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STATUS OF ATLANTIC SALMON (*SALMO SALAR*) IN THE BUCTOUCHE RIVER, AND RELATIVE JUVENILE ABUNDANCE IN OTHER SOUTHEASTERN NEW BRUNSWICK RIVERS IN 1999

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ABSTRACT

Due to egg depositions well below the conservation requirement in recent years, the angling season was closed and there was no First Nation allocation of salmon on the Buctouche River as of 1998. Salmon returns in 1999 were calculated from catches and known efficiency of an estuary trapnet operated by Buctouche first Nation. Total large salmon returns were estimated at 244 and total small salmon returns at 115, with respective spawning escapements of 244 and 111. Total egg deposition was estimated at 102% of the conservation requirement. This represents a tripling of the level in 1998, and the first instance in seven assessed years when the requirement may have been met. Juvenile densities on the Buctouche were well below optimum, especially for fry, confirming the low egg deposition observed in 1998. Results from a juvenile survey of four other southeastern New Brunswick rivers indicated that the level of spawning success has been variable and asynchronous. The variability, unpredictability and generally depressed status observed in the Buctouche stock appears to be characteristic of most rivers in the area, and a valid basis for the general management of stocks. The forecast for the Buctouche in 2000 is the five year mean of total returns, which is 167 (90% CL 114-220) large and 106 (92-120) for small salmon. With all retention fisheries closed there is only a 3% probability that the egg conservation requirement will be met in 2000.

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 depuis 1998. En 1999, la montaison a été calculée à partir des prises et de l'efficacité reconnue d'un filet-trappe placé dans l'estuaire et exploité par la Première Nation de Bouctouche. La montaison globale de gros saumons a été estimée à 244 et celle des petits saumons, à 115, avec une échappée de géniteurs de 244 et de 111 respectivement. La ponte globale était évaluée à 102 % des impératifs de conservation. Ceci représente trois fois le niveau de 1998, et c'est la première fois en sept années d'évaluation que les impératifs de conservation pourraient être atteints. Les densités de juvéniles dans la rivière Bouctouche étaient bien en deçà du niveau optimal, en particulier les alevins, ce qui corrobore le faible niveau de la ponte observé en 1998. Les résultats provenant d'un relevé des juvéniles dans quatre autres rivières du Sud-Est du Nouveau-Brunswick indiquent que le niveau de succès du frai a été variable et asynchrone. Le caractère variable, imprévisible et généralement faible observé dans le stock de la rivière Bouctouche semble bien refléter la situation dans la plupart des rivières de la région, ce qui vient confirmer la stratégie adoptée pour la gestion générale des stocks. Les prévisions pour la rivière Bouctouche en 2000 sont établies en fonction de la moyenne de cinq ans des remontées totales, soit 167 (limite de confiance de 90 % : 114-220) gros saumons et 106 (92-100) petits saumons. Malgré la fermeture de toutes les pêches aux fins de conservation, il n'y a qu'une probabilité de 3 % que les impératifs de conservation seront atteints en 2000.

SUMMARY SHEET

STOCK: Buctouche River (SFA 16)
CONSERVATION REQUIREMENT: 1.587 million eggs (280 large salmon, 157 small salmon)

	1994	1995	1996	1997	1998	1999	MIN[1]	MAX[1]	MEAN[1]
Angling catch									
Large (Released)	20	0	na (21)	9 (6)	0	0			
Small (Rel + Kept)	7	33	na (21)	9 (5)	0	0			
Aboriginal Community Harvest									
Large	12	0	4	5	0	0	0	12	4
Small	11	15	25	25	0	4	0	25	15
Broodstock removals									
Large	0	7	5	4	0	0	0	7	3
Small	0	8	5	1	0	0	0	8	3
Other known removals (mort. etc.)									
Large	0	0	0	0	1	0	0	1	0
Small	0	0	0	0	1	0	0	1	0
Total returns									
Large	225	154	134	200	102	244	102	225	163
Small	77	98	127	97	92	115	77	127	98
Spawning escapement									
Large	212	147	124	191	101	244	101	212	155
Small	59	67	78	67	91	111	59	91	72
% Egg Requirement met									
Large	72	55	45	69	33	96	33	72	55
All spawners	72	58	46	70	33	102	33	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 has been closed for salmon on the Buctouche River as of 1998. Figures in parentheses are from telephone surveys, others provided by New Brunswick Department of Natural Resources and Energy (NBDNRE).

Aboriginal community harvest: There has been no allocation of salmon as of 1998. Buctouche First Nation retained four small salmon from an estuary trapnet for food.

Data and assessment: Returns of large and small salmon to the Buctouche River in 1999 were estimated from catches at, and calculated efficiency of, a trapnet operated in the estuary by Buctouche First Nation.

State of the stock: Total egg deposition from large and small salmon was estimated at 102% of the conservation requirement. This is the first in seven assessed years that the requirement may have been met.

Forecast for 2000: The forecast for the Buctouche in 2000 is the five year mean of total returns, which is 167 (90% CL 114-220) large and 106 (92-120) for small salmon.

Management Considerations: With all retention fisheries closed there is only a 3% probability that the egg conservation requirement will be met in 2000. However, small salmon have typically contributed only about 2% of total 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-sea-winter fish, enters the river during September and October. Prior to 1998 the resource was 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.

Adult returns have been assessed previously from 1993 through 1998, and juvenile abundance since 1996 (Atkinson and Claytor MS1994, Atkinson *et al.* MS1995, Atkinson and Chaput MS1996, Atkinson *et al*. MS 1997, Atkinson *et al*. MS 1998, Atkinson *et al*. MS 1999). 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. Past 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 1999 returns were estimated from the catches and the calculated efficiency at an estuary trapnet operated by Buctouche First Nation

Results of electroseining during the summer of 1999 have been included for the Buctouche, Cocagne, Richibucto, Coal Branch and Kouchibouguac rivers.

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, and remains in effect. There was consequently no First Nation allocation, despite which four small salmon (less than 63 cm) were removed from the trapnet 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 has been closed on the Buctouche River as of 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 (63 cm or more) be released and only small salmon (less than 63 cm) 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 season in 1998. Little effort was devoted to angling black salmon, and almost all angling for bright salmon occurred from late September to the end of the season. Although a trout fishery is open until September 15 in the main stem, it is unlikely to result in a significant by-catch of salmon since the peak of the run to the estuary occurs in the last week of the month.

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 1999.

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 1999 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.

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 the egg conservation requirement 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 observed similarity of biological characteristics. Stock characteristics used were the means of values observed on the Buctouche from 1993-99. 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 (1992-99).

Egg Requirement: 1.587 million eggs
Large Spawners: 280 (2SW component: 219)
Small Spawners: 157

Research Data

Estuary Trapnet

In co-operation with Buctouche First Nation, a trapnet was operated in the tidal portion of the river to enumerate and mark salmon. This was located 5 km upriver (west) of the Route 11 bridge in Bouctouche (Fig. 1). The box portion of the trap 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 trap was 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.

The trap was operated from September 1 to October 16. Timing of the run to the estuary peaked for both large and small salmon during Week 39 (Sep. 24-30), which was about one week later than in 1998 (Fig. 2). Drought conditions had prevailed up to this point, when consistent heavy rain commenced and persisted throughout the fall. Total catch, exclusive of recaptures, was 40 large and 33 small salmon (Table 4). Not reflected in the Table 4 total for small salmon (29) are four unrecorded removals for First Nation food, as described above. Relative to 1998, the catch at this site for approximately the same period tripled for large and quadrupled for small salmon.

Operation of a counting fence in freshwater as a recapture facility had been anticipated, but the Southeastern Anglers Association received inadequate funding to carry out the project. Lack of suitable sites for seining, combined with water levels generally too high to permit it anyway, precluded a mark/recapture experiment for the current year. Consequently, calculated trap efficiency from previous years was used to estimate stock parameters.

Biological Characteristics

A length-frequency histogram for all adult salmon caught on the Buctouche River in 1999 indicates modal values of 76-78 cm and 58-60 cm for large and small fish, respectively (Fig. 3). The mean length of large salmon was 77.6 cm; 85% were females (mean length 77.6 cm) and 15% males. Mean length of small salmon was 57.7 cm; 21% were females (mean length 58.3 cm) and 79% males. The large salmon proportion of the trap catch was 57 %. Age determinations from samples taken in 1999 show that of known-age fish, 2, 3 and 4 year smolts respectively comprised 34% and 63% and 3% of the sample. The proportion of 3 year old smolts in 1999 was the highest on record and well above the average of 40%. Of the multi-seawinter (MSW) component, 79% were maiden two-sea-winter (2SW) fish and 21% were repeat spawners. This is a more normal proportion than was seen in 1998, where only 33% were maiden 2SW fish. Repeat spawning one-seawinter (1SW) fish, or grilse, represented 25% of all repeat spawners and 5% of all MSW fish (Table 5). Biological characteristics for the Buctouche demonstrate expected annual variation, but no trends have been observed in the time series. As above, unexpected excursions from the mean are usually noted.

The length-frequency distribution for all wild juveniles sampled by electroseining shows modal values for wild fry, small parr and large parr of 50, 85, and 135 mm, respectively (Fig. 4). Mean lengths were 47, 91, and 132 mm. Mean length of small parr was about 8% less than the average for previous years.

Electroseining

Buctouche River

In August of 1999, 10 sites were electroseined on the Buctouche River (Fig. 1). One site on the main river (1) and one on the South Branch (3) were closed 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 (usually 900 seconds or more) 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 (# per unit = 100 sq. m). 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.

Juvenile densities at spot check sites were predicted from the regression of density at closed sites on CPUE (900 seconds, or 15 minutes) for all sites available. The regression is updated yearly as additional sites are accumulated in the data set. For the current year, fry density = 15 min. catch x 0.8374 + 2.2880 ($N=11$, $R^2=0.94$, $P<0.0001$), and parr density = 15 min. catch x 0.5033 +7.1705 ($N=8$, $R^2=0.76$, $P=0.0049$). Since a significant predictive relationship for parr was only developed with the inclusion of the 1999 data, all years presented have been calculated on this basis. In all cases, parr age classes have been combined for calculating density.

Results of electroseining on the Buctouche River in 1999 are presented as CPUE for all species (Table 6), juvenile salmon density at closed sites (Table 7), and yearly (1996-99) comparisons of salmon CPUE and density (Table 8).

Wild juveniles

Densities of fry at all sites but one (12) were considerably lower than in 1998, ranging from 1.1 to 38.2/unit. Mean density at main river sites dropped from 20.6 to 4.6/unit, a 78% decline. On the South Branch, mean fry levels dropped 31% from 21.1 to 14.6/unit (Tables 7, 8). This was expected in view of the fact that unmarked fry were stocked in the spring of 1998, and spawning escapement in the fall was the worst on record (Atkinson *et al*. 1999). Parr densities ranged from 9.8 to 23.4/unit, with means for the main river and South Branch of 13.4 and 15.2 respectively. This is essentially unchanged from the previous year, which is surprising in the case of the main river, since most of the fry in 1998 were stocked here and might have been expected to augment parr numbers in 1999. Overwinter survival may not have been good for these hatchery fish.

Mean densities in 1999 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. The only individual site which approached or exceeded the norm was site 3, where fry were 38.2/unit. Estimates of egg to fry survival rates (1996-99) were calculated by multiplying mean densities by the total units of habitat and dividing by the egg deposition in the previous year (Table 9). For 1999 this rate is 9.9% which is 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 is little more 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 Buctouche 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/sq. m applied to this smaller area of quality habitat, it would have been exceeded in three of the seven assessed years (1994, 1997, 1999) and only narrowly missed in a fourth (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, 33,000 adipose clipped 0+ fingerlings were stocked at six sites in the main Buctouche River and one in the South Branch (Atkinson *et al*. 1998). The majority of these fish were expected to leave as age 2+ smolts in the spring of 1999, which appears to be the case as a total of only 5 large (2+) hatchery parr were caught from all sites.

Other Southeastern New Brunswick Rivers

The status of the salmon stock on the Buctouche River has been used as a general index for managing harvests on all the small rivers flowing into Northumberland Strait between the Miramichi River and the Nova Scotia border. As an indication of the validity of this application, spot check electroseinng as described above was conducted at two sites on each of the Cocagne, Kouchibouguac, and Richibucto/Coal Branch rivers. Like the Buctouche, these are small, shallow, low gradient streams with a generally course (cobble) substrate. None has a significant impediment to ascending runs, all of which occur in the fall. Biological characteristics for Richibucto fish are similar to those of Buctouche, and the other rivers are not expected to differ significantly. Juvenile densities have been predicted using the regressions derived for the Buctouche River.

Cocagne River

Catch per unit effort for all species is presented in Table 10, catch and predicted density for salmon juveniles in Table 12. Fry densities (8.1, 3.1) are very low and suggest either few spawners in 1998, poor overwinter survival, or both. Parr densities (38.2, 18.6) are similar to the better Buctouche sites, but below “normal” levels. They do indicate that spawning was better in years prior to 1998 and, as on the Buctouche, probably show a great deal of annual variation.

Richibucto and Coal Branch Rivers

Catch per unit effort for all species caught on the Richibucto main stem and Coal Branch is presented in Table 12, catch and predicted density for salmon juveniles in Table 13. Results from spot check sites done in 1997-98 are also included for comparison. Fry densities on the main stem (22.6, 53.9) in 1999 were the highest in recent years. The mean (38.3) actually exceeds Elson’s norm of 29, and implies that spawning escapement in 1998 was good. Parr densities (11.3, 14.8) were not substantially different from previous years, and similar to those observed on the Buctouche. They are only about one third of normal levels, and confirm poor spawning at least prior to 1998. The Richibucto has been assessed previously (Atkinson and Claytor MS1994, Atkinson *et al*. MS1995, Atkinson and Cormier MS1998) and has not achieved the conservation requirement.

Coal Branch enters the estuary immediately adjacent to the main Richibucto. Fry densities (4.1, 7.4) were very low, similar to previous years at these sites and to current levels on Cocagne and most of Buctouche. It seems anomalous that this river did not benefit from the apparently increased returns to the main

Richibucto, where fry are more than double the levels seen in the two prior years. Low densities of parr (11.3, 14.8) are comparable to those seen previously on this, the Richibucto, and Buctouche rivers. These data suggest poor spawning returns to Coal Branch in the past few years.

Kouchibouguac River

Catches of all species and predicted salmon densities are given in Tables 14 and 15. Fry densities (43.9, 60.3) on the Kouchibouguac in 1999 were the highest of all rivers sampled and considerably exceeded Elson's norm of 29, indicating a level of egg deposition in 1998 which possibly exceeded the requirement of 2.4/sq. m. Parr densities (29.8, 35.1), though lower than the norm of 38, are twice the levels seen in other southeastern rivers for the past three years and imply that returns to the river have been good for both 1997 and 1998. Electroseining data for the Kouchibouguac River for 1977, 1978, and 1982 (Table 17) show that 1978 had high fry densities (29.1 – 186.6), while the other years had low levels comparable to recent years in other rivers in the area. Parr densities were never high and generally at lower levels than in recent years on other nearby rivers. One tributary, Tweedie Brook, showed consistently higher abundance of both fry and parr than other sites.

Conclusion

The electroseining data presented for these small southeastern New Brunswick rivers, scant though they are, imply that returns of salmon are quite variable annually and not necessarily synchronous among rivers. In most years the conservation requirement as currently defined is probably not met, and if or when it will be is unpredictable. The one possible exception may be the Kouchibouguac River, the most northerly of this group and in fairly close proximity to the Miramichi. Current juvenile abundance suggests that in the last two years spawning escapement was relatively good, possibly approaching conservation levels. More extensive future monitoring will help to define this river's relative status within the group. The variable, unpredictable and generally depressed status of the Buctouche stock, as observed over the seven assessed years 1993-99, is probably characteristic of most rivers in the area. As such, it is a good qualitative index on which to base the management of the salmon resource on these rivers. However, returns to the Buctouche in any given year are probably not a reliable indication of concurrent returns to other rivers.

Estimation of Stock Parameters

Lacking a mark/recapture estimate, returns of large and small salmon past the estuary trap were calculated by dividing trap catches in 1999 by the mean trap efficiency as observed in 1997 and 1998, when it was installed early enough to sample over the major portion of the run. The efficiency is defined as the ratio of trap catch to returns past the trap, as determined by mark/recapture. Between September 10 and October 27 (the earliest and latest dates common to both years), the efficiency was 16% for large salmon in both years. Unaccountably, it was not consistent for small salmon, being 44% in 1997 and 8% in 1998, with a mean of 26%. Trap catch in 1999 from September 10 to October 16 (last day fished) was 39 large, 26 small wild, and 4 small hatchery salmon.

Total returns to the system were obtained by adding known removals prior to interception at the trap, and spawning escapement by subtracting total known removals from total returns. For 1999 there were no known removals prior to interception, and 4 small salmon were removed from the trap for food by Buctouche First Nation, as mentioned above. Because estimates of unrecorded 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/sq. m) used to calculate the conservation requirement compensates for in-river

losses to poaching and disease. Consequently, in-river poaching estimates, if any, are not subtracted from total returns to calculate spawning escapement.

Assessment Results

Total Returns and Spawning Escapement

The estimate of total returns to the Buctouche River in 1999 is 244 for large salmon and 115 for small salmon, with respective spawning escapements of 244 and 111 (Table 17). It is estimated that 15, or 13% of small salmon were of hatchery origin, originating from the stocking of fall fingerlings in 1977. If half or more of the 38,867 stocked fish left as 2+ smolts, the survival rate was only 0.007% or less.

Based on fecundity values derived from stock characteristics observed in the current year, large salmon accounted for 96% of the requirement, with total egg deposition estimated at 102% for the system, assuming that all fish spawned in the Buctouche River and its tributaries (Table 18). This is a significant improvement over 1998 (33%), and the first assessed year in seven when the requirement may have been met.

Sources of Uncertainty

Although the trap efficiency was identical for large salmon for the previous two years, it may not have been the same in 1999, especially since this fall had water flows much higher than normal. It is likely that this would lower efficiency (thus raising return estimates) by allowing fish earlier access to freshwater and reducing residence time in the estuary, as has been observed on the Miramichi (Dave Moore, pers. com.). This effect may be minimal for fall runs, where residence time in the estuary is usually brief.

The trap was removed eleven days earlier than the last day used to calculate trap efficiency, thus catches (and return estimates) might have been slightly higher. Again, this effect is expected to have been minimal since run timing for the past six years shows that the peak of estuary catches is over by the end of September, and few fish are caught after October 15.

Trap efficiencies are not consistent for small salmon, consequently the return estimate is less reliable than for large. This is of relatively minor importance to egg deposition, since small salmon have typically contributed only about 1% of total eggs (6% in 1999).

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 electroseining 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/sq. m. 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%. As stated earlier, if the conservation requirement was based on 2.4 eggs/sq. m applied to this smaller area of quality habitat, it would have been exceeded in three of the seven assessed years and only narrowly missed in a fourth.

Ecological Considerations

Water flows in the Buctouche River were abnormally high from late September onward, ensuring access to areas of suitable spawning habitat and deterring efforts at poaching.

Forecast/Prospects

The forecast for the Buctouche in 2000 is the five year mean of total returns, which is 167 (90% CL 114-220) large and 106 (92-120) small salmon. This represents only 60% and 68% respectively of the fish requirements. With all retention fisheries closed there is only a 3% probability that the egg conservation requirement will be met in 2000.

Management Considerations

At the Buctouche Salmon Science workshop, held on 30 November, 1999, the representatives of river and angling associations were greatly concerned by decreasing interest and support from members for restoration and conservation efforts, attributable to the continued closure of the angling season on southeast New Brunswick rivers. Without the incentive offered by angling, associations fear that loss of membership will ultimately result in their collapse, along with future conservation work, collaboration with DFO in assessment projects, etc.

As stated in the Forecast, it is highly unlikely that the egg conservation requirement will be met on the Buctouche in 2000. However, small salmon have typically contributed only about 2% (0-6%) of total egg deposition, and could arguably sustain a very restricted harvest. Egg loss relative to potential harvests of salmon (Fig. 5) shows, for example, that the removal of one large and ten small salmon would result in an egg loss of less than 1%. Although the figure indicates that removals of up to 50 small salmon would result in only a 2% egg loss, such a harvest would be quite excessive (47%) relative to expected returns of 106 fish.

Research Recommendations

1. Operate at least one marking trap in the Buctouche 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. Extend juvenile surveys in southeastern New Brunswick rivers as an index of spawning success and future potential adult returns.

Acknowledgements

We thank Buctouche First Nation for operating the estuary trapnet and collecting relevant data.

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Table 1. First Nation allocation and harvest of Atlantic salmon from the Buctouche R., 1992-99.

	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
1999	0	0	0	4

Table 2. Atlantic salmon angling catch on the Buctouche R., 1984 - 1999. 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	-
1999 (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 1993-99)	
Male proportion of large salmon	0.25
Female proportion of large salmon	0.75
Mean length of large female salmon (cm)	78.9
Eggs per large female (1.4132 x LN(FL) + 2.7560)(Randall MS1985)	7549
Eggs per large salmon (eggs / lg female x lg female proportion)	5661
Male proportion of small salmon	0.89
Female proportion of small salmon	0.11
Mean length of small female salmon (cm)	55.3
Eggs per small female (3.1718 x LN(FL) - 4.5636)(Randall MS1985)	3513
Eggs per small salmon (eggs / sm female x sm female proportion)	386
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)	280
Large females (total large x lg female proportion)	210
Large males (total large - large females)	70
Small males needed (large females - large males)	140
TOTAL SMALL SALMON (sm males needed / sm male proportion)	157
2SW COMPONENT:	
Proportion 2SW (of total large salmon: mean 1992-1999)	0.78
TOTAL 2SW (total large x proportion 2SW)	219

Table 4. Salmon catch by day and standard week at Buctouche R. estuary trapnet, 1999.

	Date	Daily catch	
Std. Week	Mo/Da	Large	Small
35	901	0	0
35	902	1	0
36	903	0	0
36	904	0	0
36	905	0	0
36	906	0	0
36	907	0	0
36	908	0	0
36	909	0	3
37	910	0	1
37	911	0	0
37	912	0	0
37	913	0	0
37	914	0	0
37	915	0	0
37	916	0	1
38	917	0	0
38	918	0	0
38	919	0	0
38	920	0	0
38	921	0	0
38	922	2	1
38	923	2	0
39	924	1	0
39	925	8	10
39	926	4	0
39	927	1	0
39	928	1	0
39	929	2	0
39	930	2	0
40	1001	1	2
40	1002	0	0
40	1003	0	0
40	1004	2	1
40	1005	0	0
40	1006	0	2
40	1007	0	0
41	1008	5	3
41	1009	0	0
41	1010	3	1
41	1011	0	0
41	1012	2	1
41	1013	1	1
41	1014	0	1
42	1015	0	0
42	1016	2	1

	Weekly total		Weekly cumulative total	
Std. Week	Large	Small	Large	Small
35	1	0	1	0
36	0	3	1	3
37	0	2	1	5
38	4	1	5	6
39	19	10	24	16
40	3	5	27	21
41	11	7	38	28
42	2	1	40	29

Standardized weeks

Week	Month	Days
35	August	27-02
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

Table 5. Age distribution of Buctouche R. salmon, 1999. 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	3.2	4.2	5.2.4	Total	smolt age
2	9	9	1	1	1	2	23	34%
3	17	22	1	2	0	0	42	63%
4	2	0	0	0	0	0	2	3%
unknown	1	0	0	0	0	0	1	
Total	29	31	2	3	1	2	68	

Proportion repeat spawners of MSW:	21%
Proportion repeat 1SW of all repeats:	25%
Proportion repeat 1SW of MSW:	5%
Proportion 2SW of MSW:	79%

Table 6. Catch per 15 minute upstream sweep at all electroseining sites, Buctouche R., 1999. w - wild; h - hatchery.

			Salmon											
			Small	Large	Large									
Location	Map Site	Fry	Parr (w)	Parr (h)	Parr (w)	Chub	Dace	Eel	Lamprey	Sculpin	Shiner	Stickleback	Sucker	Trout
Main R. (100 m above Forks)	1	2	12	2	2	12	86	0	3	0	0	0	2	0
Main R. (below Rte. 490)	2	1	8	0	1	14	131	0	0	1	20	2	7	0
South Branch (below Rte. 490)	3	48	31	0	1	21	81	0	0	0	0	2	2	0
Main R. (0.6 km below St. Paul crossroad)	4	15	9	0	0	31	143	0	6	0	0	6	20	0
Upper N. Br. (below Rte. 515)	5	1	19	0	0	19	6	0	2	0	2	17	8	1
Main R. (0.3 km below Johnson Brook)	6	3	16	1	0	40	89	0	0	0	6	1	8	0
Main R. (0.5 km above Coates Mill Bridge	7	2	12	0	3	35	51	0	2	3	0	0	24	0
South Branch (0.2 km above Forks)	8	0	7	0	1	21	101	1	1	1	0	1	17	0
South Branch (3.5 km below Rte. 490)	11	1	16	0	2	14	135	1	1	0	6	1	1	0
Main R. (below Rte. 485)	12	0	13	3	0	24	64	0	3	0	21	32	13	0

Table 7. Densities of juvenile salmonids from closed site electroseining on the Buctouche R., 1999; * variances unreliable due to small catch or negative value.

Location	Map Site	Area (m^2)	No.of Sweeps	Life Stage	Sweep Catch	Pop. Estimate	Variance	Upsweep Catch	Total Estimate	Density /100 sq. m	Mean FL(cm)	PHS
Main R. (100 m above Forks)	1	399	3	Fry	2	2.2	*0.06415	2	4.2	1.1	4.83	0.1
South Branch (below Rte. 490)	3	362	3	Fry	84	85.3	*3.49138	53	138.3	38.2	4.63	3.6
Main R. (100 m above Forks)	1	399	3	Parr	21	22.1	9.30539	17	39.1	9.8	10.27	7.4
South Branch (below Rte. 490)	3	362	3	Parr	43	49.5	*43.6306	35	84.5	23.4	9.27	13.5

Table 8. Catch and density (per 100 sq. m, see text) of assumed wild juvenile salmon per 15 minute upstream sweep, Buctouche R., 1996-99. Shaded values are predicted for spot check sites. Catches and densities of fry in 1998 have an indeterminate hatchery component.

FRY

		Catch/15 min				Observed or predicted density			
Location	Map Site	1996	1997	1998	1999	1996	1997	1998	1999
Main R. (100 m above Forks)	1	9.6	8.0	4.1	1.6	5.0	12.2	4.2	1.1
Main R. (below Rte. 490)	2	3.6	4.3	4.9	0.9	5.1	6.0	13.1	3.1
South Branch (below Rte. 490)	3	5.9	14.6	48.5	47.9	7.2	16.2	47.4	38.2
Main R. (0.6 km below St. Paul crossroad)	4	0.0	6.4	18.4	14.8	2.1	7.8	18.7	14.7
Upper N. Br. (below Rte. 515)	5	0.0	7.4	72.2	0.8	2.1	8.8	67.2	2.9
Main R. (0.3 km below Johnson Brook)	6	2.0	3.2	20.4	2.7	2.6	5.0	20.4	4.6
Main R. (0.5 km above Coates Mill Bridge	7	20.0	6.9	18.4	1.9	20.1	8.3	18.7	3.8
South Branch (0.2 km above Forks)	8	1.5	0.8	2.4	0.0	3.5	2.8	4.3	2.3
South Branch (3.5 km below Rte. 490)	11	17.3	8.7	10.6	1.3	17.7	9.9	11.7	3.3
Main R. (below Rte. 485)	12	0.0	0.8	0.0	0.0	2.1	2.8	2.1	2.3
Mean	Main R.	5.0	5.3	19.8	3.2	5.6	7.3	20.6	4.6
Mean	South Br.	8.2	8.0	20.5	16.4	9.4	9.6	21.1	14.6

PARR

		Catch/15 min				Observed or predicted density			
Location	Map Site	1996	1997	1998	1999	1996	1997	1998	1999
Main R. (100 m above Forks)	1	13.9	7.1	15.7	13.2	5.9	15.2	16.0	9.8
Main R. (below Rte. 490)	2	2.2	1.7	24.6	9.4	4.6	8.0	23.0	11.9
South Branch (below Rte. 490)	3	9.9	10.2	31.1	31.7	26.0	11.1	20.9	23.4
Main R. (0.6 km below St. Paul crossroad)	4	1.6	7.0	4.8	8.5	8.0	10.7	9.6	11.5
Upper N. Br. (below Rte. 515)	5	2.5	1.5	1.8	19.0	8.4	7.9	8.1	16.7
Main R. (0.3 km below Johnson Brook)	6	7.3	4.3	7.1	16.3	8.8	9.3	10.7	15.4
Main R. (0.5 km above Coates Mill Bridge	7	22.8	35.2	32.4	14.8	18.6	24.9	23.5	14.6
South Branch (0.2 km above Forks)	8	7.6	13.8	7.3	7.5	11.0	14.1	10.8	10.9
South Branch (3.5 km below Rte. 490)	11	15.1	13.0	11.5	17.7	14.8	13.7	12.9	16.1
Main R. (below Rte. 485)	12	0.0	0.8	0.0	13.4	7.2	7.6	7.2	13.9
Mean	Main R.	7.2	8.2	12.3	13.5	8.8	11.9	14.0	13.4
Mean	South Br.	10.9	12.3	16.6	19.0	12.3	12.5	15.9	15.2

Table 9. Estimates of egg to fry survival, Buctouche R., 1996-99. 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	1999
Mean fry density	Main R.	5.6	7.3	20.6	6.0	4.6
	South Br.	9.4	9.6	21.1	21.1	14.6
Units of habitat	Main R.	4507	4507	4507	4507	4507
	South Br.	2105	2105	2105	2105	2105
Number of fry	Main R.	25158	32755	93007	27205	20732
	South Br.	19874	20294	44451	44451	30733
Total fry	System	45032	53048	137458	71656	51465
Egg deposition in previous year	System	920460	730020	1115550	1115550	521877
Percent egg to fry survival	System	4.9%	7.3%	12.3%	6.4%	9.9%

Table 10. Catch per 15 minute upstream sweep at Cocagne R. electroseining sites, 1999.

		Salmon									
Location	Site	Fry	Small Parr	Large Parr	Chub	Dace	Eel	Shiner	Stickleback	Sucker	Trout
Cocagne R. (below Poirier Rd. crossing)	1	7	61	1	23	429	1	5	1	94	1
Cocagne R. (200m below Victoria Rd. crossing)	2	1	22	1	48	122	2	22	8	78	0

Table 11. Catch of wild juvenile salmon per 15 min upstream sweep, and predicted density (per 100 sq. m, see text), Cocagne R., 1999.

FRY

		Catch/15 min	Predicted density
Location	Site	1999	1999
Cocagne R. (below Poirier Rd. crossing)	1	7.0	8.1
Cocagne R. (200m below Victoria Rd. crossing)	2	1.0	3.1

PARR

		Catch/15 min	Predicted density
Location	Site	1999	1999
Cocagne R. (below Poirier Rd. crossing)	1	61.7	38.2
Cocagne R. (200m below Victoria Rd. crossing)	2	22.7	18.6

Table 12. Catch per 15 minute upstream sweep at Richibucto R. and Coal Branch electroseining sites, 1999.

		Salmon											
Location	Site	Fry	Small Parr	Large Parr	Chub	Dace	Eel	Lamprey	Sculpin	Shiner	Stickleback	Sucker	Trout
Coal Branch (below Beersville crossing)	C2	2	8	1	8	168	0	0	14	0	0	5	1
Coal Branch (below Rte. 465)	C3	6	10	0	27	189	0	0	0	0	3	2	0
Richibucto R. (below Rte. 126)	R1	24	8	0	5	115	1	9	5	11	2	12	0
Richibucto R. (above Rte. 116)	R2	62	13	2	15	295	0	1	0	4	0	33	0

Table 13. Catch of wild juvenile salmon per 15 min upstream sweep, and predicted density (per 100 sq. m, see text), Richibucto R. and Coal Branch, 1997-99.

FRY

		Catch/15 min			Predicted density		
Location	Site	1997	1998	1999	1997	1998	1999
Coal Branch (hd. tide above Fords Mills)	C1	5.7	-	-	7.4	-	-
Coal Branch (below Beersville xing)	C2	4.4	3.6	2.2	6.2	5.4	4.1
Coal Branch (below Rte. 465)	C3	-	-	6.1	-	-	7.4
Coal Branch (South Forks, below Rte. 465)	C5	3.7	0.0	-	5.5	2.1	-
Richibucto R. (below Rte. 126)	R1	10.8	15.9	24.3	12.1	16.9	22.6
Richibucto R. (above Rte. 116)	R2	10.5	12.6	61.6	11.9	13.8	53.9
Mean	Coal Br.	4.6	1.8	4.2	6.4	3.7	5.8
Mean	Rich. R	10.7	14.3	43.0	12.0	15.4	38.3

PARR

		Catch/15 min			Predicted density		
Coal Branch (hd. tide above Fords Mills)	C1	14.6	-	-	14.5	-	-
Coal Branch (below Beersville xing)	C2	6.7	6.3	8.6	10.5	10.3	11.5
Coal Branch (below Rte. 465)	C3	-	-	10.1	-	-	12.3
Coal Branch (South Forks, below Rte. 465)	C5	8.4	17.4	-	11.4	15.9	-
Richibucto R. (below Rte. 126)	R1	11.4	11.1	8.1	12.9	12.8	11.3
Richibucto R. (above Rte. 116)	R2	33.2	11.7	15.1	23.9	13.0	14.8
Mean	Coal Br.	9.9	11.8	9.4	12.1	13.1	11.9
Mean	Rich. R	22.3	11.4	11.6	18.4	12.9	13.0

Table 14. Catch per 15 minute upstream sweep at Kouchibouguac R. electroseining sites, 1999.

Location	Site	Salmon			Dace	Eel	Lamprey	Sculpin	Stickleback	Sucker	Trout
		Fry	Small Parr	Large Parr							
Kouchibouguac R. (300m below Rte. 480 crossing)	1	69	44	1	26	1	3	2	1	0	8
Kouchibouguac R. (400m below Desherbiers Rd. crossing)	2	50	54	2	173	0	0	0	0	8	4

Table 15. Catch of wild juvenile salmon per 15 min upstream sweep, and predicted density (per 100 sq. m, see text), Kouchibouguac R., 1999.

FRY

Location	Site	Catch/15 min	Predicted density
		1999	1999
Kouchibouguac R. (300m below Rte. 480 crossing)	1	69.3	60.3
Kouchibouguac R. (400m below Desherbiers Rd. crossing)	2	49.7	43.9

PARR

Location	Site	Catch/15 min	Predicted density
		1999	1999
Kouchibouguac R. (300m below Rte. 480 crossing)	1	44.9	29.8
Kouchibouguac R. (400m below Desherbiers Rd. crossing)	2	55.5	35.1

Table 16. Density of juvenile salmon observed on the Kouchibouguac R., 1977-82. The specific location of sites is not known.

FRY

Location	Site	1977	1978	1982
Kouchibouguac R.	470	8.8	-	-
Kouchibouguac R.	471	-	-	-
Kouchibouguac R.	472	9.9	147.9	-
Kouchibouguac R.	473	3.8	186.6	1.9
McInnis Br.	480	5.8	29.1	1.2
Tweedie Br.	490	45.4	101.6	28.3

PARR

Kouchibouguac R.	470	21	-	-
Kouchibouguac R.	471	8.9	-	-
Kouchibouguac R.	472	9.7	9	-
Kouchibouguac R.	473	4.8	3.2	3.1
McInnis Br.	480	6.4	5.7	4.2
Tweedie Br.	490	22.1	27.4	11.2

Table 17. Total returns and spawning escapement of large and small salmon to the Buctouche R., 1999.

	Large Salmon	Small Salmon
Trap efficiency	0.16	0.26
Catch (wild)	39	26
Catch (hatchery)	0	4
Returns (wild)	244	100
Returns (hatchery)	0	15
Total Returns	244	115
Removals	0	4
Spawning Escapement	244	111

Table 18. Calculation of percent conservation requirement achieved, Buctouche R., 1999.

Stock characteristics - current year	
Male proportion of large salmon	0.15
Female proportion of large salmon	0.85
Mean length of large female salmon (cm)	77.6
Eggs per large female (1.4132 x LN(FL) + 2.7560)(Randall 1985)	7373
Eggs per large salmon (eggs / female x % female)	6267
Male proportion of small salmon	0.79
Female proportion of small salmon	0.21
Mean length of small female salmon (cm)	58.3
Eggs per small female (3.1718 x LN(FL) - 4.5636)(Randall 1985)	4153
Eggs per small salmon (eggs / female x % female)	872
Calculation of % conservation met	
Egg conservation requirement	1587000
Large salmon spawning escapement	244
Total large salmon eggs	1529245
% requirement met by large salmon	96
Small salmon spawning escapement	111
Total small salmon eggs	96815
% requirement met by small salmon	6
% requirement met by all salmon	102

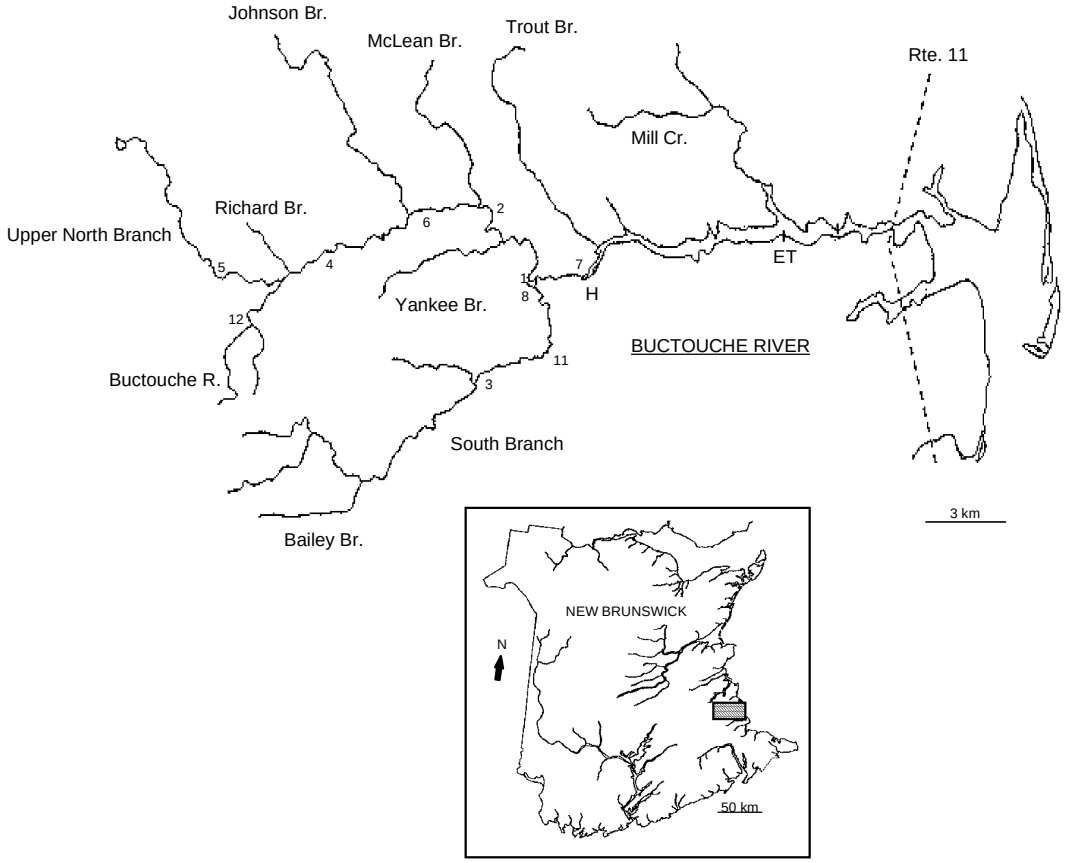

Figure 1. Location of estuary trap (ET), head of tide (H), and electroseining sites (numbered) on the Buctouche R., 1999.

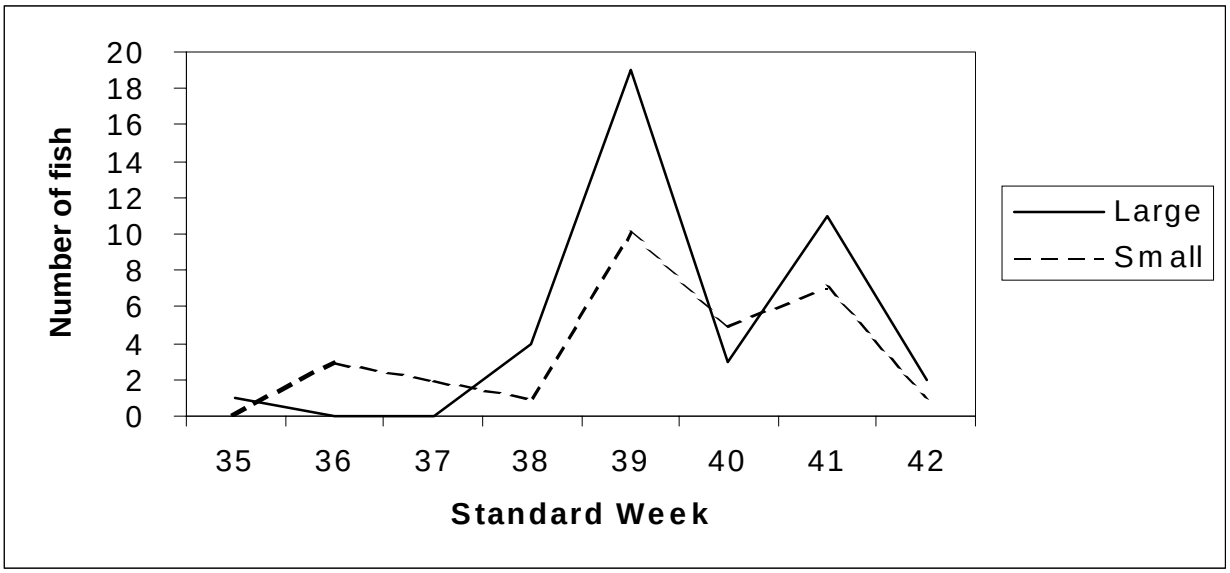

Figure 2. Salmon catches by standard week in the estuary trap, Buctouche R., 1999.

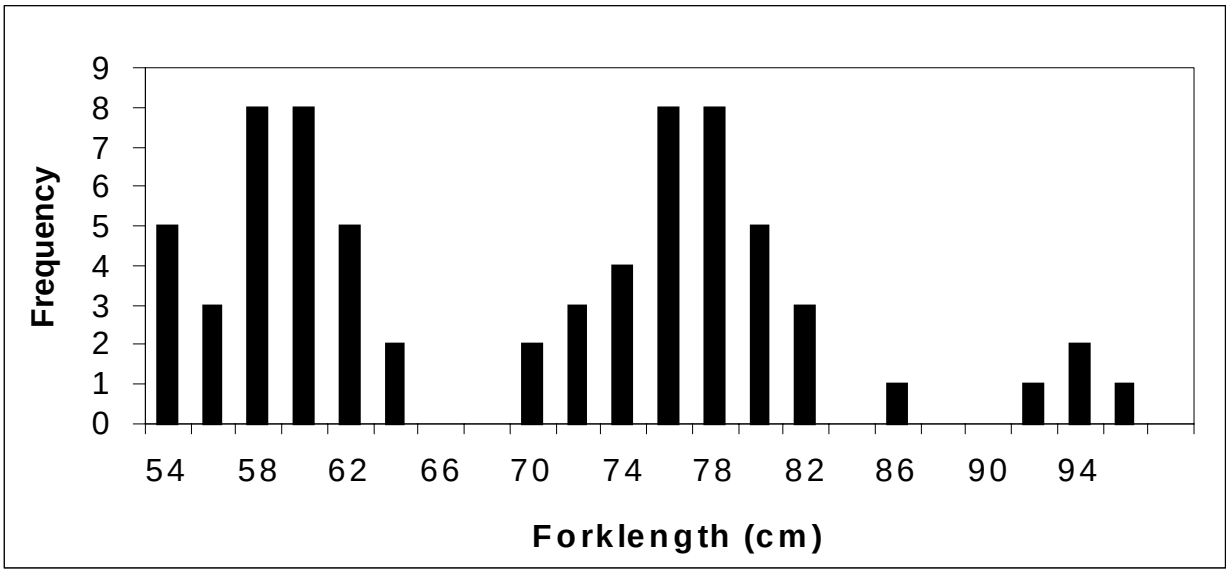

Figure 3. Length frequencies of salmon caught in the estuary trap, Buctouche R., 1999. Recaptures have been excluded (N=69).

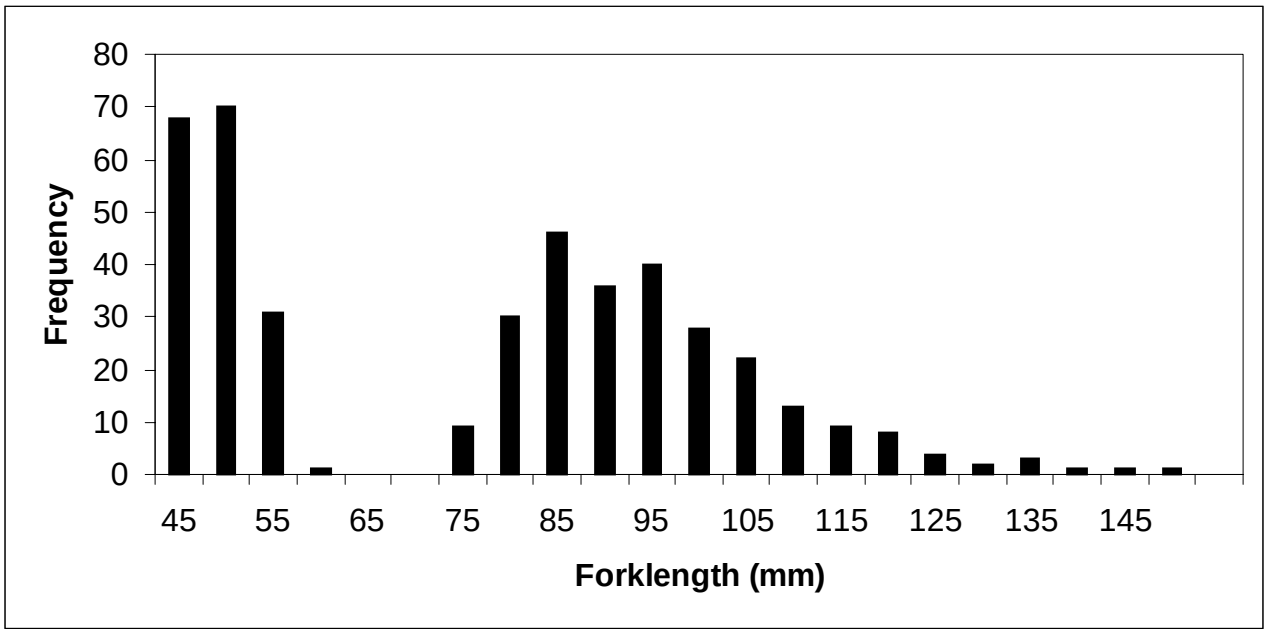

Figure 4. Length frequencies of juvenile Atlantic salmon caught at electroseining sites on the Buctouche R., 1999 (N=423).

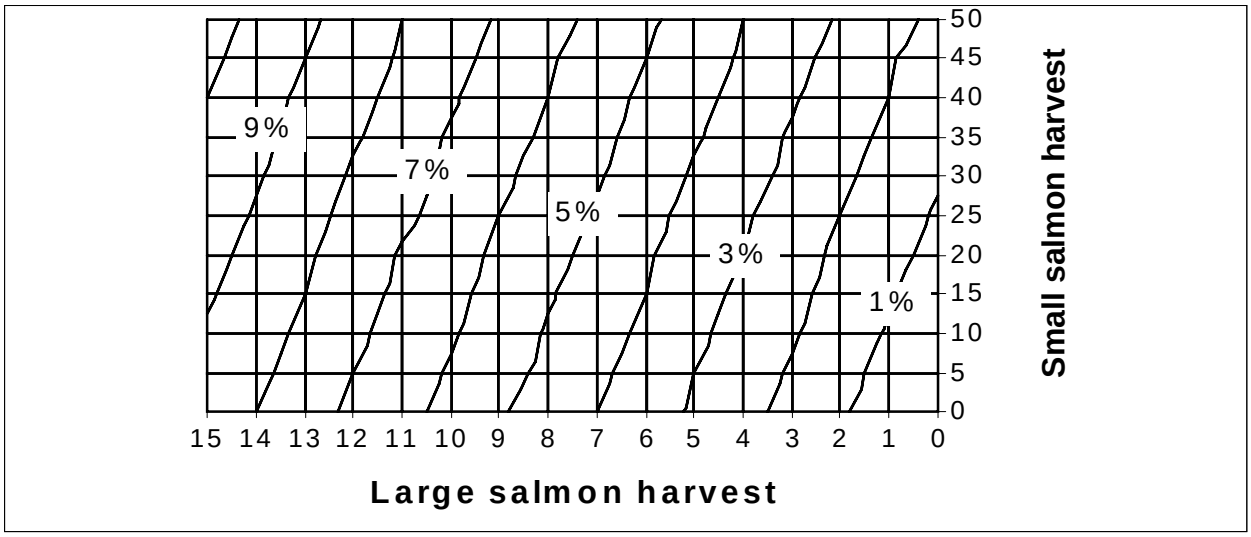

Figure 5. Percent egg loss relative to potential harvests of large and small salmon for the Buctouche River.