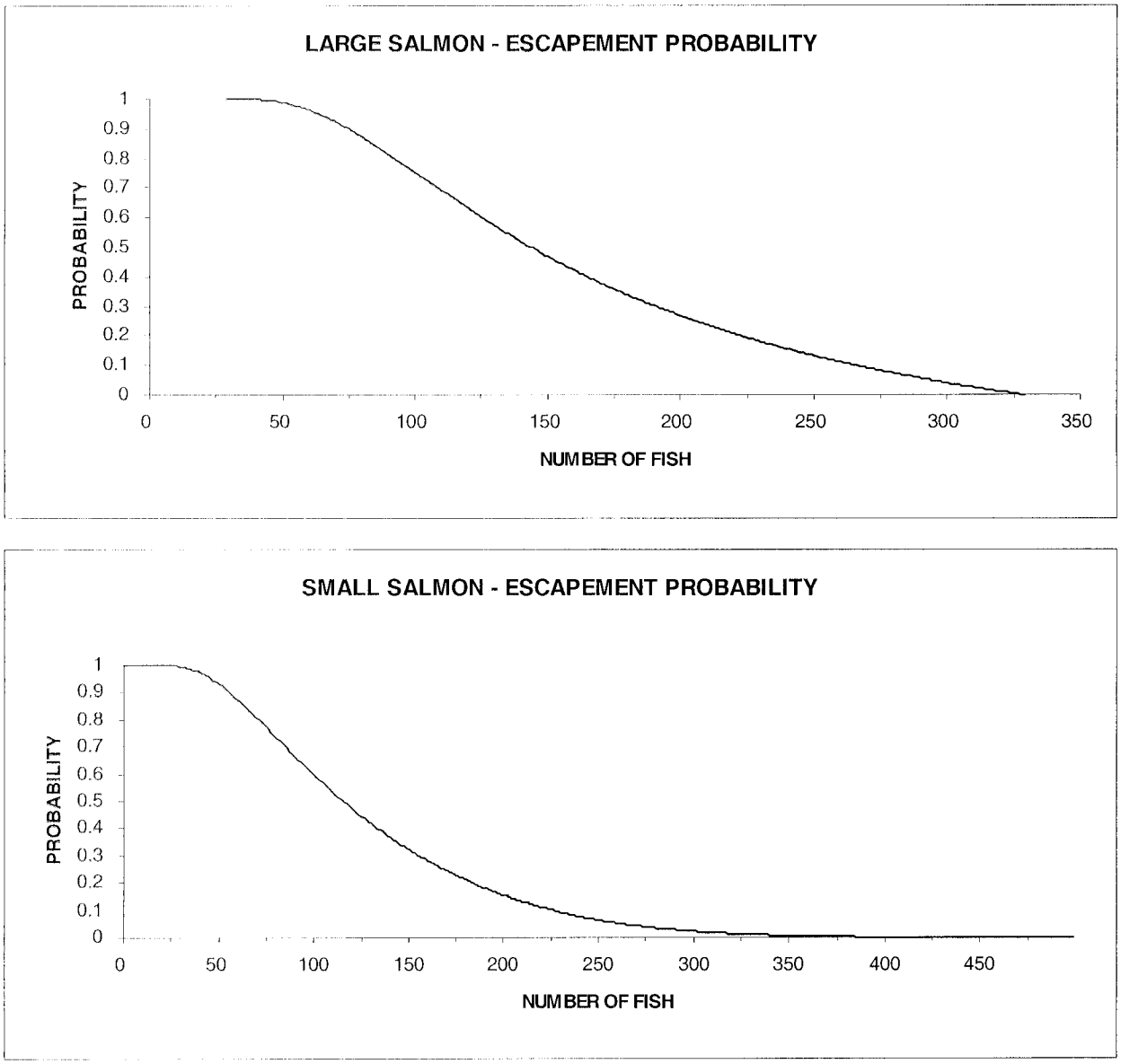

Figure 5. Bayesian probability estimates of achieving conservation spawning escapements for large (281 fish: 0.07) and small (172 fish: 0.24) salmon for the Buctouche R., 1998.