STATUS OF ATLANTIC SALMON IN THE RESTIGOUCHE RIVER IN 1995

by

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Abstract

Salmon egg deposition and large salmon spawning escapement in the Restigouche system were approximately 32% lower than 1994 levels. The estimated spawning escapements, based on an angling-based methodology with an assumed exploitation rate of 0.3, were approximately 8,000 large (67% of target) and 4,000 small (141% of target) salmon. Minimum population estimates obtained from visual surveys of spawners resembled these estimates.

Returns were approximately 12,000 large and 6,000 small salmon. Angling catches (retained+released) were 2,792 large and 1,589 small salmon. Retained large salmon catch (Québec) was 866 fish. Estimated First Nations harvest was 1187 large and 39 small salmon. Large and small salmon angling catches decreased by 19 and 60%, respectively, relative to the five-year means. Low water levels delayed upriver migration of salmon until late in the angling season.

Fry densities determined by electrofishing were the second highest since 1989. Age 1 parr were the most abundant in 24 years of electrofishing this system.

Assuming average (1991-1995) returns in 1996, total returns (angling based estimate, exploitation rate of 0.3 to 0.5) will be 9,000-14,000 large salmon and 8,000-13,000 small salmon.

Résumé

En 1995, les taux de la ponte ainsi que de l'échappée des gros saumons géniteurs dans le bassin versant de la rivière Ristigouche étaient d'environ 32 % inférieurs aux taux de 1994. En ce qui concerne l'échappée des géniteurs, calculée d'après la pêche à la ligne qui est estimée à un taux d'exploitation de 0,3, on estime qu'environ 8000 gros saumons (67 % de l'objectif) et 4000 petits saumons (141 % de l'objectif) ont réussi à s'échapper. Des estimations de la population minimale, obtenues par des relevés visuels des géniteurs, donnent les mêmes chiffres.

La remontée s'est composée d'environ 12000 gros saumons et de 6000 petits saumons. Les pêcheurs à la ligne ont capturé (pêche et remise à l'eau) 2792 gros saumons et 1589 petits. Au Québec, les pêcheurs ont retenu 866 gros saumons capturés. Les prises des Premières nations ont été estimées à 1187 gros saumons et à 39 petits saumons. Les taux de capture à la ligne des gros et des petits saumons ont diminué de 19 et de 60 % respectivement par rapport aux moyennes des cinq dernières années. Les faibles niveaux d'eau ont retardé la migration du saumon dans la partie amont de la rivière jusqu'à tard dans la saison de pêche à la ligne.

Les relevés par pêche électrique ont révélé que les densités des alevins étaient au deuxième plus haut niveau depuis 1989. L'abondance des tacons d'un an était à son apogée depuis 24 ans d'électropêche dans ce bassin versant.

En présumant que la remontée de 1996 sera conforme à la moyenne de 1991 à 1995, la remontée globale (fondée sur le taux de pêche à la ligne qui est estimé entre 0,3 et 0,5) sera de 9000 à 14000 gros saumons et de 8000 à 13000 petits saumons.

Summary Sheet

Stock: Restigouche River, SFA 15
Target: 71.4 million eggs (12,200 large salmon, 2,600 small salmon)
Rearing area: 29,768,000 m^2, 76% of SFA 15, 30% of Gulf New Brunswick

	1990	1991	1992	1993	1994	1995	MIN[1]	MAX[1]	MEAN[2]
Angling catch (retained+released)									
Large	3735	3137	4355	2055	3979	2792	1016	6707	3452
Small	4324	2522	4751	3268	4840	1589	896	6873	3941
Angling catch (retained)									
Large	893	956	1004	514	963	866	514	6707	866
Small	4324	2522	4751	3268	4840	1589	896	6873	3941
First Nations catch									
Large	1606	1111	1422	1202	1365	1187	129	2950	-
Small	136	19	55	0	76	39	0	178	-
Spawning escapement (angling exploitation method)[4]									
Large (X 1000)	6-11	5-9	7-13	3-6	7-12	4-8	1-2	11-19	6-10
Small (X 1000)	4-10	3-6	5-11	3-8	5-11	2-4	1-2	7-16	4-9
Total returns (angling exploitation method)[4]									
Large (X 1000)	10-16	9-14	12-19	6-9	11-17	8-12	6-9	23-30	--
Small (X 1000)	10-17	6-10	11-18	8-13	11-19	4-6	3-4	16-27	--
% egg target met (angling exploitation method)[4]	53-95	43-78	62-111	28-51	56-101	37-68	9-20	89-159	48-87

[1] MIN MAX for years 1970 to present.
[2] MEAN for years 1990 to 1994.
[3] Most probable value with 95% confidence limits.
[4] Range given reflects uncertainty of angling exploitation rate (assumed to be between 0.3 and 0.5), from which spawning escapement, eggs, and total returns are derived.

Landings: Angling catches of large (including catch and release in N.B.) and small salmon in 1995 were 19% and 60% lower than the five-year means, respectively.

Data and assessment: The assessment was based on angling catch with an assumed exploitation rate of 0.3-0.5. Visual surveys of spawners provide a minimum estimate of escapement similar to the angling-based estimate with exploitation rate of 0.3. For management purposes the angling-based estimate at exploitation rate=0.3 is recommended; according to this estimate, 67% of target egg spawners (large salmon) was met.

State of the stock: Egg deposition based on large salmon spawning escapement was 68% of target. Small salmon escapement exceeded target levels, but was was low compared to recent years.

Forecast for 1995: Based on mean returns from 1991-1995, between 9,000-14,000 large salmon and 8,000-13,000 small salmon are expected to return in 1996.

1 - Introduction

The objective of this report is to evaluate the status of Atlantic salmon in the Restigouche River in 1995. Numbers of spawners are estimated from (1) a mark-recapture experiment, (2) angling data and exploitation rates believed to represent lower and upper limits, and (3) visual surveys of spawners. This report summarizes angling and First Nations harvest statistics, juvenile salmon densities at 13 standard electrofishing sites, hatchery stocking and broodstock collection, and forecasts of adult salmon returns in 1996. Results of an experimental evaluation of two methods of carrying out visual counts of salmon (canoe-based counts and counts by snorkellers) are also included.

In the terminology of this report, small salmon (grilse) are adults less than 63 cm in fork length, which are comprised mainly of 1SW (one-sea-winter) maiden salmon. Large salmon (also known as salmon, MSW or multi-sea-winter salmon) are adults greater than or equal to 63 cm in fork length. This category contains mainly maiden 2SW and 3SW fish and previous spawners.

2 - Target

Egg deposition requirements for the Restigouche River, to provide 2.4 eggs per square meter, are 71,443,200 eggs (Randall 1984). About 12,200 large salmon are required to produce these eggs. An additional 2,600 small salmon are required to ensure a 1:1 sex ratio at spawning, based on past sex ratios of large and small salmon (Randall 1984). Total egg deposition is calculated as follows:

Egg deposition = (large spawners x eggs/large fish)+(small spawners x eggs/small fish)

where: eggs/large fish=5,933
eggs/small fish= 86

Eggs/fish is a mean value for the entire spawning population (males and females combined), calculated by Randall (1984) from egg counts made on fish harvested in 1983 by the freshwater, commercial, and First Nation fisheries, and sex ratios of salmon sampled at the Dalhousie trap, 1972-1980.

The above estimate of spawning target is based on DFO's estimate of rearing area, 29.8×10^6 m^2. DNRE considers the rearing area in the system to be 32.3×10^6 m^2 (A. Madden, unpubl. data). At the time when the current target egg deposition was determined, the DNRE estimate of rearing area was only 24×10^6 m^2 and consequently the larger estimate, 29.8×10^6 m^2, was used (Randall, 1984).

Research Recommendation: Target egg deposition for the Restigouche system should be re-evaluated. As well as rearing area, eggs/fish, sex ratio, and age structure of the population may have to be updated; they may have changed in response to management and regulatory changes since 1984. Biological sampling of salmon killed in angling or gillnetting fisheries would be necessary to determine sex ratios and eggs/fish, since all fish trapped by DFO for research purposes are released alive.

3 - Description of fisheries

Restigouche salmon were fished by recreational anglers and First Nation communities.

Recreational angling was permitted from June 1 to August 31. Anglers in New Brunswick tributaries and provincial boundary waters were regulated by New Brunswick policies: all large salmon were released, and catches of small salmon were restricted by seasonal and daily bag limits to eight and two fish, respectively.

In Québec tributaries, anglers were allowed to retain both small and large salmon with daily and seasonal bag limits of one and seven fish, respectively; if the first fish caught in a day was a small salmon, a second salmon could be caught and retained irrespective of size.

Most salmon captured by First Nations fisheries were gillnetted in the estuary, although some angling also took place in freshwater portions of the river. Gillnet fisheries were centred at Listuguj First Nation at Ristigouche, Québec, and at Eel River Bar First Nation near Dalhousie, N.B. (Fig. 1). No food-fishery trapnets were operated.

Eel River Bar First Nation's target harvest was set at 500 large and 50 small salmon to be harvested from Chaleur Bay, Crown Open waters of the Restigouche system, Benjamin River, Charlo River, Jacquet River and/or Eel River. The estuarine (Chaleur Bay) component of this harvest could be taken using up to 30 gillnets, each up to 400' in length, and up to three trapnets. Salmon were to be removed from other areas by angling only (jigging was specifically excluded). The season covered by this license was May 25 to December 31 1995. Fishing took place between May 29 and October 1 (Table 1).

There was no quota or harvest target for Listuguj First Nation, but in the interests of conservation the band council restricted gillnet fishing to five nights/week (allowing unobstructed passage of fish on Mondays and Tuesdays) and also designated an area of the upper estuary immediately below the mouth of the river as a conservation zone where gillnetting was not permitted. Fishing ended on July 26 (Table 1).

A third group, Madawaska Maliseet First Nation, fished upriver with a target harvest of 60 large and 190 small salmon to be taken from specified portions of the St. John and Restigouche (Crown Open waters of the Main Restigouche, Kedgwick and Gounamitz rivers) watersheds. Angling was the only authorized means of harvest. This license covered April 1 1995 to March 31 1996.

Commercial salmon fisheries in Chaleur Bay have been closed in Québec since 1984, and in New Brunswick since 1985. Commercial fisheries in both provinces were prohibited from landing salmon caught in non-salmon fishing gear (by-catch).

Harvests of large salmon in 1995 were 866 by recreational anglers (Québec only) and 1187 by First Nations (Table 2). Harvests of small salmon (New Brunswick and Québec) were 1589 by recreational anglers and 39 by First Nations.

4 - Fishery data

Fishery data were obtained from the sources listed in Appendix 6 of Claytor et al. (1994). No data were obtained from Listuguj First Nation in 1995, so the mean estuarine catch in 1989-1993 (the five most recent years for which data were available) was used, as in 1994. It was assumed that there was no river component to the Listuguj salmon harvest. The salmon harvest of Eel River Bar First Nation was subdivided into estuarine and freshwater components (R. Simonson, ERBFN band council, pers. comm.). The salmon harvest of Madawaska First Nation was entirely from freshwater portions of the river.

In 1995, angling catches of small salmon decreased by 60% relative to the 1990-1994 mean (Table 3, Fig. 2). The angling catch of large salmon decreased by 19%. Catches of small salmon decreased relative to the five-year mean by 52% to 82% in every tributary (Table 4). Catches of large salmon decreased relative to the mean in all tributaries except the Patapedia (increase of 78%). The majority of the catch (69% of large salmon, 78% of small salmon) was taken in New Brunswick or provincial boundary waters (Table 3). In 1995, 64% of the angled salmon were large, an increase of 36% over the mean proportion of angled large salmon (Table 3).

Small salmon catch per unit effort (CPUE) in 1995 was 59% lower than the five-year mean (Table 5). Large salmon CPUE was 20% lower than the mean.

Landings by New Brunswick First Nations decreased by 46% (large salmon) and 45% (small salmon) in 1995 relative to the five-year means (Table 6). Trends in Listuguj First Nation landings could not be determined.

Research recommendation: Harvest data must be obtained from all fisheries.

5 - Research data

5.1 - Morrissey Rock trapnet

For the fourth year, a tagging trapnet was operated jointly at Morrissey Rock Pool (Fig. 1) by Eel River Bar First Nation and DFO. Design and dimensions of the trapnet were similar to those described by Locke et al. (1995). The trapnet was operated from June 4 to September 4. The startup date of trapnet operations was approximately 10-12 days earlier than in the previous two years, due in large part to comparatively low water conditions in June 1995.

In response to concerns raised by Pinkham's angling camp (located approx 1 km upriver) that interception of fish at Morrissey Rock Pool was adversely affecting their fishing success, the trapnet was lifted from Tuesday evening to Wednesday evening each week, from July 4 to August 29. It appeared that this modification increased the number of fish in Pinkham's pools the first week (F. Mowbray, personal observation). Poor fishing continued in subsequent weeks, but very few small salmon returns were recorded at the trapnet during this time period (Fig. 3).

During the season 149 large and 117 small salmon were counted (Table

8, Figs. 3,4), an increase of 10% for large and a decrease of 74% for small salmon relative to 1994 captures. Large salmon captures increased despite the net operating only 6 days per week. The increase was in large part due to the earlier operating dates of the trap in 1995; large salmon captures during the operating period common to both 1994 and 1995 were similar (Fig. 4). Timing of the large salmon run was similar to that of 1993 and 1994. The small salmon run appeared to start later and end earlier than in 1993 and 1994, and daily catch during the run was lower (Fig. 3).

In total, 109 large and 103 small salmon were tagged with blue Carlin tags and released. Fish which were visibly diseased or injured were released but not tagged.

The occurrence of presumed furunculosis (based on external signs such as reddish fins or other areas of the body) was similar to that recorded in 1994 (Table 9). The incidence of parasites (sea lice), and net-marked fish was somewhat lower in 1995 than in 1994 (Table 9).

"Catches" of dead salmon on the upstream side of the trapnet and leaders, recorded as an index of in-river mortality, were lower in 1995 than in the previous two years (Table 10). These fish, which probably died upriver as a result of disease or hook-and-release mortality, may not have been carried downriver by the current to the same extent in 1995 because of the low-water conditions.

Only 18 of 103 tags applied to small salmon at Morrissey Rock trapnet were recovered, compared to 66 of 430 in 1994 and 57 of 329 in 1993 (Table 11). Despite inconsistent recording of tags by DNRE personnel at the Upsalquitch barrier fence, 17% of the tags applied to small salmon were recovered in 1995, a similar proportion to previous years (17% in 1993, 15% in 1994). As usual, few (5%) tags were recaptured at Morrissey Rock and no fish tagged at Morrissey Rock were recaptured at the Listuguj trapnets downriver (section 5.2). However, a higher proportion (28% of recoveries, 5% of tags applied) of tags were recovered from dead fish than in previous years (0.3% of tags applied in 1993, 0.5% in 1994).

5.2 - Adams' Shore and Smith Island trapnets

Listuguj First Nation operated a tagging trapnet on the Adams' Shore side of Smith Island (Fig. 1) for the second year, although in a location a few hundred metres downstream of that used in 1994. A second trap was installed in the channel on the southern side of Smith Island (referred to as the Smith Island trapnet). Design and dimensions of both trapnets were similar to those of the Morrissey Rock trapnet. Operating dates were June 6 to August 11 (Adams' Shore) and June 15 to August 11 (Smith Island).

The Adams' Shore trapnet captured 173 large and 289 small salmon (Table 8), of which 156 large and 210 small salmon were tagged and released. Data collection was similar to that at Morrissey Rock.

The Smith Island trapnet captured 36 large and 106 small salmon (Table 8), of which 26 large and 69 small salmon were tagged and released.

Catches at the two Listuguj traps, particularly the Adams' Shore

trap, continued throughout July and early August during the time period when Morrissey Rock was catching few or no fish (Fig. 5). Water depth in the north channel (where the Listuguj traps were located) was more consistent during the low water conditions of July and August when the south channel (where Morrissey Rock trap was located) was unnavigable for canoes and presumably also for salmon. Water depth probably accounts for most of the continued catch of salmon at the Listuguj traps. Another factor which would promote catches of fish at the Listuguj traps over Morrissey Rock is the relative position in the river; Adams Shore is several km further downstream than Morrissey Rock in an area subject to tidal influence and saltwater intrusion. Morrissey Rock is above tidal waters. In 1995, 38% of all recaptures of tagged small salmon (3% of all small salmon tagged at the two Listuguj traps) occurred at the Listuguj traps (Table 11), suggesting that salmon were holding position in the estuary rather than moving upriver. Days to recapture in the estuary traps varied from 0 to 6 days.

5.3 - Upsalquitch fish barrier

Returns to the barrier fence operated by DNRE at 10 Mile Pool on the Northwest Upsalquitch River (Fig. 1) were 817 small and 946 large salmon (Table 12). These returns represent a decrease of 34% relative to the 5-year mean for small salmon, and an increase of 20% for large salmon. Large salmon comprised 54% of the total run to the fence, compared to 38% on average in the past five years. As at Morrissey Rock trapnet, few salmon arrived at the fence during the low-water conditions in summer (Fig. 6). Following an increase in water level due to autumn rains, above-average numbers of large and small salmon compared to previous autumns returned to the fence. In the case of small salmon, these above-average autumn returns did not compensate for the deficit of low summer returns (Table 12).

5.4 - Causapscal fish barrier

Returns to MEF's barrier fence on the Causapscal River (a tributary of the Matapedia River; Fig. 1) were 1 small salmon and 462 large salmon (Table 12). Large salmon numbers increased relative to the five-year mean by 24%, similar to the proportional change at the Upsalquitch counting fence. Since small salmon are not retained well by the conduit fence, their proportional change is not a valid indicator of abundance of small fish at the Causapscal fence.

5.5 - Spawner surveys (canoe)

Spawner surveys were carried out by DNRE, MEF, Listuguj and/or DFO (Conservation & Protection) personnel in autumn (usually October-November) of 1982-1995 (no survey was done in 1990 due to high water). In New Brunswick waters, DNRE and DFO personnel visually surveyed spawners from canoes. On waters >20 m in width, two canoes on opposite sides of the stream were poled downstream, each carrying one or two persons, with the observer standing. On narrower streams, one canoe was used. Areas which were inaccessible by canoe were walked. In Québec waters, spawners were counted by snorkelling (1993-1995; see section 5.6) or canoe (previous years). Ideally, the objective of these spawner surveys was to directly observe spawners in 80-85% of the Restigouche River system, including all the main spawning areas but excluding some smaller tributaries (e.g. Tom's, Christopher, Hailes and Berry brooks)

which generally contain few spawners. However, the proportion of the Restigouche system directly surveyed for spawners was sometimes much less than 80-85%. When spawner counts could not be carried out in a particular tributary, redd counts later in the season were often substituted, using an estimate of redds/fish from previous years to calculate spawner abundance. Historical relationships between parts of the system were sometimes utilized to estimate spawner numbers in areas which were not surveyed. Barrier fence counts were added to the totals for the Northwest Upsalquitch and Causapscal rivers. DNRE collated the data from the various sources and generated abundance estimates for each tributary.

The estimated abundance of spawners in the entire system in 1995 was 8,304 large and 2,637 small salmon (Table 13a). In 1995, 29% of spawners were reported from the Matapedia, 26% from the Upsalquitch, and the remainder were more-or-less equally distributed (10-13% per tributary) in the Patapedia, Kedgwick, Little Main and Main Restigouche rivers (Table 14a).

5.6 - Spawner surveys (snorkel)

Snorkelling was used by MEF to survey the entire system for the second time in 1995. Between October 1-25, the Causapscal, Kedgwick, Little Main Restigouche, Gounamitz, Upsalquitch, Main Restigouche, Matapedia and Patapedia rivers were surveyed. Mid-season surveys of selected areas were also carried out from July 23 to August 23 (D'Amours 1996). The method used varied with river size and water clarity. When conditions allowed (clear water, weak current), canoe counts were carried out during the spawning season when salmon were concentrated in the head and foot of pools. However, in most tributaries, salmon were counted by divers. In small tributaries such as the upper Patapedia, Causapscal and Gounamitz rivers, one diver drifted downriver counting all salmon. In intermediate-size tributaries (e.g. the lower reaches of the Patapedia, the Little Main, and the upper reaches of the Kedgwick River), the team included a diver and a canoeist. The canoe preceded the diver downriver, so as to form a 45° angle with the bank, and funnel salmon towards the diver, who was responsible for counting. In large and deep rivers (Main Restigouche, Matapedia, Kedgwick, Upsalquitch rivers) two divers and a canoe formed a 45° angle with the bank. As they drifted downriver, the first diver was responsible for counting fish passing between himself and the canoe. The second diver counted all other fish.

Abundance of spawners observed by this method in 1995 was 7,570 large salmon and 3,430 small salmon (Table 13b). The area covered was approximately 75% of the spawning habitat. The distribution of salmon among tributaries (Table 14b) was approximately similar to that of the canoe counts, with the exception of the Little Main Restigouche River, which accounted for only 1% of fish. This is explained by the attribution of fish at Junction Pool, near the mouth of the Kedgwick and Little Main Restigouche rivers, to the Kedgwick River. In the canoe-based surveys (section 5.5), fish counted in Junction Pool were attributed to the Little Main Restigouche River.

5.7 - Evaluation of spawner counting methods

Spawner counts by canoe and snorkelling were evaluated by an experiment on October 11-19, 1995 (Locke, unpub.ms.). The experiment took place in a 3.2 km stretch of river just above the Northwest Upsalquitch

River barrier fence. The fence at the upper end of the holding pool was used as the downstream boundary of the experimental stretch, and the upstream end was barricaded with nylon netting. Salmon were released into the stretch from the holding pool. Three or four snorkellers counted fish twice daily from October 11 to October 13, for a total of 22 counts. An additional two counts were carried out on October 18. A total of eight canoe-based counts were obtained from October 18 to October 19.

Snorkellers counted, at best, 96% of the expected numbers of large salmon and 70% of small salmon. Accuracy was probably overestimated, especially for large salmon, because initial abundance may have been underestimated. However, behavioural differences may make large salmon easier to count than small salmon. Replicability (precision) of the counts was also better for large salmon.

Canoe-based counts were 85% and 69% of snorkeller counts of large and small salmon. Replicability of the canoe-based counts was also lower than that of diver counts.

Both canoe-based and snorkelling counts underestimated the number of Carlin-tagged fish present, especially when many untagged fish were present.

The experiment did not address the effects of (1) movements of fish between stretches of river, which could occur during the approximately three weeks over which Restigouche River diver counts took place in 1995 or (2) the other methods used by DNRE (e.g. redd counts, historical fish distributions) to supplement canoe-based spawner counts.

5.8 - Hatchery stocking and broodstock collection

In total, 425,000 eyed eggs, 221,572 age 0 parr, and 14,162 age 1 parr were distributed by the Charlo Salmonid Enhancement Centre (Table 15).

Adults to be used as broodstock were collected from Forks Pool in the Kedgwick River (68 female large salmon, 69 male large salmon) and Junction Pool at the confluence of the Kedgwick and Little Main Restigouche rivers (8 female large salmon, 8 male large salmon, 10 male small salmon). At Charlo, 568,848 eggs were collected from Kedgwick River stock, and 76,670 eggs from presumed Little Main Restigouche stock. An additional 11,128 eggs were spawned from 3 female and 2 male large salmon at the Northwest Upsalquitch barrier fence. A total of 656,646 eggs was collected (0.9% of the target for the Restigouche system).

5.9 - Electrofishing

Juvenile salmon were electrofished by DFO at 13 of the 15 standard sites during July and August (Fig. 1). Two sites could not be sampled due to insufficient water. Abundances were calculated by the removal method (Zippin 1956). Densities of juveniles per unit area were determined using site areas measured at the time of sampling. Ninety-five percent confidence intervals of the mean densities were calculated after individual site counts were transformed to natural logarithms. Densities of salmon fry and parr have been estimated at these sites each year since 1972.

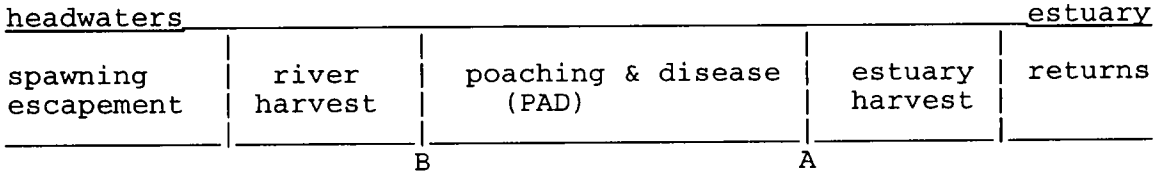
Mean abundances of 71.9 age 0, 14.7 age 1 and 2.6 age 2 parr·100 m^{-2} had increased by 13%, 19% and decreased by 19% respectively relative to their five-year means (Table 16, Fig. 7). With the exception of the exceptionally large cohort spawned in 1990, the age 0 cohort from spawning in 1994 was the largest since 1988. The age 1 cohort sampled in 1995 was the most abundant since sampling started - marginally more abundant than the 1990 cohort.

6 - Estimation of stock parameters

6.1 - Angling-based estimate

Total returns were considered to be the sum of estuary harvest, river harvest, poaching and disease (PAD) removals, and spawning escapement.

Returns = Estuary harvest + PAD + River harvest + Escapement



Estuary harvest is First Nations harvest.

An adjustment for mortality resulting from poaching and disease is normally excluded from calculations of spawning escapement in other rivers since the target egg deposition level of 2.4 eggs/m^2 takes this source of mortality into account. It has been retained in the assessment for the Restigouche River since in this system poaching and disease occurs prior to or at the same time as in-river removals and thus must be added to these to estimate returns.

The poaching and disease (PAD) mortality rate was assumed to be 0.14 of the population entering the river (i.e. after estuary harvest, but before angling) for small salmon and 0.16 for large salmon, as in previous assessments (Randall et al. 1988). The calculation was made as follows:

For large salmon, **PAD = 0.16[B/0.84]** because,

PAD = 16% of the population at point A and,

The population at point A = B + 0.16 A
= B/0.84

B, the population available to anglers = angling catch/exploitation rate
B = Catch/Exp

Therefore, **PAD = 0.16[(Catch/Exp)/0.84]**

By similar logic, PAD for small salmon was calculated as:

PAD = 0.14[(Catch/Exp)/0.86]

River harvest for small fish is the sum of fish lost to angling, broodstock collection (Charlo hatchery, N.B.) and First Nations river removals.

River harvest for large fish is the sum of fish lost to angling (Québec), mortality associated with catch and release (N.B.), broodstock collection and First Nations river removals. The mortality rate associated with catch-and-release of large salmon was assumed to be 6% (from observations summarized in Appendix 1 of Courtenay et al. 1991).

Spawning escapement was calculated as angling catch divided by angling exploitation rate minus river harvest. Angling exploitation rate is unknown for the Restigouche River, but Randall et al. (1990) argued that it is probably somewhere between 0.3 and 0.5. Therefore, spawning escapements were calculated for these limits.

Returns were estimated as 7,811-12,243 large (Tables 17, 18) and 3,713-6,177 small (Tables 19, 20) salmon. The ranges reflect the difference in the estimates when exploitation rate is set to 0.3 or 0.5. Spawning escapement was calculated as 4,425-8,148 large and 1,558-3,677 small salmon.

6.2 - Mark-recapture experiment

6.2.1 - With angling tag recaptures

An estimate of river population (point A in PAD description) in 1995 was made using small salmon marked with blue carlin tags at the Morrissey Rock trapnet. The estimate was obtained using a Bayesian estimator as described by Gazey and Staley (1986). The most probable population size given R recaptures out of M marks in a sampled catch of C was calculated over a range of possible population sizes. Total small salmon returns to point "A" (the trapnet) by August 15 was calculated using all angling returns (to August 31) of tags applied up to August 15 (to allow two weeks for fish to disperse throughout the system).

The values of R, M and C required for the Bayesian estimate were obtained as:

M ('Tags applied'): 103 small salmon were tagged and released by August 15. 10% tagging mortality was assumed as in the Miramichi River. Tag loss was assumed to occur after tagging mortality at a rate of 0.009/day as in the Margaree River (Chaput et al. 1993). Median days to recapture was 12 days.

R ('Tags recaptured'): All recaptures at angling camps contacted for tag returns were utilized. This accounted for 9 of the 10 angled small salmon tags (applied at Morrissey Rock) returned in 1995. Tag reporting rate was believed to be 100% at these camps.

C ('Total recaptures'): The total small salmon catch at these angling camps was 966.

Spawning escapement was obtained by subtracting angling catch (including First Nations in-river catch), other freshwater removals

(broodstock, hook-and release mortality of large salmon) and a poaching-and-disease correction (see section 6.1). Total returns were obtained by adding First Nation estuary harvest.

The above procedure was used to obtain small salmon estimates. Since reporting of large salmon tags was less reliable than small salmon tags, the large salmon population estimate was made using the ratio of large:small salmon in the combined New Brunswick and Québec angling catch (64% large salmon, Table 3).

The spawning escapement estimates from the 1995 mark-recapture study were 12,020 (95% C.L. of 6,980-32,927) large (Table 21) and 5,969 (3,067-18,009) small (Table 22) salmon. Returns of large salmon were estimated as 16,852 (10,852-41,741) fish and of small salmon were 8,843 (5,468-22,843) fish.

7 - Assessment results

	Large spawners	**Small spawners**
Target (71.4 million eggs):	**12,200**	**2,600**
Mark-recapture estimate (95% confidence limits)	12,020 (6,980 -32,927)	5,969 (3,067-18,009)
Angling exploitation estimate, ER=0.3	8,148	3,677
Angling exploitation estimate, ER=0.5	4,425	1,558
Canoe-based spawner counts	8,304	2,637
Diver spawner counts	7,570	3,430

As summarized above, only the mark-recapture method indicated that spawning escapement of large salmon was close to target. The other methods concluded that large salmon spawning escapement was, at best, about two-thirds of the target level. Spawning escapement of small salmon exceeded target by all but the angling exploitation rate (ER=0.5) method.

This is the second year (out of three years when the mark-recapture method was used) in which the mark-recapture estimates exceeded all other estimates by a factor of ~1.5 or more (Fig. 8). As in 1994, this estimate is not believed to accurately represent conditions on the river.

For 1995, the angling exploitation-based (ER=0.3) estimates are supported for management purposes. They are more conservative than the mark-recapture estimates. It is clearly nonsensical to support the angling exploitation (ER=0.5) estimates which are lower than the observed spawners in the system. In addition, ER=0.3 is similar to the ER observed

in Gaspé rivers (G. Landry, unpub. data) in 1995. Given the poor angling success (low CPUE) in 1995 (Table 5), and low water conditions which delayed upstream migration of salmon until late in the season, angling exploitation rate was probably considerably less than 0.5.

Based on the angling exploitation (ER=0.3) estimate, 67% of the spawning target was achieved in 1995 (Fig. 9).

8 - Ecological considerations

Water discharge was low in 1995 and water temperatures were high through much of the summer. Few or no fish entered the river during low-water conditions in July and August, resulting in poor catches at Morrissey Rock trapnet and the Upsalquitch barrier fence (Figs. 3,4,6). Given the continued catches of salmon at the Listuguj trapnets during July and August (Fig. 5), salmon were evidently holding position in the lower portion of the river or in the estuary, or moving into the river via the north channel, which had greater water depth than the south channel.

The common perception of anglers and others on the river was that the incidence of furunculosis-induced mortality was elevated because of the warm, low-water conditions, although this is not apparent from dead salmon "catches" on the upstream side of Morrissey Rock trapnet (Table 10), or from trapnet catches of salmon with external signs of furunculosis (Table 9). However, tag returns from salmon found dead were higher than those of the past two years (Table 11), suggesting that disease, temperature or some other factor was stressing fish more than usual.

9 - Forecast/Prospects

Three forms of forecasting were used:

(1) Five-year mean: Returns of large and small salmon in 1996 were predicted to be similar to average returns for the period 1991 to 1995 (based on the angling catch-exploitation rate method with ER of 0.3 to 0.5).

(2) Adult survival: Returns of small fish in 1994 and 1995 were assumed to reflect the relative survival at sea of cohorts contributing to large salmon returns in 1996. The average of returns of small salmon in 1994 and 1995 was compared to the previous 5-year average, as a possible index of sea survival. The predicted return of large salmon in 1996 from this method is expressed as a percent change from the forecast of 1995 returns derived by this method.

(3) Spawning success: Abundance of age 1 parr was used to predict future returns of both large and small salmon. Forecasting from juvenile densities is based on ages of spawners in the Restigouche River, where most small salmon return to spawn at age 3 or 4, and most large salmon return to spawn at age 4 to 6 (unpub. data). Thus, small salmon returning to spawn in 1996 originate from eggs laid in 1991 or 1992. Large salmon returning in 1996 originate from eggs laid in 1989 through 1991. The average of age 1 parr densities in 1991 to 1993 was compared to the previous 5-year average, as a possible index of recruitment

strength of large salmon. Similarly, for potential returns of small salmon in 1996, age 1 parr densities in 1993 and 1994 were considered. Predicted returns based on parr abundance are expressed as a percent change from the forecast of 1995 returns derived by this method.

Forecasts for 1996 returns are as follows:

	Large salmon	Small salmon
Five-year mean	9,013-14,194	7,920-13,183
Adult survival	-13%	--
Spawning success	+33%	-3%

10 - Management Considerations

It is likely that only 67% of the large salmon target for spawning escapement was met. Despite poor small salmon returns to the river in 1995, small salmon escapement was met and current harvesting strategies appear to be feasible. Large salmon escapement could be improved by reducing estuary and river harvests targetted at this portion of the stock.

11 - Research Recommendations

1. The effectiveness of the current mark-recapture estimate must be evaluated. Its performance as an assessment technique for this river has been poor. Alternative means of population assessment, for example an expansion of the diver-based spawner counts, should be considered.

2. Reliable harvest data from Listuguj First Nation netting is required for this assessment, regardless of the assessment method selected.

3. The spawning target for the Restigouche should be re-examined. Alternative estimates of habitat area are presently in use by DFO and DNRE. Biological characteristics of the stock have not been sampled since the commercial fishery closure and adoption of a catch-and-release fishery for large salmon in New Brunswick. Collection of data on sex ratios, length-weight relationships, and egg production could be carried out at existing harvest fisheries.

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Table 1. Operating dates of First Nations fisheries in Chaleur Bay and Restigouche River, 1979 to 1995.

Year	New Brunswick		Québec
	Gillnet	Trapnet[a]	Gillnet
1979	May 14 - Oct 24		Jun 6 - Aug 1
1980	May 19 - Jul 13		Jun 2 - Jul 28
1981	May 15 - Aug 30		
1982	May 17 - Aug 1		Jun 9 - Aug 2
1983	May 16 - Aug 28		Jun 3 - Aug 7
1984	May 14 - Aug 27		Jun 5 - Aug 10
1985	May 20 - Aug 25		Jun 3 - Jul 31
1986	May 19 - Aug 10	May 26 - Jul 20	Jun 2 - Jun 26
1987	May 24 - Jul 27	May 24 - Jul 15	Jun 1 - Jun 30
1988	May 16 - Aug 26	May 16 - Aug 14	Jun 6 - Jul 6
1989	May 15 - Aug 20	May 29 - Aug 20	Jun 5 - Jun 30
1990	May 14 - Jul 22	May 22 - Jul 25	Jun 11 - Jul 6
1991	May 12 - Jul 27	May 26 - Jul 27	Jun 3 - Jun 28
1992	May 25 - Aug 23	May 26 - Aug 2	Jun 10, 11, 12, 16, 17, 25 & 30 Jul 1, 6, 9, 10, 14, 15 & 19
1993	May 17 - Aug 8		May 17 - Aug 8
1994	May 16 - Jul 16		N/A
1995	May 29 - Oct 1		? - Jul 26

[a] One trap net in 1986. Two trap nets in 1987 to 1992.

Table 2. Preliminary estimates of harvests (numbers) of small and large salmon in Restigouche River, 1995. Harvests of salmon in 1994 are given for comparison.

Fishery		1995		1994		Mean (90-94)		1995 c.f. Mean	
		Small	Large	Small	Large	Small	Large	Small	Large
First Nations									
	N.B.	21	202	58	380	38	376	-45%	-46%
	P.Q.[a]	18	985	18	985	-	-	-	-
Angling									
	N.B.	1235		3942		3192		-61%	
	P.Q.	354	866	898	963	749	866	-53%	0%
Total		1628	2053	4916	2328	-	-	-	-

[a] Québec First Nation harvests (1994 to 1995) are 1989-93 means. Thus, previous five year means were not calculated in this and subsequent tables that involve First Nations harvasts.

Table 3. Estimated angling catches of salmon in the Restigouche River, 1970 to 1995. Estimates of large salmon (1984 to 1995) include released fish in New Brunswick. New Brunswick catch-and-release data were estimates from angling lodge logbooks, crown reserve angler questionnaires and DFO fishery officers.

	Large			Small			Proportion Large		
Year	PQ	NB	Total	PQ	NB	Total	PQ	NB	Total
1970	326	1716	2042	166	1340	1506	0.66	0.56	0.58
1971	259	757	1016	173	999	1172	0.60	0.43	0.46
1972	1171	3870	5041	111	978	1089	0.91	0.80	0.82
1973	1146	3746	4892	147	1423	1570	0.89	0.72	0.76
1974	1163	4785	5948	129	1038	1167	0.90	0.82	0.84
1975	741	2160	2901	149	1130	1279	0.83	0.66	0.69
1976	1029	4481	5510	377	2345	2722	0.73	0.66	0.67
1977	1579	5128	6707	459	2333	2792	0.77	0.69	0.71
1978	1652	3373	5025	282	1322	1604	0.85	0.72	0.76
1979	826	997	1823	556	1990	2546	0.60	0.33	0.42
1980	2059	4098	6157	409	2833	3242	0.83	0.59	0.66
1981	1408	2832	4240	635	3010	3645	0.69	0.48	0.54
1982	962	1620	2582	402	2449	2851	0.71	0.40	0.48
1983	587	1481	2068	181	715	896	0.76	0.67	0.70
1984	604	1672	2276	314	1474	1788	0.66	0.53	0.56
1985	851	3563	4414	344	3258	3602	0.71	0.52	0.55
1986	1420	4763	6183	502	4915	5417	0.74	0.49	0.53
1987	970	3203	4173	696	4414	5110	0.58	0.42	0.45
1988	1129	4546	5675	789	6084	6873	0.59	0.43	0.45
1989	1162	3441	4603	509	2851	3360	0.70	0.55	0.58
1990	893	2842	3735	765	3559	4324	0.54	0.44	0.46
1991	956	2181	3137	535	1987	2522	0.64	0.52	0.55
1992	1004	3351	4355	752	3999	4751	0.57	0.46	0.48
1993	514	1541	2055	796	2472	3268	0.39	0.38	0.39
1994	963	3016	3979	898	3942	4840	0.52	0.43	0.45
1995	866	1926	2792	354	1235	1589	0.71	0.61	0.64
Mean (90-94)	866	2586	3452	749	3192	3941	0.53	0.45	0.47
1995 c.f. Mean	0%	-26%	-19%	-53%	-61%	-60%	+34%	+36%	+36%

Table 4. Estimated angling salmon catches from Restigouche River, by tributary, 1970 to 1995. Prior to 1982 Little Main catches included in Main Restigouche. Catches of large salmon (1984 to 1995) include released fish in New Brunswick.

	Matapedia		Upsalquitch		Patapedia		Kedgwick		Little Main		Main Restigouche	
Year	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large
1970	162	290	270	122	4	24	323	205			747	1401
1971	153	217	344	90	20	40	128	67			527	602
1972	102	1010	362	984	7	144	165	425			453	2478
1973	147	1098	498	512	0	43	128	548			797	2691
1974	124	1083	433	579	5	63	80	289			525	3934
1975	131	692	462	262	18	31	136	316			532	1600
1976	296	922	767	753	80	88	209	348			1370	3399
1977	278	1312	554	901	181	227	368	684			1411	3583
1978	251	1457	449	507	31	158	143	423			730	2480
1979	466	754	507	135	90	60	316	123			1167	751
1980	311	1784	1178	592	95	229	284	468			1374	3084
1981	485	1176	1234	221	148	175	356	473			1422	2195
1982	259	841	818	214	143	112	322	190	59	50	1250	1175
1983	154	456	203	218	27	103	68	224	14	0	430	1067
1984	285	560	483	346	44	59	149	164	102	27	725	1120
1985	291	807	1175	507	104	84	330	185	163	50	1539	2781
1986	389	1289	1397	630	163	187	566	519	481	155	2421	3403
1987	602	915	819	410	193	77	583	409	407	142	2506	2220
1988	680	1068	1296	659	185	107	807	707	524	74	3381	3060
1989	466	1119	836	515	73	62	208	544	43	31	1734	2332
1990	718	856	905	375	81	45	304	258	152	108	2164	2093
1991	521	940	403	195	30	29	277	403	121	75	1170	1495
1992	693	966	1180	561	122	57	420	320	238	141	2098	2310
1993	735	505	644	221	80	16	231	104	85	42	1493	1167
1994	822	917	1212	508	147	51	455	231	269	106	1935	2166
1995	337	829	307	304	32	71	119	202	32	32	762	1354
Mean (90-94)	698	837	869	372	92	40	337	263	173	94	1772	1846
1995 c.f. Mean	-52%	-1%	-65%	-18%	-65%	+78%	-65%	-23%	-82%	-66%	-57%	-27%

Table 5. Preliminary estimates of angling catch, effort and CPUE in New Brunswick and Québec portions of the Restigouche River, 1995. Catch, effort and CPUE in 1994 are given for comparison.

		1995			1994			Mean (90-94)			1995 c.f. Mean		
		Catch	Effort	CPUE	Catch	Effort	CPUE	Catch	Effort	CPUE	Catch	Effort	CPUE
N.B.	Small	1235	9948	0.12	3942	10303	0.38	3192	10163	0.31	-61%	-2%	-61%
	Large[a]	1926	9948	0.19	3016	10303	0.29	2586	10163	0.25	-26%	-2%	-24%
P.Q.	Small	354	6980	0.05	898	8554	0.10	749	7461	0.10	-53%	-6%	-50%
	Large	866	6980	0.12	963	8554	0.11	866	7461	0.12	0%	-6%	0%
N.B.+ P.Q.	Small	1589	16928	0.09	4840	18857	0.26	3941	17625	0.22	-60%	-4%	-59%
	Large	2792	16928	0.16	3979	18857	0.21	3452	17625	0.20	-19%	-4%	-20%

[a] Estimates of N.B. large salmon are released fish.

Table 6. First Nations salmon landings for Chaleur Bay and Restigouche River, 1975 to 1995.

	New Brunswick									Québec			
	Estuary			River			Total			Estuary			
Year	Small	Large	Total	Small	Large	Total	Small	Large	Total	Small	Large	Total	Total
1975	3	132	135				3	132	135				135
1976	13	124	137				13	124	137	0	1517	1517	1654
1977	19	212	231				19	212	231	0	2738	2738	2969
1978	23	129	152				23	129	152				152
1979	84	148	232				84	148	232	85	748	833	1065
1980	34	264	298				34	264	298	24	1563	1587	1885
1981	20	211	231				20	211	231				231
1982	12	155	167				12	155	167	148	1521	1669	1836
1983	0	260	260				0	260	260	32	1216	1248	1508
1984	1	213	214				1	213	214	177	1070	1247	1461
1985	0	241	241				0	241	241	35	976	1011	1252
1986	26	431	457				26	431	457	4	1145	1149	1606
1987[a]	95	916	1011				95	916	1011	5	986	991	2002
1988	70	509	579				70	509	579	3	921	924	1503
1989	151	568	719				151	568	719	12	1081	1093	1812
1990	120	471	591				120	471	591	16	1135	1151	1742
1991	10	252	262				10	252	262	9	859	868	1130
1992	2	464	466	0	10	10	2	474	476	53	948	1001	1477
1993	0	293	293	0	8	8	0	301	301	0	901	901	1202
1994[b]	29	348	377	29	32	61	58	380	438	18	985	1003	1441
1995	0	178	178	21	24	45	21	202	223	18	985	1003	1226
Mean (90-94)	32	366	398	10	17	26	38	376	414	-	-	-	-
1995 c.f. Mean	-100%	-51%	-55%	+110%	+41%	+73%	-45%	-46%	-46%	-	-	-	-

[a] Québec First Nation landings from (Randall et al. 1988).
[b] Québec First Nation landings (1994 to 1995) are 1989-93 means.

Table 7. Commercial, angling and First Nations salmon landings from Chaleur Bay and Restigouche River, 1970 to 1995.

	Commercial		Angling		First Nations		
Year	Small	Large	Small	Large	Small	Large	Total
1970		18180	1506	2042			21728
1971		8967	1172	1016			11155
1972	36	23	1089	5041			6189
1973	1272	295	1570	4892			8029
1974	132	68	1167	5948			7315
1975	163	1026	1279	2901	3	132	5504
1976	5107	225	2722	5510	13	1641	15218
1977	1134	168	2792	6707	19	2950	13770
1978	1522	156	1604	5025	23	129	8459
1979	83	671	2546	1823	169	896	6188
1980	1986	9	3242	6157	58	1827	13279
1981	3045	3534	3645	4240	20	211	14695
1982	2202	4437	2851	2582	160	1676	13908
1983	1552	4569	896	2068	32	1476	10593
1984	7161	2026	1788	604	178	1283	13040
1985	0	0	3602	851	35	1217	5705
1986	0	0	5417	1420	30	1576	8443
1987	0	0	5110	970	100	1902	8082
1988	0	0	6873	1129	73	1430	9505
1989	0	0	3360	1162	163	1649	6334
1990	0	0	4324	893	136	1606	6959
1991	0	0	2522	956	19	1111	4608
1992	0	0	4751	1004	55	1422	7232
1993	0	0	3268	514	0	1202	4984
1994	0	0	4840	963	76	1365	7244
1995	0	0	1589	866	39	1187	3681
Mean (90-94)	0	0	3941	866	-	-	-
1995 c.f. Mean	0%	0%	-60%	0%	-	-	-

Table 8. Salmon catches at Morrissey Rock, Adams' Shore and Smith Island trapnets.

	Morrissey Rock			Adams' Shore			Smith Island		
Year	Small	Large	Operating dates	Small	Large	Operating dates	Small	Large	Operating dates
1992	63	38	Jul. 15-Aug. 5 Aug. 11-Oct. 22						
1993	342	51	Jun. 1-Jun. 2 Jun. 16-Aug. 16						
1994	455	136	Jun. 16-Sep. 20	141	23	Jun. 20-Sep. 11			
1995	117	149	Jun. 4-Jul. 4 Jul. 6-Jul. 11 Jul. 13-Jul. 18 Jul. 20-Jul. 25 Jul. 27-Aug. 1 Aug. 3-Aug. 8 Aug. 10-Aug. 15 Aug. 17-Aug. 22 Aug. 24-Aug. 29 Aug. 31-Sep. 4	289	173	Jun. 6-Aug. 11	106	36	Jun. 15-Aug. 11

Table 9. Percentage of salmon trapped at Morrissey Rock with presumed furunculosis (i.e. with red fins or body) ectoparasites (sea lice) or net marks.

(a) Large salmon

Period[a]	1993 Percent of salmon with: Furunculosis	1993 Sea lice	1993 Net marks	1993 Total catch at trap	1994 Percent of salmon with: Furunculosis	1994 Sea lice	1994 Net marks	1994 Total catch at trap	1995 Percent of salmon with: Furunculosis	1995 Sea lice	1995 Net marks	1995 Total catch at trap
Jun. 1-15	0	0	0	1	-	-	-	-	3	50	13	32
Jun. 16-30	0	7	14	14	0	46	42	43	0	16	8	61
Jul. 1-15	0	5	18	22	6	49	18	55	0	23	9	34
Jul. 16-31	11	0	0	9	0	14	0	28	19	24	14	21
Aug. 1-15	25	0	0	4	0	43	29	7	0	0	0	1
Aug. 16-31	0	0	0	1	0	100	0	1	0	0	0	0
Sep. 1-15	-	-	-	-	0	0	0	1	0	0	0	0
Sep. 16-30	-	-	-	-	0	0	0	1	-	-	-	-
Total number with condition	2	2	6	51	3	55	30	136	5	39	15	149

(b) Small salmon

Period[a]	1993 Percent of salmon with: Furunculosis	1993 Sea lice	1993 Net marks	1993 Total catch at trap	1994 Percent of salmon with: Furunculosis	1994 Sea lice	1994 Net marks	1994 Total catch at trap	1995 Percent of salmon with: Furunculosis	1995 Sea lice	1995 Net marks	1995 Total catch at trap
Jun. 1-15	0	0	0	0	-	-	-	-	0	0	0	0
Jun. 16-30	0	57	14	14	0	31	23	26	0	39	6	18
Jul. 1-15	0	10	10	117	2	27	13	199	0	23	11	47
Jul. 16-31	2	12	8	115	2	45	22	168	2	21	12	43
Aug. 1-15	5	40	14	91	0	55	15	54	0	13	12	8
Aug. 16-31	0	0	0	5	0	60	20	5	0	0	0	1
Sep. 1-15	-	-	-	-	0	100	0	1	0	0	0	0
Sep. 16-30	-	-	-	-	0	100	0	2	-	-	-	-
Total number with condition	7	69	36	342	7	173	77	455	1	28	12	117

[a] Operating dates are shown in Table 8.

Table 10. Dead salmon (large and small combined) found against the upstream side of the Morrissey Rock trapnet and leaders.

Period[a]	1993	1994	1995
Jun. 1-15	0	-	0
Jun. 16-30	3	0	0
Jul. 1-15	13	3	3
Jul. 16-31	0	5	0
Aug. 1-15	0	6	0
Aug. 16-31	0	0	0
Sep. 1-15	-	1	0
Sep. 16-30	-	0	-
Total	16	15	3

[a] Operating dates are shown in Table 8.

Table 11. Means by which tags applied to small salmon were recovered in 1993, 1994 and 1995.

	Percent of recoveries			
	Morrissey Rock trap			Listuguj traps
Method of recovery	1993	1994	1995	1995
Angling	63	58	56	33
Upsalquitch barrier fence	32	24	6	5
Morrissey Rock recaptures	3	11	5	5
Listuguj traps recaptures	-	-	-	38
Broodstock	0	4	5	5
Found dead by anglers	2	3	28	14
Total number recovered	57	66	18	21
Total number applied	329	430	103	279

Table 12. Counts of salmon at two fish barriers in the Restigouche River system.

Year	Small	Large	Total	Proportion Large	Operating Dates
NW Upsalquitch barrier					
1980	843	887	1730	0.51	Jun. 17 - Oct. 19
1981	789	481	1270	0.38	Jun. 5 - Oct. 29
1982	819	622	1441	0.43	Jun. 4 - Oct. 17
1983	430	301	731	0.41	Jun. 20 - Oct. 30
1984	518	642	1160	0.55	Jun. 8 - Oct. 28
1985	748	517	1265	0.41	Jun. 5 - Oct. 27
1986	1738	1166	2904	0.40	Jun. 6 - Oct. 23
1987	1557	1000	2557	0.39	Jun. 10 - Oct. 29
1988	1121	993	2114	0.47	Jun. 6 - Oct. 25
1989	1051	894	1945	0.46	Jun. 4 - Oct. 22
1990	1324	946	2270	0.42	Jun. 22 - Oct. 14
1991	1267	930	2197	0.42	Jun. 1 - Oct. 16
1992	1351	963	2314	0.42	Jun. 22 - Oct. 22
1993	957	353	1310	0.27	Jun. 27 - Oct. 13
1994	1329	740	2069	0.36	Jun. 26 - Oct. 18
1995	817	946	1763	0.54	Jun. 19 - Oct. 23
Mean (90-94)	1246	786	2032	0.38	
1995 c.f. Mean	-34%	+20%	-13%	+42%	
Causapscal barrier					
1988	49	505	554	0.91	Jun. 12 - Sep. 6
1989	7	605	612	0.99	Jun. 18 - Sep. 14
1990	37	456	493	0.92	Jun. 12 - Aug. 14
1991	9	451	460	0.98	Jun. 17 - Aug. 26
1992	8	350	358	0.98	Jun. 12 - Aug. 5
1993	12	256	268	0.96	Jun. 18 - Aug. 17
1994	3	349	352	0.99	Jun. 21 - Sep. 21
1995	1	462	463	1.00	Jun. 12 - Sep. 14
Mean (90-94)	14	372	386	0.97	
1995 c.f. Mean	-93%	+24%	+20%	+3%	

Table 13. (a) DNRE canoe-based spawner counts, by tributary, of the Restigouche River system, 1985 to 1995.

	Matapedia		Upsalquitch		Patapedia		Kedgwick		Little Main		Main Restigouche		Restigouche System		Restigouche System
Year	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large	Small + Large
1985	321	892	925	1174	61	548	108	968	525	1859	343	2342	2283	7783	10066
1986	336	1114	2632	2451	311	728	281	976	1241	2541	413	1708	5214	9518	14732
1987	622	946	1948	2179	80	953	582	1729	610	1418	357	949	4199	8174	12373
1988	791	1243	1761	2140	317	1117	602	1546	536	2128	238	962	4245	9136	13381
1989	764	1834	1387	2223	178	1012	289	1640	923	2442	803	2837	4344	11988	16332
1990[a]	1080	1289			214	783									
1991	640	1152	2247	1575	162	586	423	1204	332	862	453	1713	4257	7092	11349
1992	711	1023	1986	1434	141	502	161	515	200	665	73	565	3272	4704	7976
1993	628	1010	1183	570	98	442	127	370	175	500	141	620	2352	3512	5864
1994	384	1376	1909	1534	282	670	518	1111	611	1192	686	988	4390	6871	11261
1995	669	2461	1263	1578	232	825	83	1244	96	1319	294	877	2637	8304	10941
Mean (90-94)	689	1170	1831	1278	179	597	307	800	330	805	338	972	3568	5545	9113
1995 c.f. Mean	-3%	+110%	-31%	+23%	+30%	+38%	-73%	+56%	-71%	+64%	-13%	-10%	-26%	+50%	+20%

[a] Count incomplete. High water prevented field spawner count in New Brunswick.

(b) MEF diver-based spawner counts, by tributary, of the Restigouche River system, 1994 to 1995.

	Matapedia		Upsalquitch		Patapedia		Kedgwick		Little Main		Main Restigouche		Restigouche System		Restigouche System
Year	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large	Small + Large
1994	383	1389	1795	1282	282	670	960	772	572	414	458	1157	4450	5684	10134
1995	669	2461	1497	2002	232	825	717	1276	102	43	213	963	3430	7570	11000
1995 c.f. 1994	+75%	+77%	-17%	+56%	-18%	+23%	-25%	+65%	-82%	-90%	-53%	-17%	-23%	+33%	+9%

Table 14. (a) Distribution of spawners and spawning habitat among tributaries. From DNRE spawner counts.

	Percentage of total spawner numbers by tributary:					
Year	Matapedia	Upsalquitch	Patapedia	Kedgwick	Little Main	Main Restigouche
1985	12.0	20.9	6.0	10.7	23.7	26.7
1986	9.8	34.5	7.1	8.5	25.7	14.4
1987	12.7	33.3	8.3	18.7	16.4	10.6
1988	15.2	29.2	10.7	16.0	19.9	9.0
1989	15.9	22.1	7.3	11.8	20.6	22.3
1991	15.8	33.7	6.6	14.3	10.5	19.1
1992	21.7	42.9	8.1	8.5	10.8	8.0
1993	27.9	29.9	9.2	8.5	11.5	13.0
1994	15.6	30.6	8.4	14.5	16.0	14.9
1995	28.6	26.0	9.7	12.1	12.9	10.7
Mean (90-94)	20.3	34.3	8.1	11.5	12.2	13.8
1995 c.f. Mean (90-94)	+41%	-24%	+20%	+5%	+6%	-22%
Habitat	21.4	13.1	5.8	8.1	5.9	45.8

(b) Distribution of spawners and spawning habitat among tributaries. From MEF spawner counts.

	Percentage of total spawner numbers by tributary:					
Year	Matapedia	Upsalquitch	Patapedia	Kedgwick	Little Main	Main Restigouche
1994	17.5	30.4	9.4	17.1	9.7	15.9
1995	28.5	31.8	9.6	18.1	1.3	10.7
1995 c.f. 1994	+63%	+5%	+2%	+6%	-87%	-33%
Habitat	21.4	13.1	5.8	8.1	5.9	45.8

Table 15. Distributions of Atlantic salmon to the Restigouche River system (by system of broodstock origin) by the Charlo Salmonid Enhancement Centre in 1995. Fish were not adipose-clipped or otherwise marked unless noted under Destination.

River	Number	Stage	Destination
Kedgwick	150,000	eyed eggs	MSRT[a] incubation boxes
	22,000	0 parr	MSRT[a] satellite site
	138,572	0 parr	Kedgwick River (49,464 adipose-clipped)
	13,102	1 parr	Kedgwick River (all adipose-clipped)
	1,060	1 parr	MSRT[a] satellite site (all adipose-clipped)
Little Main	250,000	eyed eggs	NWSA[b] incubation boxes
	25,000	eyed eggs	MSRT[a] incubation boxes
	30,000	0 parr	Runnymede Lodge satellite site (M. Restigouche R.)
	16,000	0 parr	Boston Brook Lodge satellite site (L.M. Restigouche R.)
	10,500	0 parr	MSRT[a] satellite site
	4,500	0 parr	Boland Brook Lodge satellite site (Upsalquitch R.)

[a] Management of Salmon in the Restigouche and Tributaries.
[b] Northwest Salmon Association.

Table 16. Juvenile densities of Atlantic salmon in the Restigouche River, 1972 to 1995. Juvenile densities (number per 100m2) are mean densities of 15 (1972-90 & 93), 8 (1991), 10 (1992), 11 (1994) and 13 (1995) standard sites, designated by year of spawning.

Year (i)	Juvenile salmon densities 0 (year i+1)	1 (year i+2)	2 (year i+3)
1971	5.2	2.8	0.6
1972	22.0	6.1	1.5
1973	13.1	4.8	1.0
1974	28.6	6.9	1.4
1975	13.3	3.9	1.0
1976	14.7	6.3	1.4
1977	19.5	5.9	2.1
1978	6.1	3.8	0.4
1979	9.3	2.4	0.4
1980	18.9	3.3	3.1
1981	11.2	7.8	2.5
1982	25.4	7.3	1.6
1983	25.1	10.4	2.8
1984	25.2	7.5	4.7
1985	23.9	9.4	2.1
1986	42.0	6.1	1.9
1987	53.2	12.1	3.1
1988	72.1	12.9	2.9
1989	53.2	12.3	2.8
1990	106.5	14.6	4.7
1991	49.6	11.5	2.6
1992	51.4	10.9	2.6
1993	58.5	14.7	-
1994	71.9	-	-
1995	-	-	-
Mean (90-94)	63.8	12.4	3.2
1995 c.f. Mean	+13%	+19%	-19%

Table 17. Estimated spawners (S) and total returns (R) of large salmon in Restigouche River, 1970 to 1995. Spawners were estimated using an angling exploitation rate (u) of 0.3.

Year	Harvest		Catch Including Releases	Poaching and Disease (PAD)	Spawners (S)	Returns (R)
	Estuary	River				
1970	18180	2042		1297	4765	26284
1971	8967	1016		645	2371	12999
1972	23	5041		3201	11762	20027
1973	295	4892		3106	11415	19708
1974	68	5948		3777	13879	23672
1975	1158	2901		1842	6769	12670
1976	1866	5510		3499	12857	23732
1977	3118	6707		4259	15650	29734
1978	285	5025		3191	11725	20226
1979	1567	1823		1158	4254	8802
1980	1836	6157		3910	14366	26269
1981	3745	4240		2692	9893	20570
1982	6113	2582		1640	6025	16360
1983	6045	2068		1313	4825	14251
1984[a]	3309	722	2276	1445	6865	12341
1985	1217	1173	4414	2803	13540	18733
1986	1576	1695	6183	3926	18915	26112
1987	1902	1170	4173	2650	12740	18462
1988	1430	1329	5675	3604	17588	23951
1989	1649	1492	4603	2923	13851	19915
1990	1606	1146	3735	2372	11304	16428
1991	1111	1181	3137	1992	9276	13560
1992	1412	1337	4355	2765	13180	18694
1993	1194	779	2055	1305	6071	9349
1994	1333	1308	3979	2527	11955	17123
1995	1163	1159	2792	1773	8148	12243
Mean (90-94)	-	1150	3452	2192	10357	-
1995 c.f. Mean	-	+1%	-19%	-19%	-21%	-

Table 18. Estimated spawners (S) and total returns (R) of large salmon in Restigouche River, 1970 to 1995. Spawners were estimated using an angling exploitation rate (u) of 0.5.

Year	Harvest		Catch Including Releases	Poaching and Disease (PAD)	Spawners (S)	Returns (R)
	Estuary	River				
1970	18180	2042		778	2042	23042
1971	8967	1016		387	1016	11386
1972	23	5041		1921	5041	12026
1973	295	4892		1864	4892	11943
1974	68	5948		2266	5948	14230
1975	1158	2901		1105	2901	8065
1976	1866	5510		2099	5510	14985
1977	3118	6707		2555	6707	19087
1978	285	5025		1915	5025	12250
1979	1567	1823		695	1823	5908
1980	1836	6157		2346	6157	16496
1981	3745	4240		1615	4240	13840
1982	6113	2582		984	2582	12261
1983	6045	2068		788	2068	10969
1984	3309	722	2276	867	3830	8728
1985	1217	1173	4414	1682	7655	11727
1986	1576	1695	6183	2356	10671	16298
1987	1902	1170	4173	1590	7176	11838
1988	1430	1329	5675	2162	10021	14942
1989	1649	1492	4603	1754	7714	12609
1990	1606	1146	3735	1423	6324	10499
1991	1111	1181	3137	1195	5093	8580
1992	1412	1337	4355	1659	7373	11781
1993	1194	779	2055	783	3331	6087
1994	1333	1308	3979	1516	6650	10807
1995	1163	1159	2792	1064	4425	7811
Mean (90-94)	-	1150	3452	1315	5754	-
1995 c.f. Mean	-	+1%	-19%	-19%	-23%	-

Table 19. Estimated spawners (S) and total returns (R) of small salmon in Restigouche River, 1970 to 1995. Spawners were estimated using an angling exploitation rate (u) of 0.3.

Year	Harvest		Catch	Poaching and Disease (PAD)	Spawners (S)	Returns (R)
	Estuary	River				
1970	0	1506		817	3514	5837
1971	0	1172		636	2735	4543
1972	36	1089		591	2541	4257
1973	1272	1570		852	3663	7357
1974	132	1167		633	2723	4655
1975	166	1279		694	2984	5123
1976	5120	2722		1477	6351	15670
1977	1153	2792		1515	6515	11975
1978	1545	1604		870	3743	7762
1979	252	2546		1382	5941	10121
1980	2044	3242		1759	7565	14610
1981	3065	3645		1978	8505	17193
1982	2362	2851		1547	6652	13412
1983	1584	896		486	2091	5057
1984	7339	1788		970	4172	14269
1985	35	3602		1955	8405	13997
1986	30	5417		2940	12640	21027
1987	100	5110		2773	11923	19906
1988	73	6873		3730	16037	26713
1989	163	3360		1823	7840	13186
1990	136	4324		2346	10089	16895
1991	19	2522		1369	5885	9795
1992	55	4755	4751	2578	11082	18470
1993	0	3288	3268	1773	7605	12666
1994	47	4869	4840	2627	11264	18807
1995	18	1620	1589	862	3677	6177
Mean (90-94)	-	3952	4286	2139	9185	-
1995 c.f. Mean	-	-59%	-63%	-60%	-60%	-

Table 20. Estimated spawners (S) and total returns (R) of small salmon in Restigouche River, 1970 to 1995. Spawners were estimated using an angling exploitation rate (u) of 0.5.

Year	Harvest		Catch	Poaching and Disease (PAD)	Spawners (S)	Returns (R)
	Estuary	River				
1970	0	1506		490	1506	3502
1971	0	1172		382	1172	2726
1972	36	1089		355	1089	2569
1973	1272	1570		511	1570	4923
1974	132	1167		380	1167	2846
1975	166	1279		416	1279	3140
1976	5120	2722		886	2722	11450
1977	1153	2792		909	2792	7646
1978	1545	1604		522	1604	5275
1979	252	2546		829	2546	6173
1980	2044	3242		1056	3242	9584
1981	3065	3645		1187	3645	11542
1982	2362	2851		928	2851	8992
1983	1584	896		292	896	3668
1984	7339	1788		582	1788	11497
1985	35	3602		1173	3602	8412
1986	30	5417		1764	5417	12628
1987	100	5110		1664	5110	11984
1988	73	6873		2238	6873	16057
1989	163	3360		1094	3360	7977
1990	136	4324		1408	4324	10192
1991	19	2522		821	2522	5884
1992	55	4755	4751	1547	4747	11104
1993	0	3288	3268	1064	3248	7600
1994	47	4869	4840	1576	4811	11303
1995	18	1620	1589	517	1558	3713
Mean (90-94)	-	3952	4286	1283	3930	-
1995 c.f. Mean	-	-59%	-63%	-60%	-60%	-

Table 21. Estimated spawners and total returns of large salmon in Restigouche River, 1993 to 1995, with 95% confidence limits. Spawners were estimated using mark-recapture techniques.

Year	Harvest		River population at point A	Poaching and Disease (PAD)	Spawners		Returns	
	Estuary	River						
1993	1194	779	7672	1228	5665	(4323-9022)	8866	(7268-12862)
1994	1333	1308	20864	3338	16218	(12438-25839)	22197	(17697-33651)
1995	1163	1159	15689	2510	12020	(6980-32927)	16852	(10852-41741)
Mean (93-94)	-	1044	14268	2283	10942		-	
1995 c.f. Mean	-	+11%	+10%	+10%	+10%		-	

Table 22. Estimated spawners and total returns of small salmon in Restigouche River, 1993 to 1995, with 95% confidence limits. Spawners were estimated using mark-recapture techniques.

Year	Harvest		River population at point A	Poaching and Disease (PAD)	Spawners		Returns	
	Estuary	River						
1993	0	3288	12000	1680	7032	(4882-12407)	12000	(9500-18250)
1994	47	4869	25500	3570	17061	(12331-29101)	25547	(20047-39547)
1995	18	1620	8825	1236	5969	(3067-18009)	8843	(5468-22843)
Mean (93-94)	-	4079	18750	2625	12047		-	
1995 c.f. Mean	-	-60%	-53%	-53%	-50%		-	

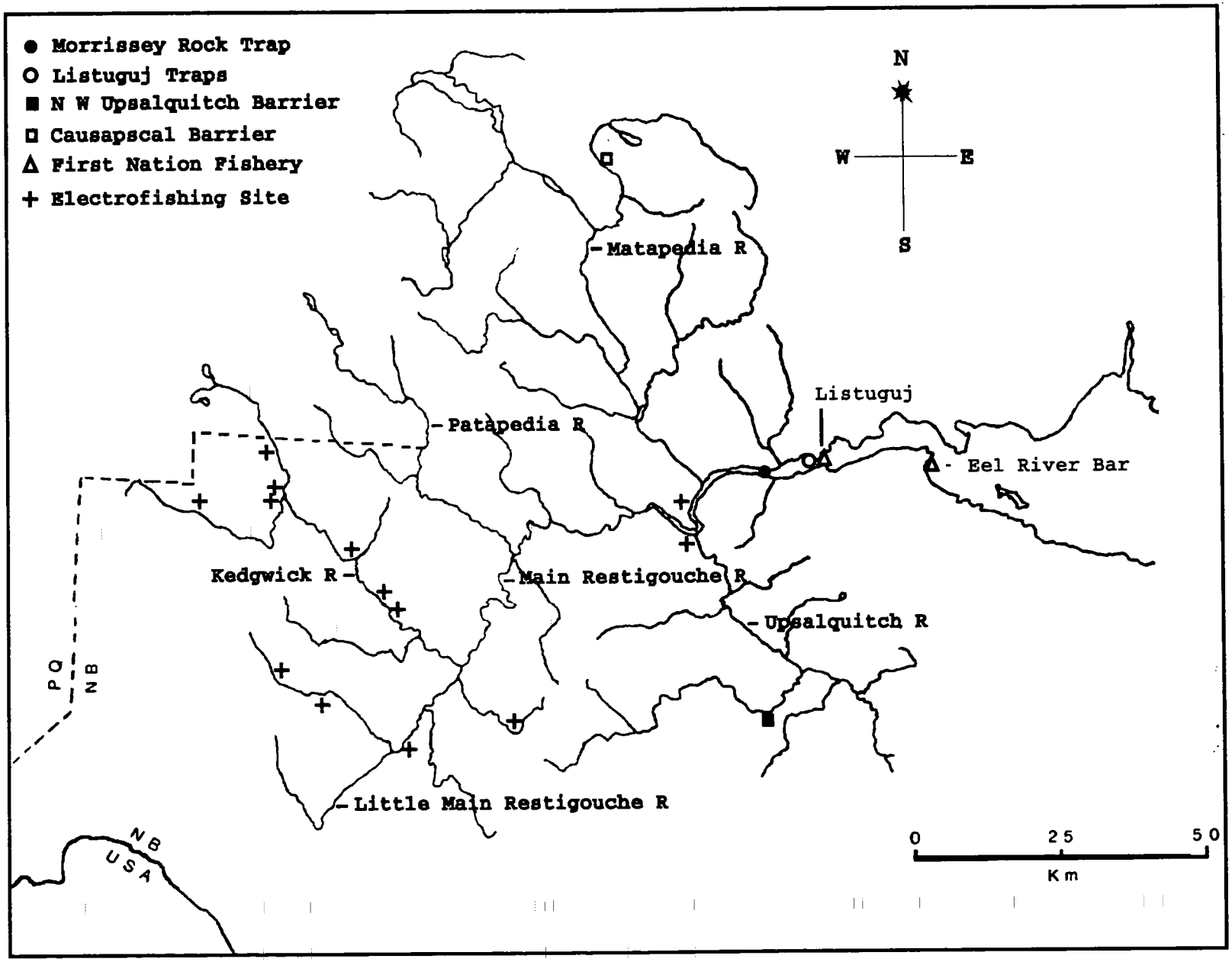


Figure 1. Map of the Restigouche River showing the location of salmon counting facilities, First Nations fisheries and electrofishing sites in 1995.

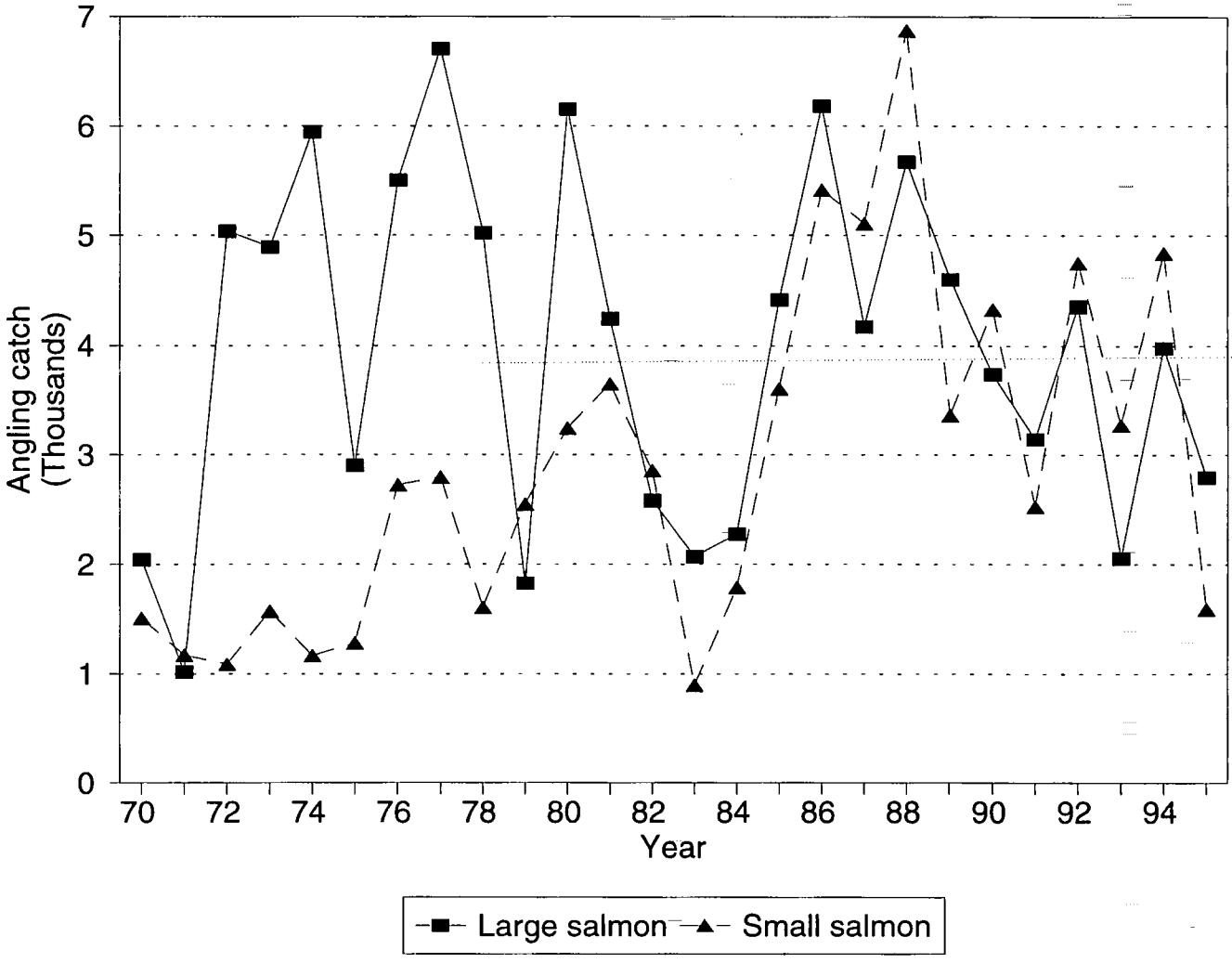


Figure 2. Angling catch of Atlantic salmon in the Restigouche River, 1970-1995.

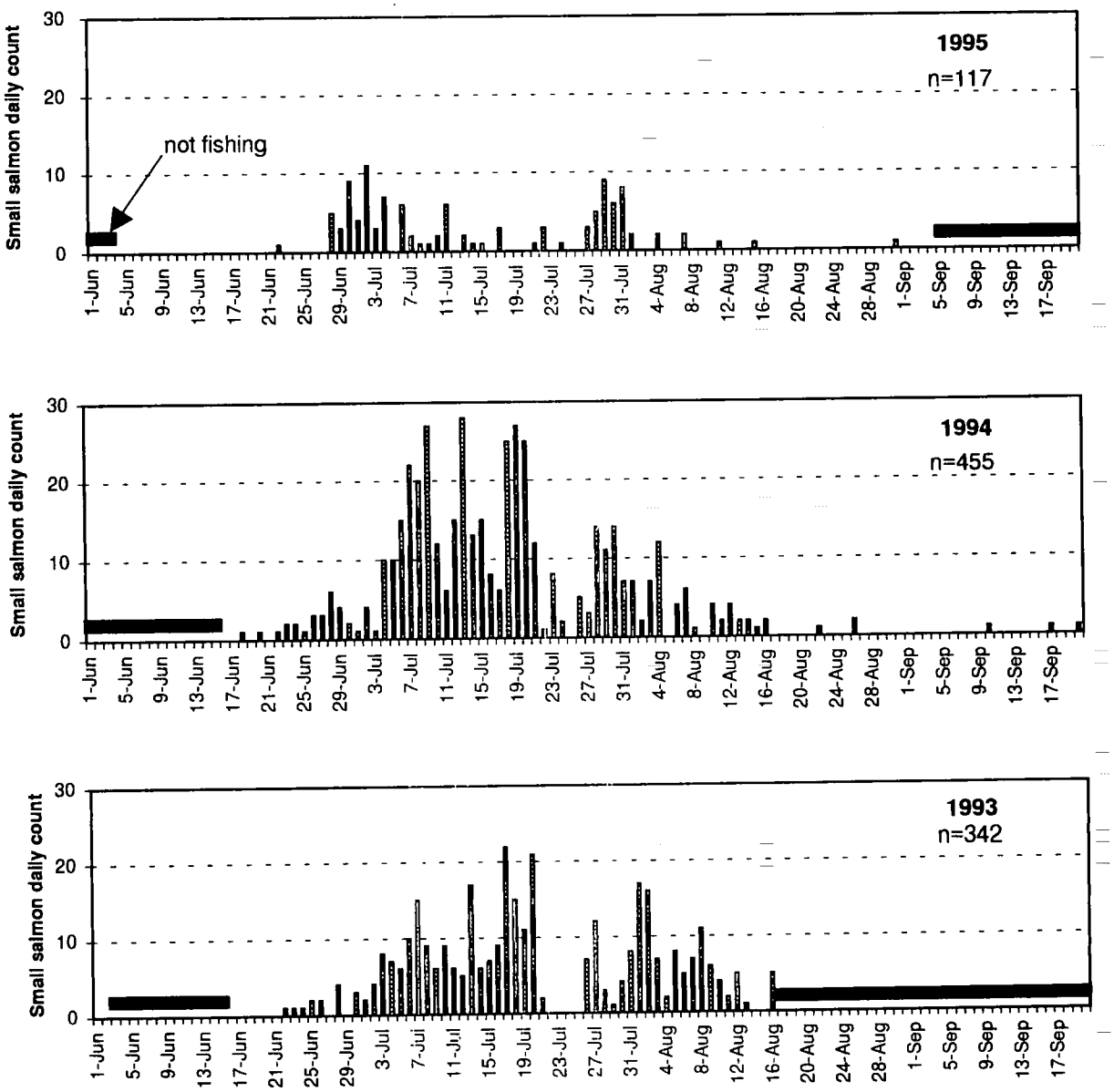


Figure 3. Daily catches of small salmon at Morrissey Rock assessment trap in 1993-1995. Horizontal bars indicate periods when the trap was not operating. In addition, the trap did not operate in 1995 on July 4, 11, 18, 25, August 1, 8, 15, 22 and 29.

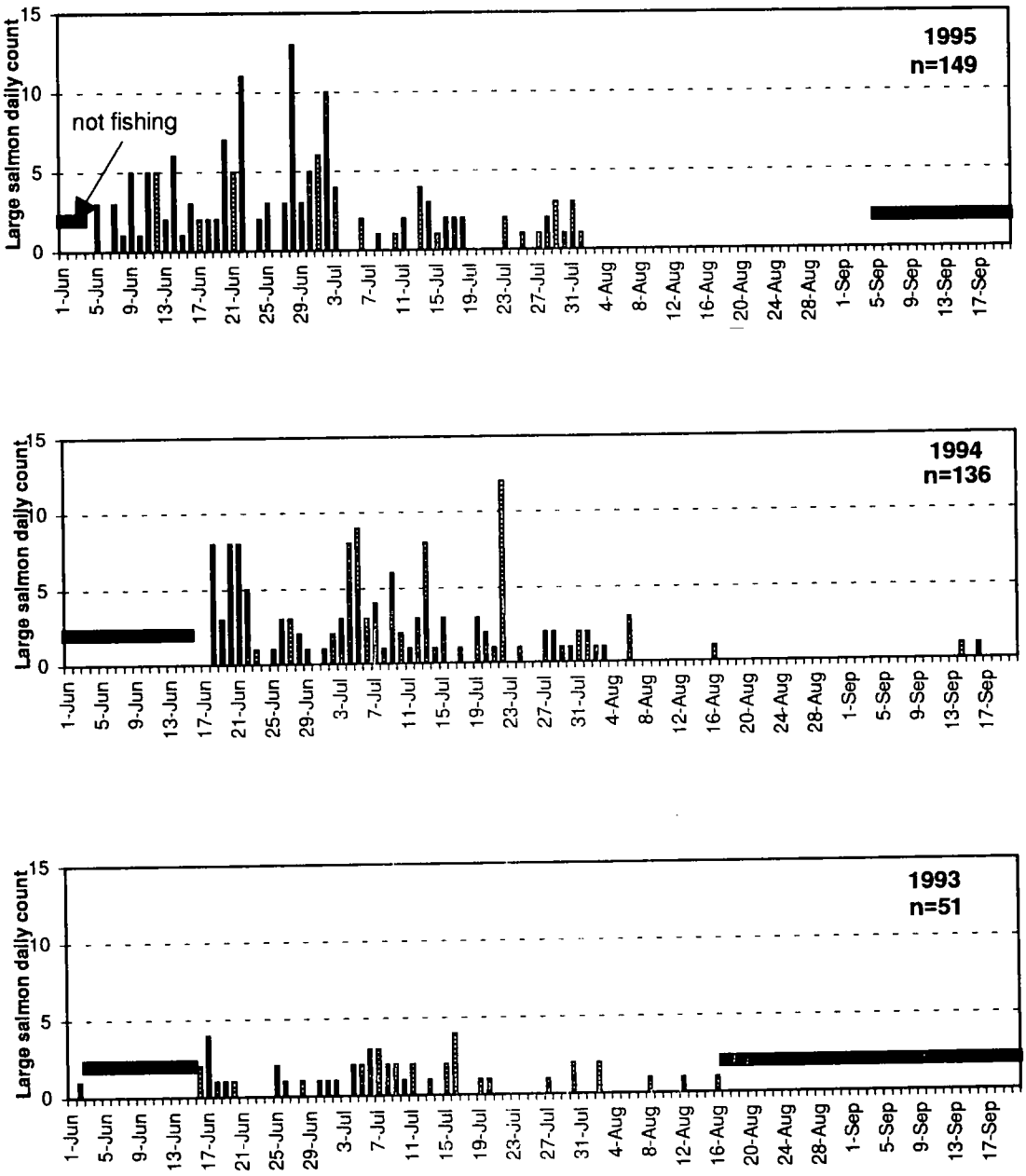


Figure 4. Daily catches of large salmon at Morrissey Rock assessment trap in 1993-1995. Horizontal bars and dates when the trap did not operate, as in Figure 3.

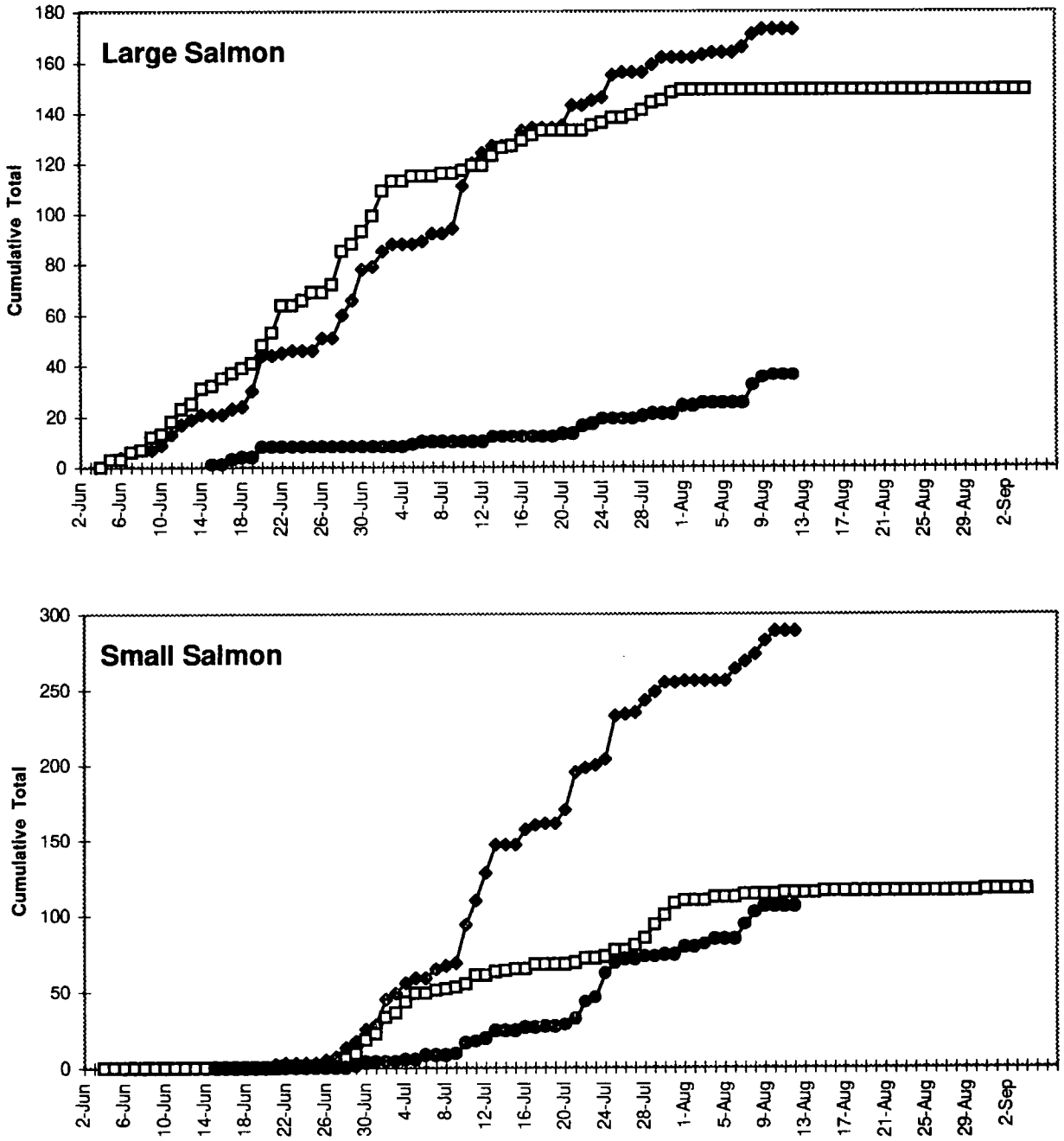


Figure 5. Cumulative catches of small and large salmon at the Morrissey Rock (squares), Adams' Shore (diamonds) and Smith Island (circles) assessment traps in 1995.

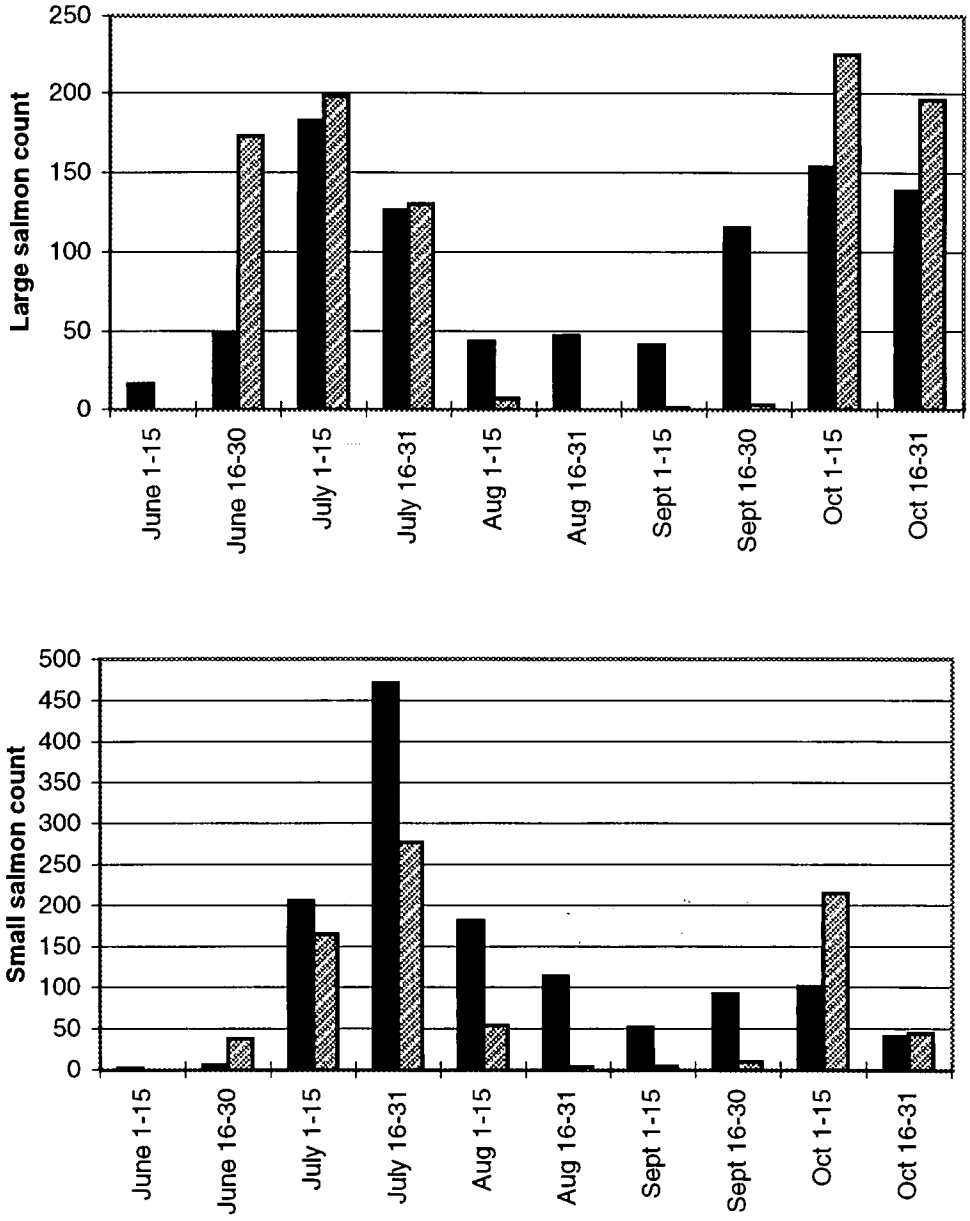


Figure 6. Daily catches of large and small salmon at the Northwest Upsalquitch barrier fence in 1995 (hatched bars), compared to the five-year (1990-1994) mean (solid bars).

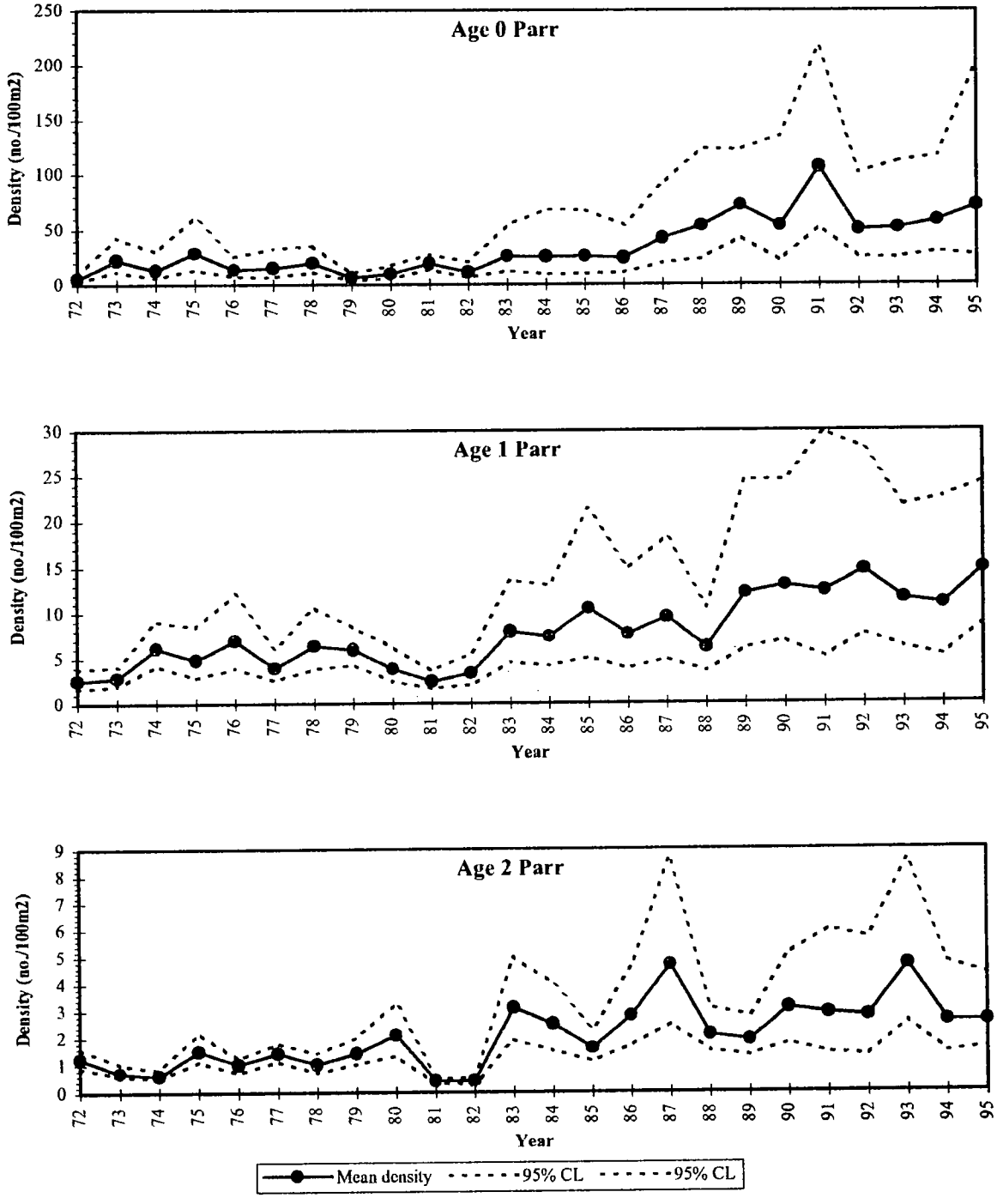
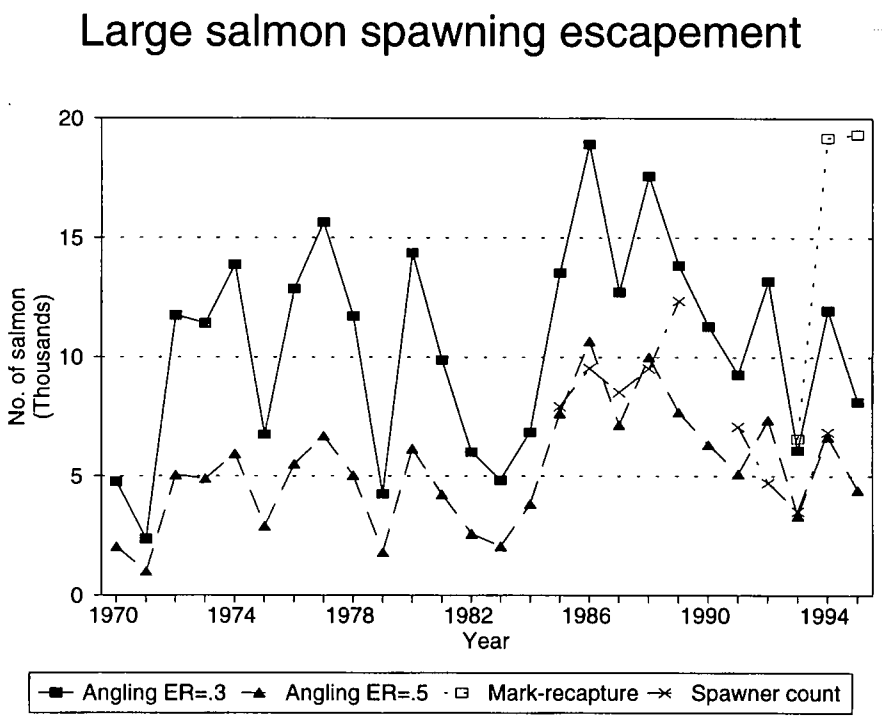


Figure 7. Mean densities of age 0, 1 and 2 parr in the Restigouche River, 1972-1995 (15 sites, 1972-1990 and 1993; 3 sites, 1991; 10 sites, 1992; 11 sites, 1994; 13 sites, 1995). Dashed lines are 95% confidence limits.



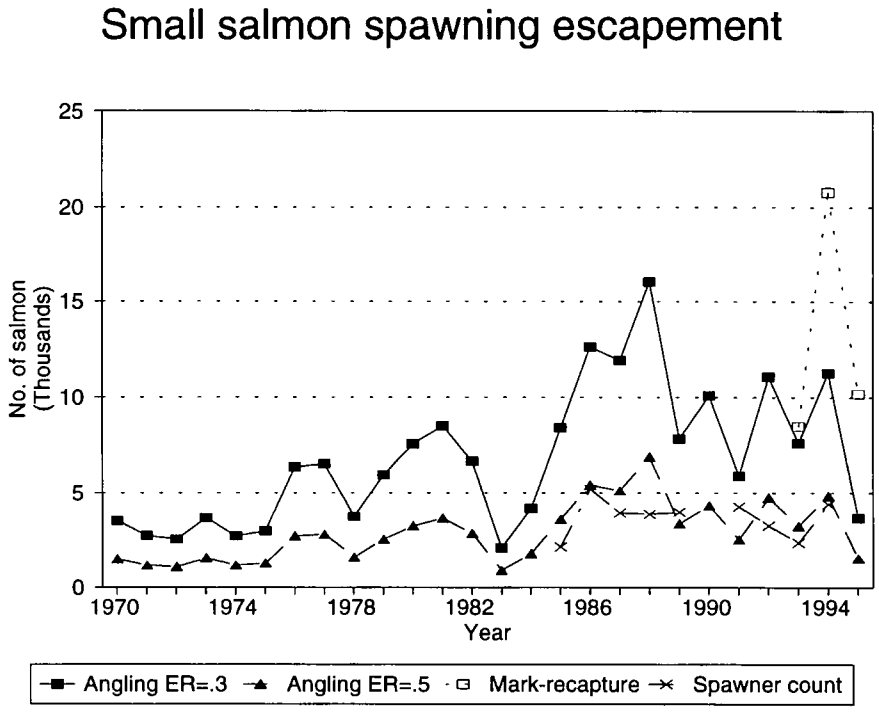


Figure 8. Comparison of large and small salmon spawning escapement estimates by various methods (angling exploitation rates (ER) of 0.3 and 0.5, mark-recapture estimate, and visual spawner counts), 1970-1995.

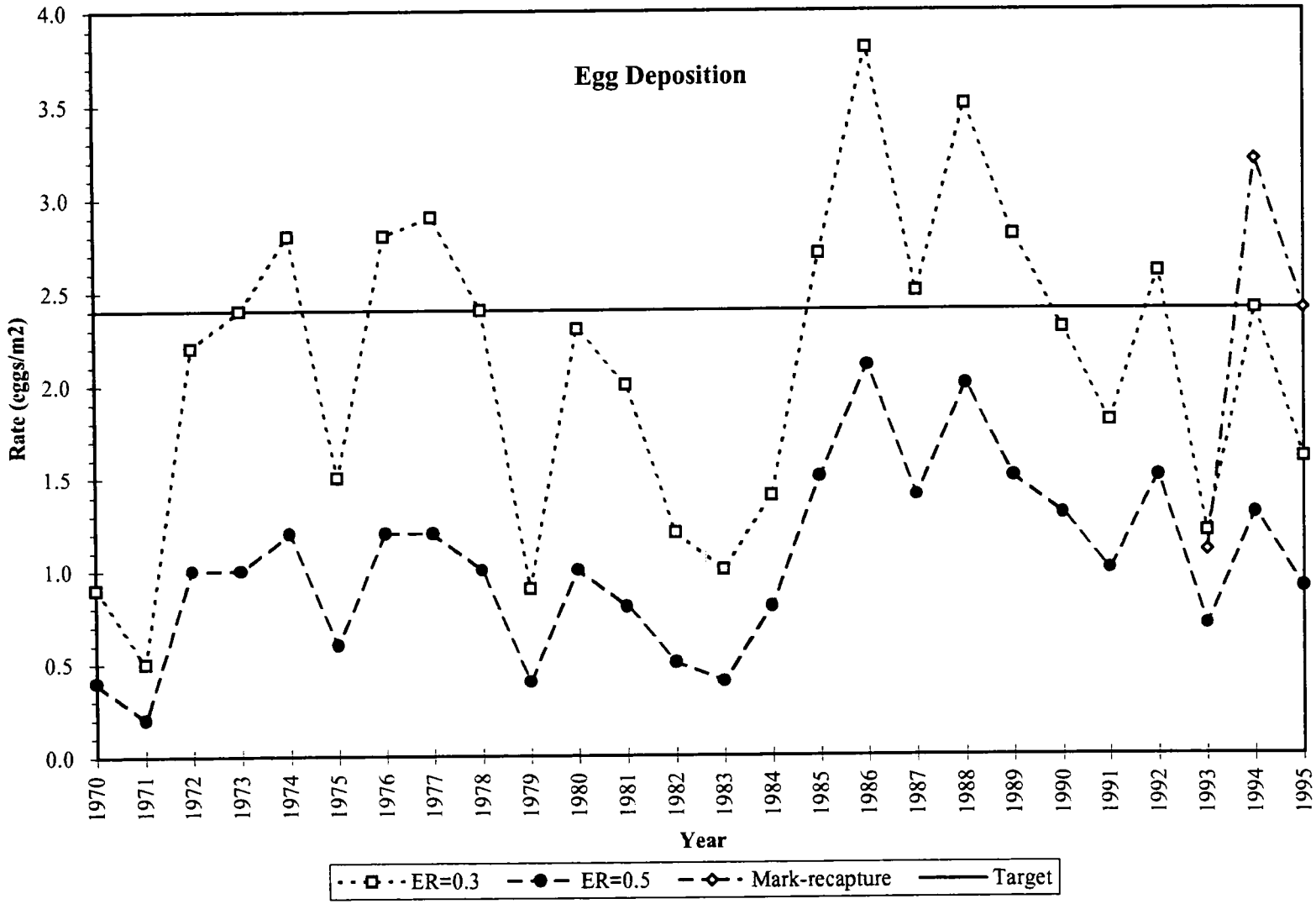


Figure 9. Egg deposition rates of Restigouche River salmon, estimated from angling exploitation rate method (two levels of exploitation rate, ER), and mark-recapture method, 1970-1995. Horizontal line indicates target deposition rate.