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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 2000

by

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Abstract

Due to egg depositions well below the conservation requirement in most years, all harvesting of Atlantic salmon on the Buctouche River was proscribed as of 1998. Nonetheless, in 2000 ten small salmon were retained for food by Buctouche First Nation. Salmon returns in 2000 were calculated from the catches and calculated efficiency of an estuary trapnet operated by Buctouche First Nation. Total large salmon returns were estimated at 100 and total small salmon returns at 38, with respective spawning escapements of 100 and 28. Total egg deposition was estimated at 36% of the conservation requirement, which is 26% below the previous five year average. Salmon fry densities on the Buctouche and four other rivers in southeastern New Brunswick generally exceeded the Elson norm of 29 per unit, indicating that spawning escapement was unusually high in the area in 1999 and confirming that year's assessment of high returns to the Buctouche. The forecast for the Buctouche in 2001 is the five year mean of total returns, which is 156 (90% CL 95-217) large and 94 (61-127) small salmon. This is well below the conservation requirement, and with all retention fisheries closed there is only a 4% probability that the egg requirement will be met in 2001. However, since small salmon typically contribute only 2% of all eggs, they could arguably sustain a restricted fishery with minimum impact on egg deposition.

Résumé

Étant donné que la ponte a été très inférieure aux impératifs de conservation, toute capture de saumon atlantique dans la rivière Bouctouche a été interdite à compter de 1998. Néanmoins, la Première Nation de Bouctouche a retenu dix petits saumons au chapitre d'une pêche de subsistance. Le retour des saumons en 2000 a été calculé à partir des captures et en fonction du degré d'efficacité calculé d'un filet-trappe d'estuaire exploité par la Première Nation de Bouctouche. On a évalué à 100 le nombre total de gros saumons en montaison et à 38 le nombre de petits saumons en montaison. Quant au nombre de saumons ayant atteint les frayères, il est évalué à 100 et 28 respectivement. La ponte globale a été évaluée à 36 % de l'objectif propre à assurer la conservation des stocks, ce qui est de 26 % inférieur à la moyenne des cinq années antérieures. La densité des alevins dans la rivière Bouctouche et dans quatre autres rivières du Sud-Est du Nouveau-Brunswick a en règle générale dépassé la norme Elson, qui est de 29 par unité, ce qui indique que l'échappée des géniteurs aux frayères a été exceptionnellement élevée dans le secteur en 1999, confirmant ainsi l'évaluation de 1999 qui faisait état d'une remonte élevée dans la rivière Bouctouche. Les prévisions visant la rivière Bouctouche pour 2001 correspondent à la moyenne des montaisons globales des cinq dernières années, soit de 156 (90 %, LC de 95-217) gros saumons et de 94 (LC de 61-127) petits saumons. Voilà qui est bien en deçà des impératifs de conservation, et malgré la fermeture de toute pêche normale (avec retenue des captures), la probabilité que l'objectif de ponte soit atteint en 2001 est de 4 %. Cependant, étant donné que les petits saumons ne contribuent généralement que 2 % de tous les œufs produits, il est permis de croire qu'ils pourraient soutenir une pêche limitée qui n'aurait qu'une incidence minime sur la ponte.

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SUMMARY SHEET

STOCK: Buctouche River (SFA 16)

	1995	1996	1997	1998	1999	2000	MIN[1]	MAX[1]	MEAN[1]
Angling catch									
Large (Released)	0	na (21)	9 (6)	0	0	0			
Small (Rel + Kept)	33	na (21)	9 (5)	0	0	0			
Aboriginal Community Harvest									
Large	0	4	5	0	0	0	0	5	2
Small	15	25	25	0	4	10	0	25	14
Broodstock removals									
Large	7	5	4	0	0	0	0	7	3
Small	8	5	1	0	0	0	0	8	3
Other known removals (mort. etc.)									
Large	0	0	0	1	0	0	0	1	0
Small	0	0	0	1	0	0	0	1	0
Total returns									
Large	154	134	200	102	244	100	102	244	167
Small	98	127	97	92	115	38	92	127	106
Spawning escapement									
Large	147	124	191	101	244	100	101	244	161
Small	67	78	67	91	111	28	67	111	83
% Egg Requirement met									
Large	55	45	69	33	96	36	33	96	60
All spawners	58	46	70	33	102	36	33	102	62

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

CONSERVATION REQUIREMENT: 1.587 million eggs (280 large salmon, 157 small salmon)

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: Although there has been no allocation of salmon as of 1998, in 2000 Buctouche First Nation retained ten small salmon from an estuary trapnet for food.

Data and assessment: Catches at, and calculated efficiency of a trapnet operated in the estuary by Buctouche First Nation were used to estimate total returns of large salmon at 100 and small salmon at 38. Subtracting known removals, spawning escapements were 100 and 28 respectively.

State of the stock: Total egg deposition from large and small salmon was estimated at only 36% of the conservation requirement, a level 26% below the previous five year average. In five of six rivers surveyed for juveniles, high fry densities, generally exceeding the Elson norm of 29 per unit, indicated substantial adult returns to most southeast NB rivers in 1999.

Forecast for 2001: The forecast for the Buctouche in 2001 is the five year mean of total returns, which is 156 (90% CL 95-217) large and 94 (61-127) small salmon. This would result in only about 56% of the required egg deposition.

Management Considerations: With all retention fisheries closed there is only a 4% probability that the egg conservation requirement will be met in 2001. However, small salmon have typically contributed only about 2% of total egg deposition and could arguably sustain a restricted fishery.

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). It is a small, shallow, low gradient system with no man-made barriers to ascending fish. A spawning run of wild Atlantic salmon, composed of approximately two thirds multi-sea-winter fish, enters the river during September and October. In the past, Buctouche salmon were exploited in a commercial fishery, for food by Buctouche First Nation, and by recreational anglers. Commercial harvesting of Atlantic salmon ceased in 1984, and as of 1998, all harvesting was curtailed due to persistently low returns. The status of the Buctouche stock, with additional information on juvenile densities from other rivers in the area, is used as an index to regulate the utilization of the salmon resource in southeastern New Brunswick rivers.

Adult returns have been assessed yearly since 1993, 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, Atkinson *et al*. 2000). 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. Since 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 2000 have been included for the Buctouche, Cocagne, Richibucto/Coal Branch, Kouchibouguac and Kouchibouguacis rivers.

Description of Fisheries

Commercial

Commercial harvesting of Atlantic salmon ceased as of 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 in 2000, despite which ten 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) could 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, and is usually later entering the river.

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). Since the angling season remained closed in 2000, there was no catch.

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 2000 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. 2). 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 61 m (200'), extending from shore into a door in the middle of the long side of the box, was made from 14 cm (5.5") mesh polypropylene. The trap was configured to fish in an upstream direction. Large 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. Despite having no allocation of salmon, it was reported that all small salmon were retained for food. Daily catches and other pertinent information relative to small salmon was not recorded: as of October 14 a cumulative total of ten was reported, after which none was caught in the trapnet.

The trap was operated from September 16 to November 3. Timing of the run to the estuary peaked for large salmon during Week 39 (Sep. 24-30) (Fig.3), which was the same as in 1999 (Atkinson *et al*. 2000).

Total reported captures were 16 large salmon (Table 4). Relative to 1999, the catch at this site for approximately the same period was only about one third.

Biological Characteristics

Of the 16 large salmon caught, one was a male and the rest female, the latter having a mean length of 78.8 cm. The large salmon proportion of the trap catch was 62%. Age determinations from samples taken in 2000 show that of known-age fish, 2 and 3 year smolts respectively comprised 63% and 38% of the sample. Of the multi-sea-winter (MSW) component, 69% were maiden two-sea-winter (2SW) fish and 31% were repeat spawners. There were no repeat spawning one-sea-winter (1SW) fish (Table 5). Four of the sixteen fish caught were returns from fall fingerlings stocked in 1996. These were all females which had left the river as age 2+ smolts and spent two winters at sea. Biological characteristics for the Buctouche demonstrate expected annual variation, but no trends have been observed in the time series. Unexpected excursions from the mean are usually noted.

Juvenile Electroseining Survey

Buctouche River

In August of 2000, 10 sites were electroseined on the Buctouche River (Fig. 2). 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 (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 (1958) procedure, then the initial upstream sweep catch was added before calculating density (# per unit = 100 sq. m). An exception to this was parr density at site 1, which was calculated from four sweeps (upstream plus downstream) due to low numbers caught. Percent Habitat Saturation (PHS) values were derived for juvenile salmon 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 on CPUE (900 seconds, or 15 minutes) for all closed sites available. The regression is updated annually as additional sites are accumulated in the data set. For the current year, updated regressions are as follows: fry density = 15 min. catch x 0.9605 + 0.135 ($N=13$, $R^2=0.94$, $P<0.0001$), and parr density = 15 min. catch x 0.5878 + 6.616 ($N=9$, $R^2=0.68$, $P=0.0061$). In all cases, parr age classes have been combined for calculating density.

Results of electroseining on the Buctouche River in 2000 are presented as CPUE for all species (Table 6), juvenile salmon density at closed sites (Table 7), and yearly (1996-00) comparisons of density (Table 8). Juvenile length frequencies for Buctouche and other rivers sampled are shown in Figure 4.

With the exception of sites 5 and 12, which were likely inaccessible due to beaver dams, densities of fry were considerably higher than in 1999, ranging from 23.8 to 149.5/unit. Mean density at main river sites rose from 4.6 to 28/unit, a five–fold increase. On the South Branch, mean fry density showed a similar four–fold increase, from 14.6 to 79.4/unit (Table 8). This was expected in view of the fact that for the first time in seven assessed years, returns in 1999 were estimated to have achieved 102% of the spawning requirement (Atkinson *et al*. 2000). Despite unusually high fry numbers, growth rate was not reduced, as mean length at sites 3 and 4 was significantly greater than in 1999, probably due to less critically high temperatures in the summer of 2000. These were the only two sites where significant numbers of fry occurred in both years, one each on the main river and South Branch. Parr densities ranged from 3.4 to 29.2/unit, with means for the main river and South Branch of 9.3 and 13, showing respective declines of 31% and 15%. This in part probably reflects the low fry numbers in 1999. Total PHS values ranged from 7.5 to 38.2, with main river and South Branch means of 12.4 and 16.7, respectively. Except for site 3 on South Branch (38.2), PHS levels are low relative to the optimum value of 27, due mainly to the lack of parr.

Fry densities in 2000 were higher than Elson's (1967) "normal" value of 29/unit at six of the ten sites, including all three on South Branch. Very low densities (0.0, 3.9) at sites 5 and 12 can be attributed to inaccessibility due to beaver dams. This supports the relatively high estimate of egg deposition achieved in 1999. Parr densities, as expected, were well below the "normal" 38/unit at all sites. Estimates of egg to fry survival rates (1996-2000) were calculated by multiplying mean density by the total units of habitat and dividing by the egg deposition in the previous year (Table 9). As only 63% of the total habitat surveyed is considered fair to good quality (DNRE database), and since electroseining is usually conducted in higher quality habitat (riffle and run), these survival rates as calculated are probably too high, but may serve as a useful relative index. For 2000 this rate is 18%, which is the highest observed to date and more than double the average of previous years. This implies that either survival conditions were much more favorable during the winter of 1999 – 2000, or egg deposition was twice what was estimated. Symons (1979) considers 9% to be a low, and 13% a medium, survival rate, 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. If it is assumed that the estimate of egg deposition in 1999 was reasonable, and mean fry densities are applied to only the 63% of good habitat, the resultant estimate of survival is 11.4%. By the same argument, previously calculated rates would range downward from this to a low of 2.5%. Thus in most years, low egg to fry survival would appear to be a constraint on the Buctouche. Certainly, quality spawning and rearing habitat is very limited, where on average 59% of the substrate in "good" 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 approached or exceeded in three of the seven "low" years. 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 generally inadequate to achieve the conservation requirement as currently defined. The relationship between eggs deposited in one year and mean fry density the following year suggests that fry density shows a relative response when egg depositions exceed about 1.5 per sq. m (Fig. 5). As is apparent from the 1999 –2000 season, the system has the capacity to respond to higher egg depositions than have occurred in recent years.

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. More specifically, the generally depressed nature of the stock has resulted in the curtailment of salmon fisheries on all these rivers, as of 1998. As an indication of the validity of this application, spot check electroseinng was conducted at two sites each on Cocagne, Kouchibouguacis, Richibucto and Coal Branch rivers, and five sites on the Kouchibouguac River to monitor juvenile salmon abundance in general, and fry levels in particular. 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 known to be similar to those of Buctouche, and the other rivers are not expected to differ significantly. Juvenile densities have been predicted as described above for the Buctouche River.

Cocagne River

Catch per unit effort for all species is presented in Table 10, density (1999, 2000) for salmon juveniles in Table 11. Fry densities at the two sites sampled (108.8, 26.6) increased an average of eleven–fold relative to 1999, indicating a significant improvement in spawning success in 2000. Parr densities (16.7, 10.5) were about half what was seen the previous year. This was expected since fry levels in 1999 were extremely low. PHS at site 1 (32.2) was near optimum due to an overabundance of fry.

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, density (1997-2000) for salmon juveniles in Table 13. Fry densities on the Richibucto (31.8, 84.8) in 2000 were the highest in recent years, showing an average increase of 52% over 1999. Parr densities (7.1, 13.9) were down 19%. PHS at site R2 (22.3) was near optimum, but again due to a high density of fry.

Adult salmon returns to the Richibucto have been assessed previously (Atkinson and Claytor MS1994, Atkinson *et al*. MS1995, Atkinson and Cormier MS1998) and did not achieve the conservation requirement in those years.

Coal Branch enters the estuary immediately adjacent to the main Richibucto. Fry densities (44.8, 20.8) were nearly five–fold greater than 1999, while parr (7.8, 7.6) declined by 35%.

Kouchibouguacis River

Catches of all species and salmon densities are shown in Tables 14 and 15. This river was sampled for the first time in 2000, indicating low densities of both fry (7.3, 4.4) and parr (11, 13.4) at the two sites visited.

Kouchibouguac River

Catches of all species and salmon densities (1999, 2000) are given in Tables 16 and 17. Three additional sites were done in 2000, since it appeared from the results at two sites in 1999 that the Kouchibouguac may be an exception to the generally impoverished state of juveniles in most of the other rivers under consideration. Except for site 5 which may have been inaccessible due to beaver dams, fry densities ranged from 45.5 to 74.7. Considering only the two sites common to both years, the mean fry density increased by 19%. The mean for all sites in 2000 was 6% below the 1999 average. Parr densities (14.6 to 32.3) dropped an average of 9% for the two common sites, 26% using all sites in 2000. Nonetheless, these remain nearly double that seen on other rivers. PHS values at sites 1 and 2 (30.6, 22.9) were near optimum, the others well below.

Discussion

With the exception of the Kouchibouguacis (sampled only in 2000) and the Kouchibouguac (no change), all rivers showed substantial improvement over 1999 in mean fry density for sites common to both years (Table 18, Fig. 6). Increases ranged from 19% to 1101%, with mean fry densities between 28 and 79 per unit. Apart from the Kouchibouguacis, with an average density of only six, mean fry levels on all rivers in 2000 were near or well in excess of Elson's "normal" value of 29. The implication of having at least "normal" density, and assuming a medium egg to fry survival rate of 12%, is that egg deposition the previous fall was approximately 2.4 per square meter (240/unit); that is, that the conservation requirement was met in all these rivers except the Kouchibouguacis. Since the number of sites was only two on rivers other than the Buctouche and Kouchibouguac, it is undoubtedly too optimistic to assume that the real average density throughout the various watersheds was 29 or greater. However, the Buctouche provides at least partial confirmation in that it was estimated to have achieved the conservation requirement in 1999 (Atkinson *et al*. 2000), and has at least the expected number of fry at most individual sites, and on average. Mean parr densities in 2000 declined on all rivers by 6% to 52%, relative to sites sampled in both years. This was expected on the Buctouche, Cocagne and Coal Branch where fry levels were low or dropped substantially in 1999, but was surprising for Richibucto where fry in 1999 were double the previous year's level. The decline was slight (6%) on the Kouchibouguac which had abundant fry in 1999.

Electroseining data previously presented for these small southeastern New Brunswick rivers imply that numbers of salmon returning to a given river are highly variable from year to year, and that relative abundance is not normally synchronous among all rivers. In most years the conservation requirement as currently defined is probably not met, and if or when it will be is unpredictable. Results in 2000, while not refuting this thesis, were exceptional in that all but one river appear to have had sufficient, or at least significant, numbers of spawners in 1999 as inferred from juvenile surveys. For two consecutive years this has been the case on Kouchibouguac and Richibucto, but not elsewhere. Certainly, all previous assessments of adult returns to the Buctouche would not have indicated, in themselves, large returns in 1999. The status of the Buctouche stock, as observed over the eight assessed years 1993-2000, is probably characteristic of most rivers in the area and provides a valid qualitative index on which to base the management of the salmon resource on these rivers. However, assessed returns to the Buctouche in any given year are probably

not a reliable indication of concurrent returns to other rivers. This can only be elucidated the following year by monitoring the juveniles. Despite generally depressed stocks, these rivers demonstrate a capacity for recovery in producing more juveniles in response to increased egg depositions.

Estimation of Stock Parameters

Returns of large and small salmon past the estuary trap were calculated by dividing trap catches in 2001 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 in those two years. 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 2000 for the period in question was 4 large hatchery, 12 large wild salmon, and 10 small wild salmon.

Returns past the trap were calculated by dividing trap catches by the respective efficiencies for large and small 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 2000 there were no known removals prior to interception, and 10 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 are not 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 2000 is 100 for large salmon and 38 for small salmon, with respective spawning escapements of 100 and 28 (Table 19). It is estimated that 25, or 25% of large salmon were of hatchery origin, originating from the stocking of fall fingerlings in 1996.

Since small salmon weren't sampled and the sample size for large salmon was too small to obtain a reliable male:female ratio, average stock characteristics as detailed in Table 3, and mean length of large female salmon in the current year, were used to calculate fecundity values. Based on these, total egg deposition was estimated at only 36% of the conservation requirement for the Buctouche River in 2000 (Table 20). This is 66% lower than in 1999 (102%), and 26% below the previous five year mean (62%).

It is worth noting that although total estimated returns to date (15 small salmon in 1999, 25 large in 2000) from the stocking of 38,867 fingerlings in 1996 is only 0.1% of the total, the egg contribution from the returning large fish in 2000 was a substantial 25%.

Sources of Uncertainty

Trap efficiencies were 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 2% of the total.

Trap efficiencies may vary from year to year due to variables such as changes in the river channel and volume of freshwater flow.

The trap catch may have been increased by several fish if it had been operating as of 10 September, the starting date from which efficiencies were calculated. Returns may thus be slightly underestimated.

Several brooks 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 it 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.

Ecological Considerations

Water flows in the Buctouche were generally adequate for fish to ascend the river during September and October. As a result of prolonged rain beginning at the end of October, water levels were abnormally high throughout the late fall, ensuring access to areas of suitable spawning habitat and deterring efforts at poaching.

Forecast/Prospects

The forecast for the Buctouche in 2001 is the five year (1996-2000) mean of total returns, which is 156 (90% CL 95-217) large and 94 (61-127) small salmon. This represents only 56% and 60% respectively of the fish requirements. With all retention fisheries closed there is only a 4% probability that the egg conservation requirement will be met in 2001.

Management Considerations

Representatives of river and angling associations have repeatedly expressed concern over 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 2001. However, small salmon have typically contributed only about 2% (0-6%) of total egg deposition, and could arguably sustain a very restricted harvest. For example, in a good year, hook-and-release mortalities in a non-retention angling fishery would not likely exceed one large and two small salmon (3% of maximum catches, as per Table 2). Egg loss relative to potential harvests of salmon (Fig. 7) shows that such a fishery would result in the loss of fewer than 1% of all eggs. The removal of one large and twelve small salmon would result in an egg loss of only 1%. Although the figure indicates that removals of up to 50 small salmon would result in only a 2% egg loss, such a harvest could seriously unbalance appropriate sex ratios if only 94 small salmon are expected in 2001.

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. Continue juvenile surveys in southeastern New Brunswick rivers as an index of spawning success and future potential adult returns.

Acknowledgements

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Table 1. First Nation allocation and harvest of Atlantic salmon from the Buctouche R., 1992-2000.

	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
2000	0	0	0	10

Table 2. Atlantic salmon angling catch on the Buctouche R., 1984 - 2000. 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	-
2000 (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, 2000. *Daily catches of small salmon were not recorded: as of October 14 a cumulative total of ten was reported, after which none was caught in the trapnet.

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

	Weekly total		Weekly cumulative total	
Std. Week	Large	Small	Large	Small
37	0	-	0	-
38	2	-	2	-
39	9	-	11	-
40	1	-	12	-
41	3	-	15	10*
42	0	0	15	10*
43	1	0	16	10*
44	0	0	16	10*

Standardized weeks

Std. Week	Month	Days
37	Sep	10-16
38	Sep	17-23
39	Sep	24-30
40	Oct	01-07
41	Oct	08-14
42	Oct	15-21
43	Oct	22-28
44	Nov	29-04

Table 5. Age distribution of MSW salmon, Buctouche R , 2000. 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	2SW	3.2	4.2.3	6.2.4	Total	smolt age
2	8	1	0	1	10	63%
3	3	2	1	0	6	38%
Total	11	3	1	1	16	

Proportion repeat spawners of MSW:	31%
Proportion repeat 1SW of all repeats:	0%
Proportion repeat 1SW of MSW:	0%
Proportion 2SW of MSW:	69%

Table 6. Catch per 15 minute upstream sweep at all electroseining sites, Buctouche R., 2000

		Salmon												
Location	Site	Fry	Small parr	Large parr	Catfish	Chub	Dace	Eel	Lamprey	Sculpin	Shiner	Stickle-back	Sucker	Trout
Main R. (100 m above Forks)	1	96	2	3	0	6	83	1	0	0	0	1	0	0
Main R. (below Rte. 490)	2	19	1	0	0	7	103	0	0	1	4	3	3	0
South Branch (below Rte. 490)	3	133	24	2	0	0	37	0	1	0	0	0	0	0
Main R. (0.6 km below St. Paul crossroad)	4	50	4	0	0	2	52	1	1	0	0	1	1	0
Upper N. Br (below Rte. 515)	5	0	5	2	1	20	15	0	3	0	0	26	4	2
Main R. (0.3 km below Johnson Brook)	6	25	10	2	0	2	66	0	2	0	0	1	0	0
Main R. (0.5 km above Coates Mill Bridge	7	37	7	3	0	9	36	2	0	3	0	1	6	0
South Branch (0.2 km above Forks)	8	52	1	2	0	24	53	0	1	0	0	2	5	0
South Branch (3.5 km below Rte. 490)	11	40	3	1	0	3	39	1	0	0	0	1	0	2
Main R. (below Rte. 485)	12	4	2	1	0	12	55	0	1	0	4	8	10	0

Table 7. Density (#/100 sq. m, see text) of juvenile salmon from closed site electroseining on the Buctouche R., 2000. Parr density at site 1 was calculated using all sweeps in the Zippin method (see text).

Location	Site	Area (m2)	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	396	3	Fry	143	165.3	118.0996	96	261.3	66.1	5.51	9.8
South Branch (below Rte. 490)	3	317	3	Fry	246	302.9	405.6005	171	473.9	149.5	5.25	19.6
Main R. (100 m above Forks)	1	396	4	Parr	10	13.7	unreliable	-	13.7	3.4	12.58	4.3
South Branch (below Rte. 490)	3	317	3	Parr	25	59.7	unreliable	33	92.7	29.2	9.63	18.6

Table 8. Density (#/100 sq. m) of juvenile salmon, Buctouche R., 1996-2000. Shaded values are predicted for spot check sites (see text). Fry densities in 1998 have an indeterminate hatchery component: means (*) have been adjusted to represent wild fry, assuming a 50% survival rate of stocked fish. Percent habitat saturation (PHS) values given for current year only.

		FRY					PARR					Total PHS
Location	Site	1996	1997	1998	1999	2000	1996	1997	1998	1999	2000	2000
Main R. (100 m above Forks)	1	5.0	12.2	4.2	1.1	66.1	5.9	15.2	16.0	9.8	3.4	14.2
Main R. (below Rte. 490)	2	5.1	6.0	13.1	3.1	18.0	4.6	8.0	23.0	11.9	7.2	8.1
South Branch (below Rte. 490)	3	7.2	16.2	47.4	38.2	149.5	26.0	11.1	20.9	23.4	29.2	38.2
Main R. (0.6 km below St. Paul crossroad)	4	2.1	7.8	18.7	14.7	48.4	8.0	10.7	9.6	11.5	8.8	13.8
Upper N. Br. (below Rte. 515)	5	2.1	8.8	67.2	2.9	0.0	8.4	7.9	8.1	16.7	11.1	11.8
Main R. (0.3 km below Johnson Brook)	6	2.6	5.0	20.4	4.6	23.8	8.8	9.3	10.7	15.4	13.4	13.1
Main R. (0.5 km above Coates Mill Bridge	7	20.1	8.3	18.7	3.8	35.6	18.6	24.9	23.5	14.6	12.5	18.5
South Branch (0.2 km above Forks)	8	3.5	2.8	4.3	2.3	49.9	11.0	14.1	10.8	10.9	8.0	14.4
South Branch (3.5 km below Rte. 490)	11	17.7	9.9	11.7	3.3	38.9	14.8	13.7	12.9	16.1	8.6	12.8
Main R. (below Rte. 485)	12	2.1	2.8	2.1	2.3	3.9	7.2	7.6	7.2	13.9	8.3	7.5
Mean	Main R.	5.6	7.3	13.3*	4.6	28.0	8.8	11.9	14.0	13.4	9.3	12.4
Mean	South Br.	9.4	9.6	21.1	14.6	79.4	12.3	12.5	15.9	15.2	13.0	16.7
Mean	All sites	6.7	8.0	15.6*	7.6	43.4	11.3	12.3	14.3	14.4	11.1	15.2

Table 9. Estimates of egg to fry survival, Buctouche R., 1996-2000.

		1996	1997	1998	1999	2000
Mean fry density	Main R.	5.6	7.3	13.3	4.6	28.0
	South Br.	9.4	9.6	21.1	14.6	79.4
Units of habitat	Main R.	4507	4507	4507	4507	4507
	South Br.	2105	2105	2105	2105	2105
Number of fry	Main R.	25158	32755	59943	20732	126191
	South Br.	19874	20294	44451	30733	167200
Total fry	System	45032	53048	104394	51465	293391
Egg deposition in previous year	System	920460	730020	1115550	521877	1626060
Percent egg to fry survival	System	4.9%	7.3%	9.4%	9.9%	18.0%

Table 10. Catch per 15 minute upstream sweep at Cocagne R. electroseining sites, 2000.

		Salmon								
Location	Site	Fry	Small parr	Large parr	Chub	Dace	Eel	Stickle-back	Sucker	Trout
Cocagne R. (below Poirier Rd. crossing)	1	113	11	6	2	69	0	0	13	1
Cocagne R. (200m below Victoria Rd. crossing)	2	28	5	2	15	65	1	1	10	3

Table 11. Density (#/100 sq. m, see text) of juvenile salmon, Cocagne R., 1999-2000. Percent habitat saturation (PHS) values given for current year only.

		FRY		**PARR**		Total PHS
Location	Site	1999	2000	1999	2000	2000
Cocagne R. (below Poirier Rd. crossing)	1	8.1	108.8	38.2	16.7	32.2
Cocagne R. (200m below Victoria Rd. crossing)	2	3.1	26.6	18.6	10.5	13.0
Mean	all	5.6	67.7	28.4	13.6	22.6

Table 12. Catch per 15 minute upstream sweep at Richibucto R. and Coal Branch electroseining sites, 2000.

		Salmon												
Location	Site	Fry	Small parr	Large parr	Chub	Dace	Eel	Lamprey	Sculpin	Shiner	Stickle-back	Sucker	Trout
Coal Branch (100 m below Beersville crossing)	C2	47	2	0	6	61	0	1	3	11	4	2	1
Coal Branch (250 m below Rte. 465)	C3	22	2	0	2	86	0	0	0	3	0	1	0
Richibucto R. (200 m below Rte. 126)	R1	33	0	1	2	19	1	1	0	0	4	0	0
Richibucto R. (above Rte. 116)	R2	88	12	0	2	20	1	1	1	0	0	0	0

Table 13. Density (#/100 sq. m, see text) of juvenile salmon, Richibucto and Coal Branch rivers, 1997-2000. Percent habitat saturation (PHS) values given for current year only.

		FRY				**PARR**				Total PHS
Location	Site	1997	1998	1999	2000	1997	1998	1999	2000	2000
Coal Branch (hd. tide above Fords Mills)	C1	7.4	-	-	-	14.5	-	-	-	
Coal Branch (100 m below Beersville crossing)	C2	6.2	5.4	4.1	44.8	10.5	10.3	11.5	7.8	12.9
Coal Branch (250 m below Rte. 465)	C3	-	-	7.4	20.8	-	-	12.3	7.6	8.1
Coal Branch (South Forks, below Rte. 465)	C5	5.5	2.1	-	-	11.4	15.9	-	-	
Richibucto R. (200 m below Rte. 126)	R1	12.1	16.9	22.6	31.8	12.9	12.8	11.3	7.1	13.6
Richibucto R. (above Rte. 116)	R2	11.9	13.8	53.9	84.8	23.9	13.0	14.8	13.9	22.3
Mean	Coal Br.	6.4	3.7	5.8	32.8	12.1	13.1	11.9	7.7	10.5
Mean	Richibucto R.	12.0	15.4	38.3	58.3	18.4	12.9	13.0	10.5	18.0

Table 14. Catch per 15 minute upstream sweep at Kouchibouguacis R. electroseining sites, 2000.

		Salmon					
			Small	Large			
Location	Site	Fry	parr	parr	Dace	Shiner	Sucker
Kouchibouguacis R. (below Cameron's Mill cross rd.)	1	7	6	2	22	8	3
Kouchibouguacis R. (150 m below Rte. 126)	2	4	12	0	91	3	7

Table 15. Density (#/100 sq. m, see text) of juvenile salmon, Kouchibouguacis R., 2000. Percent habitat saturation (PHS) values given for current year only.

		FRY	**PARR**	Total PHS
Location	Site	2000	2000	2000
Kouchibouguacis R. (below Cameron's Mill cross rd.)	1	7.3	11.0	7.5
Kouchibouguacis R. (150 m below Rte. 126)	2	4.4	13.4	7.9
Mean	all	5.9	12.2	7.7

Table 16. Catch per 15 minute upstream sweep at Kouchibouguac R. electroseining sites, 2000.

		Salmon									
			Large	Small					Stickle-		
Location	Site	Fry	parr	parr	Dace	Eel	Lamprey	Sculpin	back	Sucker	Trout
Kouchibouguac R. (300m below Rte. 480 crossing)	1	78	39	5	5	0	3	4	1	0	4
Kouchibouguac R. (400m below Desherbiers Rd. crossing)	2	51	33	2	30	0	2	0	0	1	2
Kouchibouguac R. (150 m below mouth of Tweedie Br.)	3	47	22	1	3	1	0	1	0	0	0
Tweedie Br. (above confluence with main river)	4	78	14	0	0	0	0	32	0	0	5
Kouchibouguac R. (below Rte. 126)	5	1	32	2	136	0	1	0	0	1	0

Table 17. Density (#/100 sq. m, see text) of juvenile salmon, Kouchibouguac R., 1999-2000. Percent habitat saturation (PHS) values given for current year only.

		FRY		**PARR**		Total PHS
Location	Site	1999	2000	1999	2000	2000
Kouchibouguac R. (300m below Rte. 480 crossing)	1	69.3	77.6	29.8	32.3	30.6
Kouchibouguac R. (400m below Desherbiers Rd. crossing)	2	49.7	50.9	35.1	26.9	22.9
Kouchibouguac R. (150 m below mouth of Tweedie Br.)	3	.	47.2	.	20.3	16.9
Tweedie Br. (above confluence with main river)	4	.	77.6	.	14.6	17.3
Kouchibouguac R. (below Rte. 126)	5	.	1.0	.	26.4	14.6
Mean	all	59.5	50.9	32.4	24.1	20.5

Table 18. Mean density (#/100 sq. m, see text) of juvenile salmon in southeastern New Brunswick rivers, 1996-2000, and percent change from 1999 to 2000. Figures in parentheses represent only the two sites common to both 1999 and 2000.

FRY

River	1996	1997	1998	1999	2000	% change 99 - 00
Buctouche R. (main)	6	7	21	5	28	504%
Buctouche R. (South Br.)	9	10	21	15	79	444%
Cocagne R.	-	-	-	6	68	1101%
Coal Br.	-	6	4	6	33	469%
Richibucto R.	-	12	15	38	58	52%
Kouchibouguac R.	-	-	-	52	49 (62)	-6% (19%)
Kouchibouguacis R.	-	-	-	-	6	-

PARR

River	1996	1997	1998	1999	2000	% change 99 - 00
Buctouche R. (main)	9	12	14	13	9	-31%
Buctouche R. (South Br.)	12	12	16	15	13	-15%
Cocagne R.	-	-	-	28	14	-52%
Coal Br.	-	12	13	12	8	-35%
Richibucto R.	-	18	13	13	11	-19%
Kouchibouguac R.	-	-	-	32	24 (30)	-26%(-6%)
Kouchibouguacis R.	-	-	-	-	12	-

Table 19. Total returns and spawning escapement of large and small salmon to the Buctouche R., 2000.

	Large Salmon	Small Salmon
Trap efficiency	0.16	0.26
Catch (wild)	12	10
Catch (hatchery)	4	0
Returns (wild)	75	38
Returns (hatchery)	25	0
Total Returns	100	38
Removals	0	10
Spawning Escapement	100	28

Table 20. Calculation of percent conservation requirement achieved, Buctouche R., 2000.

Stock characteristics - current year	
Male proportion of large salmon	0.25
Female proportion of large salmon	0.75
Mean length of large female salmon (cm)	78.8
Eggs per large female (1.4132 x LN(FL) + 2.7560)(Randall 1985)	7535
Eggs per large salmon (eggs / female x % female)	5651
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 1985)	3513
Eggs per small salmon (eggs / female x % female)	386

Calculation of % conservation met	
Egg conservation requirement	1587000
Large salmon spawning escapement	100
Total large salmon eggs	565129
% requirement met by large salmon	36
Small salmon spawning escapement	28
Total small salmon eggs	10819
% requirement met by small salmon	1
% requirement met by all salmon	36

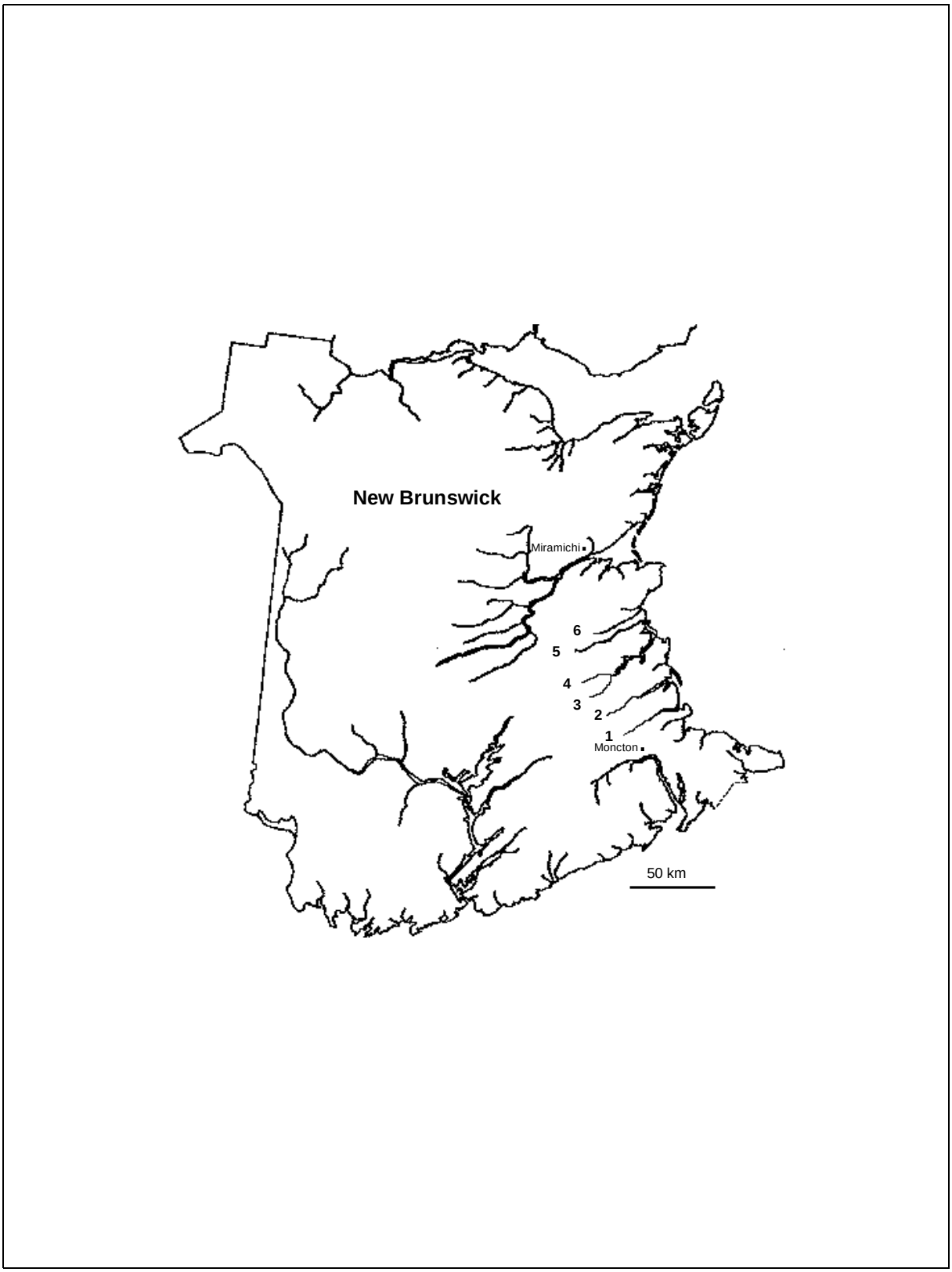

Figure 1. Location of rivers referred to in text: 1) Cocagne, 2) Buctouche, 3) Coal Branch, 4) Richibucto, 5) Kouchibouguacis, 6) Kouchibouguac.

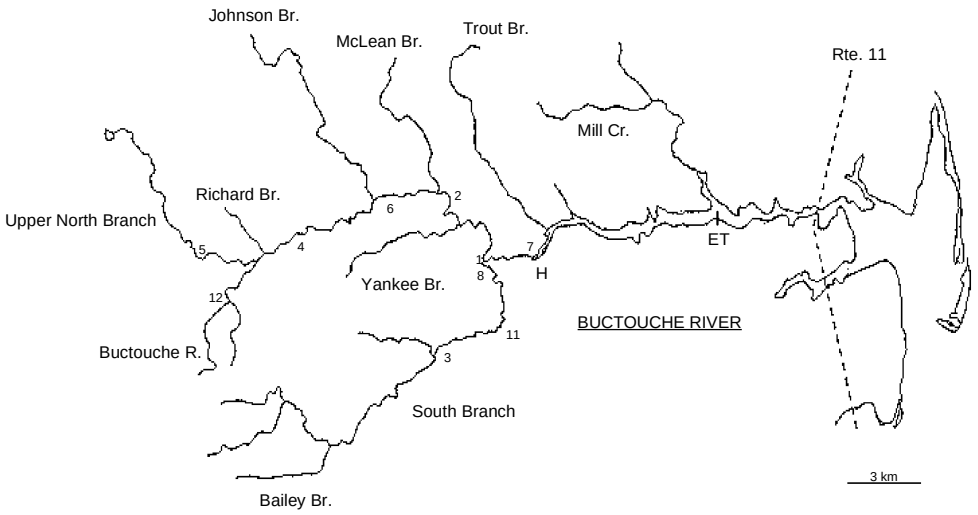

Figure 2. Location of estuary trap (ET), head of tide (H), and electroseining sites (numbered) on the Buctouche R., 2000.

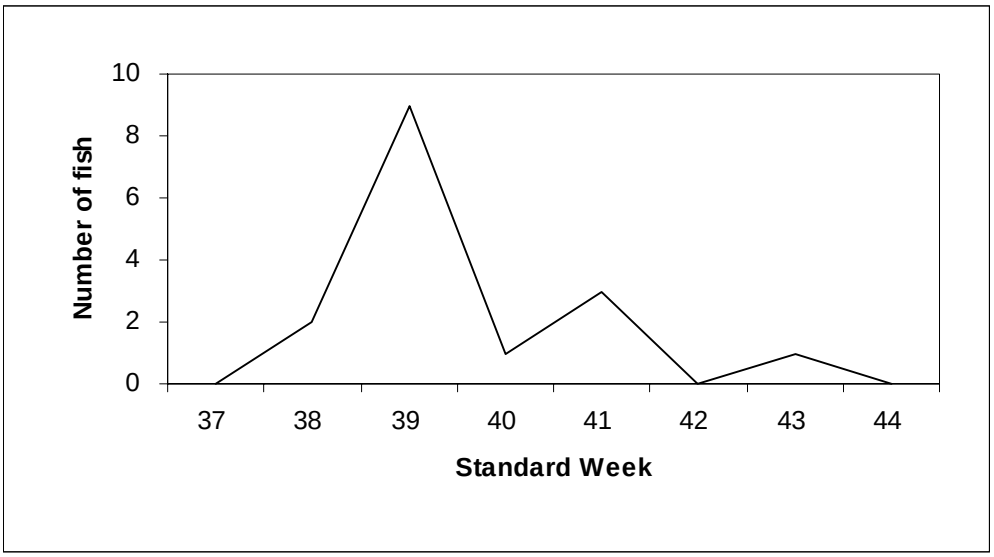

Figure 3. Large salmon catch by standard week in the estuary trap, Buctouche R., 2000.

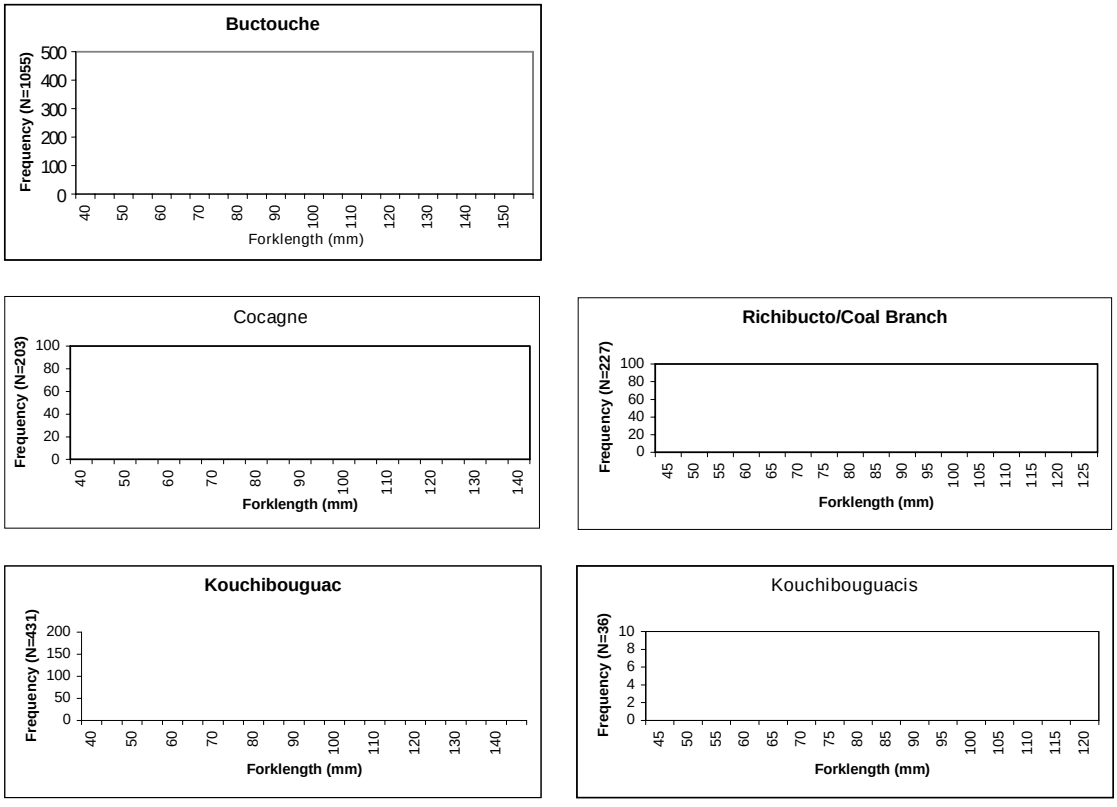

Figure 4. Length frequencies of juvenile Atlantic salmon caught at electroseining sites on all southeastern New Brunswick rivers in 2000. Juvenile categories based on aging of Buctouche R. samples: fry (0+), <71 mm; small parr (1+), 71-120 mm; large parr(2+, 3+), >120 mm.

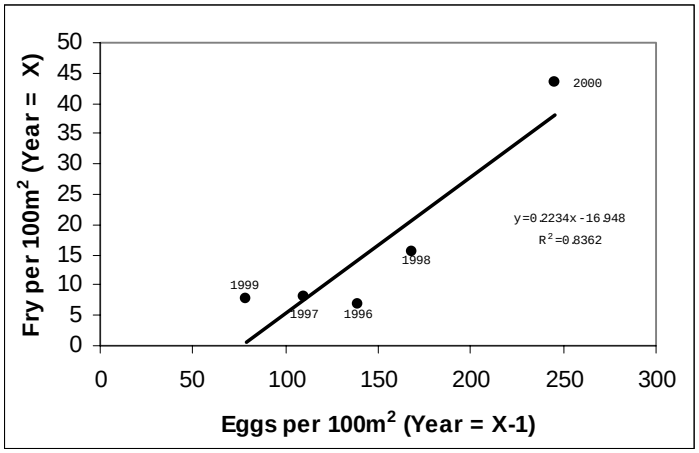

Figure 5. Relationship between mean fry density (year x) and egg deposition (year x-1) in the Buctouche R., 1996-2000.

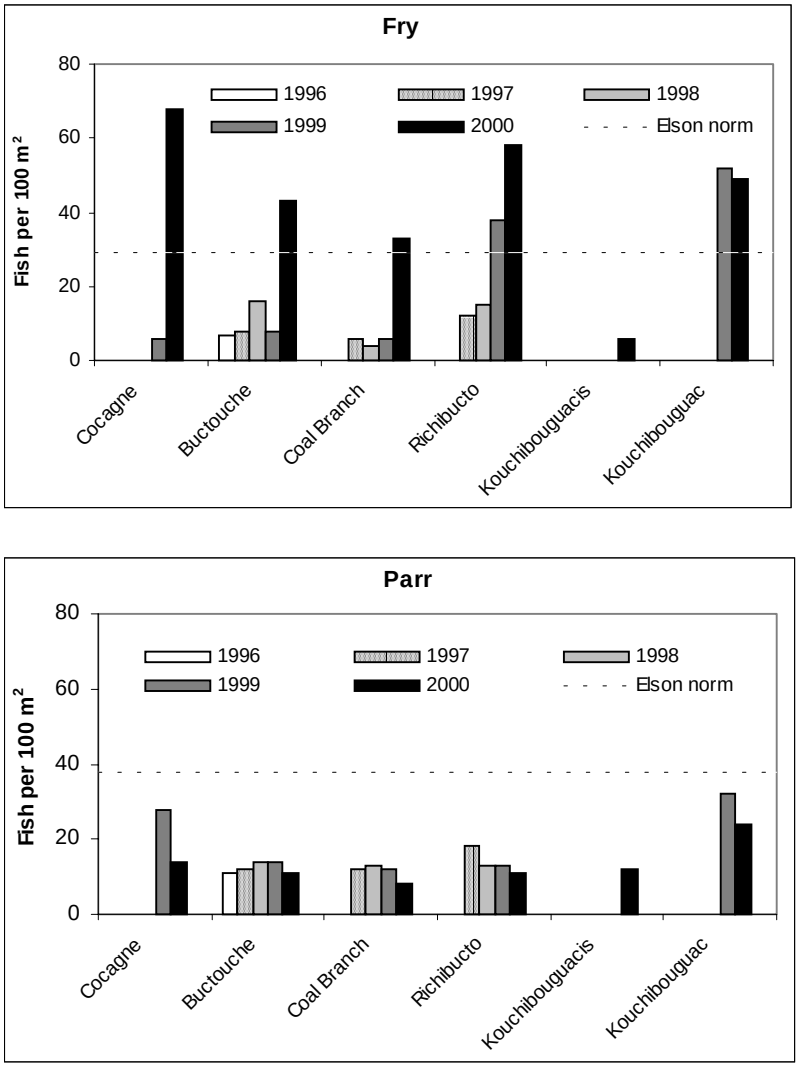

Figure 6. Juvenile densities in the Buctouche and other southeast NB rivers, 1996–2000.

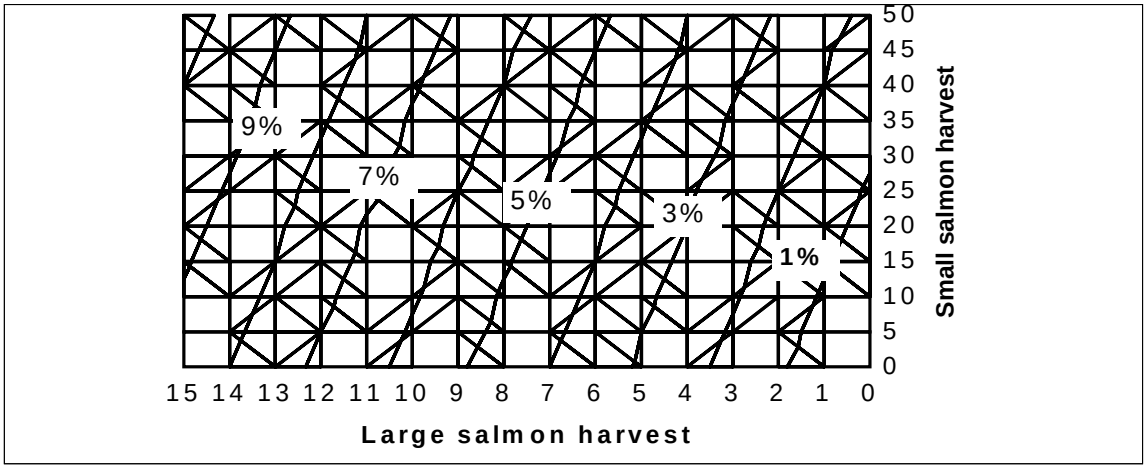

Figure 7. Percent egg loss relative to potential harvests of large and small salmon for the Buctouche River.