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Assessments of Atlantic salmon stocks in selected rivers of Eastern Cape Breton, SFA 19, to 2003

Évaluation de l'état des stocks de saumon atlantique de certaines rivières de l'est du Cap-Breton (ZPS 19) pour 2003

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Abstract

Assessments of the stock status of Atlantic salmon were conducted on the Middle, Baddeck, North and Grand rivers of SFA 19, Eastern Cape Breton Island in 2003. These rivers account for over 87% of the total recreational fishing effort exerted in the 15 Eastern Cape Breton rivers reportedly fished for salmon in 2003.

Returning salmon were estimated by snorkel count with mark-recapture calibration and from recreational catch estimates and rates. Estimated returns in 2003 were 554 large and 61 small to the Middle River, 305 large and 36 small to the Baddeck River, 395 large and 113 small to the North River, and 6 large and 34 small to the Grand River.

Conservation requirements on Middle River, which have generally not been achieved in recent years, were likely met in 2003 although expectations are low that returns will meet requirements in 2004. Returns to the Baddeck River in 2003 continue to be below conservation requirements, and expectations are that returns will not meet requirements in 2004. North River conservation requirements, which have not been met since 1999, were achieved in 2003, however, based on a five-year mean, it is unlikely that returns in 2004 will be sufficient to meet conservation requirements. Returns to Grand River in 2003 were the second lowest in the data series. Consistent low returns in recent years, and a forecast of only 43 returns in 2004 indicate a very low probability of meeting conservation requirements in 2004.

Résumé

L'état des stocks de saumon atlantique retrouvés dans les rivières Middle, Baddeck, North et Grand de la ZPS 19, située dans l'est du Cap-Breton, a été évalué en 2003. Ces cours d'eau pèsent pour plus de 87 % de l'effort total de pêche récréative déployé dans les 15 rivières de cette région où, à ce qu'il paraît, la pêche du saumon a été pratiquée en 2003.

Les remontes ont été estimées par le biais de plongées en apnée, puis étalonnées d'après les données sur la reprise de saumons étiquetés, des estimations des prises récréatives et des taux de prises récréatives. Pour 2003, elles se chiffraient comme suit : 554 gros et 61 petits saumons dans la rivière Middle, 305 gros et 36 petits saumons dans la rivière Baddeck, 395 gros et 113 petits saumons dans la rivière North et 6 gros et 34 petits saumons dans la rivière Grand.

Les impératifs de conservation pour la rivière Middle River, qui n'ont généralement pas été atteints au cours des dernières années, l'ont probablement été en 2003, quoiqu'on ne s'attende pas vraiment à ce la remonte les satisfait en 2004. La remonte dans la rivière Baddeck en 2003 continue d'être inférieure aux impératifs de conservation, et l'on s'attend à ce qu'elle ne satisfait pas aux impératifs en 2004. Les impératifs de conservation pour la rivière North, qui n'ont pas été satisfaits depuis 1999, ont été atteints en 2003; par contre, d'après la moyenne quinquennale, il est peu probable que la remonte en 2004 suffira à les satisfaire. La remonte dans la rivière Grand en 2003 était la deuxième moins abondante dans la série de données. Les remontes régulièrement peu abondantes au cours des dernières années et la prévision d'une remonte de seulement 43 saumons en 2004 indiquent qu'il est très peu probable que les impératifs de conservation seront satisfaits en 2004.

Introduction

This document assesses the status of Atlantic salmon (*Salmo salar*) populations in 2003 for Eastern Cape Breton rivers, Salmon Fishing Area 19 (SFA 19) with a brief review of the derivation of estimates since the last formal assessment in 1999 (Marshall et al. 2000). Updates have been provided annually thereafter (DFO 2001, 2002 and 2003).

Eastern Cape Breton Island (SFA 19) includes 30 salmon rivers having historically reported Atlantic salmon angling from the Inverness-Victoria county line at the Canso causeway, eastward through Richmond, Cape Breton and Victoria counties (Table 1, Figure 1). Salmon stocks are assessed annually in the Middle, Baddeck and North rivers, Victoria Co. which have their headwaters in the Cape Breton Highlands (Figure 1). These rivers have excellent water quality for Atlantic salmon rearing and no significant impediments to fish migration. The salmon stock of the Grand River (Figure 1), which is of lower gradient than rivers flowing from the highlands, has flows and temperatures influenced by headwater lakes, and empties directly to the Atlantic coast of Cape Breton, was assessed annually from 1988 to 2000 and 2001 to 2003.

Adult salmon assessments in Victoria County rivers of SFA 19 are based on fall-season snorkel diver counts of salmon with mark-recapture calibrations and from recreational catches. Autumn swim-thru counts of adult salmon have been conducted annually on the Middle River since 1989, and on the Baddeck and North rivers since 1994 (Amiro and Longard 1995, Marshall et al. 1998) with the exception of the years 1999 and 2001 on the Baddeck River and the years 1999, 2000 and 2003 on the North River when no swim-thru counts were conducted due to adverse high water conditions. Swim-thru counts of small and large salmon are traditionally conducted in mid-late October, by teams of two divers assigned to most of the four to six sections in each of the Middle, North and Baddeck rivers (Figures 2 to 4; Appendix I). Mark-recapture experiments began in 1994. Tags were applied to fish netted a day or two previous to the swim-thru. Orange streamer tags were used from 1994 to 1998 (Amiro and Longard 1995, Marshall et al. 1996-1999). Yellow disk tags applied to the anterior section at the basal margin of the dorsal fin were first introduced in 1998 (Marshall et al. 1999) and used every year thereafter.

Salmon assessments on Grand River, Richmond County were estimated from adult counts at a fishway that by-passes Grand River falls 1988-1998, from partial fishway count in 1999 and 2000, and returns to the river in recent years were estimated from recreational catch.

Based on adult escapement estimates, conservation requirements have generally not been achieved in Eastern Cape Breton rivers in recent years. Except for 1996, conservation requirements have not been met on the Middle River since 1989. Escapement to the Baddeck River has not met requirements since at least 1994. Except for 2001, the North River has not met requirements since 1999, although conservation requirements had been achieved on the North River for over a decade prior to 1999. The Grand River has not met its salmon conservation requirement upriver of the fishway since 1999. Returns to Grand River since 2000 are dependent on wild production only, a component that has not met requirements since 1990.

In the fall of 2003, mark-recapture counts of salmon were conducted on the Middle and Baddeck rivers. Returns to these rivers were estimated from escapement estimates derived from snorkel counts plus removals prior to the counts. Returns to North River were estimated from recreational catch and a mean catch rate of 0.75 for small and 0.41 for large salmon derived from mark and recapture population estimates for years 1994-1998, 2001 and 2002. Grand River returns in 2003, as in 2001 and 2002, were estimated from recreational catches and an assumed catch rate of 0.5 which is similar to that determined in other rivers.

The purpose of this document is to present the methodology and results of the 2003 Atlantic salmon assessment for each of the four monitored rivers: Middle, Baddeck, North and Grand rivers, including a brief review of the derivation of estimates since the last formal assessment in 1999, a review of adult salmon survey data collected since 1994, and juvenile salmon survey data since 1996. Firstly, a description of the fisheries is presented including commercial, recreational, aboriginal and unlicensed removals. Following this description, information for each of the four monitored rivers is presented, including:

- Background information which may include geographical location of river, habitat, stock characteristics, stocking efforts and presence of other salmonids;
- Description of river-specific conservation requirements;
- Methods and results including recreational fishery catch and effort, description of adult surveys, as well as juvenile abundance surveys and results;
- Status in 2003, including review of derivation of adult return estimates since 1994 and estimates of spawner escapement relative to requirements;
- Outlook for 2004;
- Discussion.

Area by gradient categories, recreational catch, and juvenile salmon population data on other rivers of SFA 19 is also presented. A section summarizing the adult movement through the Sydney River dam fishway between 1994 and 2003 is included. The document concludes with some pertinent fisheries management considerations.

Description of Fisheries

Commercial Fishery

The commercial salmon fishery in Eastern Cape Breton was shortened in 1984, closed in 1985, and remained closed in 2003. No commercial salmon fishing licenses remain in SFA 19.

Recreational Fishery

The recreational salmon angling season for Salmon Fishing Area 19 rivers in 2003 was open for catch-and-release fly fishing only from June 1 to July 15 and Sept. 1 to Oct. 31 with the exception of Indian Brook, Eskasoni, and North River upstream from the area known as “The Benches” which were closed all year (Table 1). The daily catch and release limit in 2003 was two fish of any combination of small salmon (<63 cm) sometimes known as “grilse” or large salmon (≥ 63.0 cm) sometimes referred to as “salmon”. Recreational catch and effort for Atlantic salmon in all Cape Breton rivers is estimated from Nova Scotia Salmon Angling Licence stubs returned by anglers. This information

has been synthesised annually between 1983 and 1989 (O'Neil et al. 1996). Annual summaries of catch, effort, and estimated small and large salmon retained and released for the four monitored rivers, Middle, Baddeck, North and Grand, 1984-2003, is provided in Appendix II.

In 2003, anglers spent an estimated 1328 rod days on the Island's eastern rivers (Table 1). Of this total, 1157 rod days were spent in the Middle, North, Baddeck and Grand rivers alone, which accounts for 87% of the total recreational fishing effort exerted in the 15 Eastern Cape Breton rivers reportedly fished for salmon in 2003 (Table 1). Preliminary estimates of catches in 2003 were 160 small and 414 large salmon for a total of 574 fish (Table 1).

These four monitored rivers also accounted for 83% of the total recreational fishing effort exerted in the 25 Eastern Cape Breton rivers reportedly fished for salmon between 1998 and 2002 (Table 2). Total effort in 2003 increased by 49% over 2002 (Table 2). Compared to 2002, the catch of small salmon was up 24% and the large salmon catch was up 224% (Table 2). Compared to the 1998-2002 mean values, effort was up 24%, the catch of small salmon was up 7% and the large salmon catch was up 111% (Table 2).

Aboriginal Fisheries and Harvest

The fishing of salmon by angling, snaring, spearing, and dip netting were permitted methods of achieving river-specific quotas for each of five First Nations (FNs) on Cape Breton Island (Eskasoni, Chapel Island, Membertou, Wagmatcook, and Waycobah) and non-river-specific allocations to harvesters of the Native Council of Nova Scotia. Allocations to First Peoples totalled 50 small and 50 large salmon from the North River. Ten tags for either small or large salmon were available to each of 22 members of the Native Council of Nova Scotia residents in SFA 19.

River	Allocation		Gear type	Season
	Small	Large		
North	50	50	angle, snare, spear, dipnet	June 1 - Oct. 25
Native Council NS	220 by maximum of 22 harvesters			

Catch reports were incomplete at the time of this writing. Indications were that an estimated 20 large and 10 small salmon were taken from a trap set in the approaches of Middle River with another 10 large and 10 small salmon angled from the Middle River by Wagmatcook, Membertou and Eskasoni FNs in late March and April. None were reported taken by FNs on the Baddeck. No FN fishing activity was reported in either the North River estuary or upriver.

Unlicensed removals of salmon

Unreported Atlantic salmon removals from Eastern Cape Breton rivers in 2003 as reported by fishery officers were estimated at 79 small and 109 large salmon for a total of 188 fish.

Small		Large		Total	
(#)	(kg)	(#)	(kg)	(#)	(kg)
79	136	109	553	188	689

Middle River

The Middle River, Victoria County, is encompassed by the North and Baddeck rivers to the east, Humes River to the west and the Margaree River to the north (Figure 1). The main stem arises in the Cape Breton Highlands, about 450 m above sea level, and flows in a southward direction to its confluence with Nyanza Bay, St. Patrick's Channel, of the Bras d'Or Lake (Figure 2). Middle River is unobstructed and not affected by acid precipitation but is exposed to agricultural practices in the lower valley.

The Middle River has a more gentle gradient profile than its neighbouring Baddeck River and North River watersheds. Wetted stream area at mean summer low categorized by gradient with respect to 17 other rivers of SFA 19 is presented in Table 3.

Historically, the salmon stock of Middle River consisted of summer and fall components (Marshall et al. 1996). In recent times, the summer component has all but disappeared. Efforts in the mid-late 1980s to redevelop a summer run from the North River stock were unsuccessful (Marshall et al. 1996). There is currently no stocking of hatchery-reared salmon in this system.

Small numbers of farmed escaped salmon have on occasion, e.g. 1997 at the Pipe Pool on the Yankee Line Road, been observed in the Middle River during dive surveys. These observations have been coincident with reported escapes from industry grow-out sites in the Bras d'Or Lakes (ICES 2003). Occasional (less than 12) adult rainbow trout (*Oncorhynchus mykiss*) are observed during annual fall swim-thru operations (DFO unpublished data) and sometimes reported angled (G. MacDonald, pers. comm.[1]). Small numbers of juvenile rainbow trout were present among juvenile salmon when assessed by electrofishing since 1998, mean annual densities being less than 12 fish per 100m^2 (Table 4).

Conservation Requirements

The conservation requirements for the Middle River as reported by Marshall et al. (1999) were based on an estimated 864,600 m^2 of wetted stream area adjusted to the mean summer low for reaches where stream gradient was >0.12% as determined from orthophotographic maps and aerial photographs (Amiro 1993) (Table 3) and 2.4 eggs per m^2 (Elson 1975). Requirements number 2.07 million eggs which, based on the average population age, size and sex composition, are expected from 470 large and 80 small salmon.

[1] Mr. G. MacDonald, Fishery Officer, P.O. Box 160, Baddeck, Nova Scotia, B0E 1B0.

Methods and Results

Recreational Fishery

Since 1998 the recreational Atlantic salmon fishery on the Middle River has been open for catch and release from June 1-July 15 and Sept. 1-Oct. 31. Anglers expended an estimated average of 263 rod days per year on the Middle River in the last five years (Table 2). The estimated effort of 334 rod days in 2003 was 45% higher than that estimated in 2002 and 27% higher than the mean effort from 1998-2002 (Table 2, Appendix II). Preliminary catches, estimated from 73 licence stub returns by anglers fishing to the Oct. 31 closure in 2003, were estimated to be 144 large and 24 small salmon (Table 1). Catches of large salmon were the highest since 1994, up 311% from 2002, and 165% higher than the previous five-year mean (Table 2, Appendix II). Small salmon catches were 14% lower than those in 2002 but 1% higher than the previous five-year mean (Table 2, Appendix II).

Adult Salmon Surveys

Returns and escapements to Middle River in 1994 to 2003 were estimated from mark-recapture techniques and maximum likelihood estimation procedures (Gazey and Staley 1986). A summary of the mark-recapture data for Middle River can be found in Appendix III.

In 2001 and 2002 however, adverse water conditions prohibited the catch and marking of salmon necessary to calibrate the snorkel count of salmon. Counts, without applying marks, were however conducted in both years, and the mean observation rate of 0.66 (90% CI: 0.54-0.78; n= 7, sd=0.09), derived from successful mark and recapture estimates in the years 1994 to 2000, was used to estimate return values in 2001 and 2002 (DFO 2002 and 2003).

A mark-recapture experiment provided data for estimation of the Middle River population in 2003. Mark-recapture methodology follows that used and described in previous assessments (Marshall et al. 1998, 1999). Marks were applied to 16 large and six small adult fish on October 20 (Appendix III). Counts of marked (recaptures) and unmarked fish were obtained on October 22 and again on November 4th by swim-thru surveys. The area of coverage was broken into five sections (Figure 2, Appendix I). Due to the high water and poor visibility on October 22, only 21 unmarked and four marked fish were observed over the 17.6 kms of river covered by the divers. On Nov 4th a second recapture run was conducted under good visibility and good water conditions. During this second swim-thru divers covered a 16 km section of the river and observed 193 fish (19 small and 174 large) of which one small and six large were marked. Input to the analysis therefore consisted of M=22; C=193 and R=7 (Appendix III).

Based on the mark and recapture derived population estimates, catch rates for the recreational fishery can be estimated. Mean catch rates for seven years between 1994 and 2003, when mark-recapture data was available, averaged 0.44 (90% CI: 0.32-0.55) for small and 0.29 (90% CI: 0.22-0.35) for large salmon (see text table below). Annual estimates of escapement, and percent of conservation requirements met in Middle River, 1989-2003, for small and large salmon by these two methods, are presented in Table 5.

Recreational fishery catch rates based on mark and recapture population estimates for small and large salmon in the Middle River, Victoria County, 1994 to 2000, and 2003.

	Catch rates	
Year	Small	Large
1994	0.51	0.39
1995	0.73	0.16
1996	0.48	0.30
1997	0.26	0.23
1998	0.35	0.39
1999	0.33	0.26
2000	0.43	0.30
2001		
2002		
2003	0.39	0.26
Mean	0.44	0.29
Sd	0.14	0.08

Juvenile Surveys

No sampling for juvenile salmon was conducted in Middle River in 2002 or 2003. Electrofishing at five sites (Figure 2) since 1996 consisted of three-four sweep removal estimates in barrier sections (Table 6, Appendix IV). Estimates of population size for both fry and parr were derived by exact solution for three sweeps and by an iterative solution by Zippin's maximum-likelihood technique for four or more sweeps as per Amiro and Longard (1995). Density (fish per $100m^2$) of juvenile salmon was estimated by dividing the population estimate by the wetted area of habitat sampled multiplied by 100. Densities are compared to a "normal index of abundance" (Elson norm) of 29 fry (age-0^+ parr) and 38 parr (age-1^+ and 2^+) per 100 m^2, which was determined from 129 sites on New Brunswick rivers (mostly the Miramichi) in the 1950s (Elson 1967).

Monitoring at two main stem index sites, Finlayson and Twin Churches, from 1996 to 2001 (Figure 2, Table 6, Appendix IV) revealed juvenile densities to be consistently at or slightly above the Elson (1967) normal index of abundances. Although fry densities dropped in 2001 to only 0.3 times the Elson norm, parr densities remained high at 1.1 times the norm (Figure 6).

Status

Population estimate from recreational fishery and catch rates

Returns to the Middle River were first derived from recreational catches. Estimated catch and release mortalities were based on a 3% hook and release mortality which applied to the reported catch indicated a mortality of four large and one small salmon. Using the mean catch rates (1994-2003) (from text table above) and estimated recreational catches of 144 large and 24 small salmon, returns to the Middle River in 2003 were estimated to be 55 (90% CI 43 – 76) small and 503 (90% CI 409 – 653) large salmon for a total of 558 (90% CI: 452 - 729) fish (Figure 5, Table 5).

Population estimates from mark and recapture and swim-thru counts

The estimated number of adult salmon in the Middle River during the 2003 swim-thru was 610 fish (90% CI: 400-1,569). Proportioning of the estimate on the basis of small and large salmon observed during the count with the addition of mortalities associated with recreational fishing and reported removals suggests a total wild salmon return of 615 fish comprised of 554 large and 61 small salmon (Figure 5, Table 5).

Escapement, the number of salmon surviving to spawn, to the Middle River in 2003 determined from returns derived from swim-thru was estimated to be 60 small and 550 large salmon (Figure 5, Table 5). Based on these numbers, small salmon escapement in 2003 was about 75% of requirement. Large salmon escapement was about 117% of requirement and up 561% from 2002, the highest since 1989 (Table 5).

Biological characteristics and estimated egg deposition

Fish requirements to provide prescribed eggs requirements are based on stock and biological characteristics. Characteristics key to the calculation include the proportion of one-sea-winter (1SW; "small") and multi-sea-winter (MSW; "large") fish in the population, proportion females in each component and an estimate of the fecundity of 1SW and MSW females. By a prior decision all prescribed eggs are to come from MSW salmon. In addition, 1SW fish are required to provide a 1:1 male to female ratio among spawners. Estimates of fecundity for Middle River are derived from the length-fecundity relationship: Log Eggs=5.741 + 0.04 Fork Length (Marshall et al. 1999).

Salmon seined in Middle River during the fall 2003 swim-thru operation were sexed, measured (fork length) and scale sampled for age determination. Based on this sample, the population estimate was re-apportioned by age and sex and the potential egg deposition was estimated (Table 7). Based on these biological samples and proportions, spawning escapement was estimated at 166 small and 444 large fish of which 55% were large female salmon (Table 8). Total female escapement was estimated to be 329 fish, which yielded 98% of the egg requirement for the river (Table 8).

Outlook

The Middle River forecast for 2004 is the mean adult return, 1999-2003, i.e. 334 fish (90% CI: 72-659), or 61% of conservation requirement. Based on this mean, the probability of the 2004 returns exceeding the conservation requirement of 550 fish is about 14%.

Discussion

While there was some agreement in the 2003 total salmon population estimates of 615 (90% CI: 395-1,574) by mark and recapture swum-thru and 558 (90% CI: 452 - 729) by the reported recreational catch and catch rates there was substantial disagreement in the proportion of large and small salmon by the two methods. The ratio of large to small ranged from about 9:1 for the swim thru, to 6:1 for the recreational catch data to 3:1 for the seining data. These differences could lead to different estimates of egg depositions which is a critical feature of the assessment. All estimates are subject to errors in the data and sampling, however, because the mark and recapture data provides a direct measurement of critical biological characteristics, particularly the proportion and size of female salmon among large fish it is, in this case, our preferred method of estimation. The ratio of large to small used in the assessment is that of the swim-thru and proportion female is that of the seining.

The regression of swim-thru count estimates and recreational catch derived estimates for Middle River 1994-2003 (Table 5) yields an R^2 value of 0.77 significant at p = 0.0008 (n=10) supporting the coincidence of the two methods and the use of the recreational catch method in the absence of seining and swim-thru data.

During the October 22^{sd} swim-thru some sections of the river had virtually zero visibility due to heavy rainfall; therefore the low recaptures were insufficient to estimate the population. Data from the second recapture run conducted on November 4th under good water conditions was therefore utilized in the assessment. This date is later than all previous mark and recaptures dates but not swim-thru dates. As the salmon stock of Middle River is principally a fall run, the later than usual raise in water level combined with the later date of the recapture swim-thru possibly resulted in more fish being present in the river system during the swim-thru count and therefore may have provided a more accurate population estimate. This may have increased the accuracy relative to previous estimates but does not negatively affect the conclusion that spawning escapement was met in 2003.

Baddeck River

The Baddeck River, Victoria County, is adjacent to the watersheds of the Middle and North rivers (Figure 1). The river arises in the Cape Breton Highlands at about 430 m elevation and flows in a south and westward direction to its confluence with Nyanza Bay, St. Patrick's Channel of the Bras d'Or Lake at a point less than 4km east of the mouth of Middle River (Figure 3). The gradient of the Baddeck River that is accessible to salmon is on average, steeper than that of the neighbouring Middle, but not as steep as that of the North River (Table 3).

The Baddeck River salmon stock has been, at least in recent times, principally a fall-run, arriving after mid-October. Stocking of juveniles of North River origin (presumably early-run characteristics) in the mid 1980s had no discernible effect on the subsequent timing of the recreational fishery (Marshall et al. 1996).

Conservation Requirements

The conservation requirements for the Baddeck River are based on a wetted substrate area of 836,300 m^2 >0.12% orthograde (Table 3) and 2.4 eggs per m^2 (Elson 1975, Marshall et al. 1999). Requirements number 2.0 million eggs which are expected from 450 large and 80 small salmon.

Methods and Results

Recreational Fishery

Since 1998, the recreational Atlantic salmon fishery on the Baddeck River has been open for catch and release from June 1 - July 15 and Sept. 1 - Oct. 31. Anglers expended an estimated average of 229 rod days per year on the Baddeck River in the last five years (Table 2). The estimated effort of 220 rod days in 2003 was 8% higher than the effort in 2002, but 4% lower than the 5-year mean (Table 2, Appendix II). Preliminary catches, estimated from 49 licence stub returns by anglers fishing to the Oct. 31 closure in 2003, were estimated to be 24 small

and 77 large salmon (Table 1). Large salmon catches were up 103% from 2002, and were 41% higher than the previous 5-year mean (Table 2, Appendix II). Small salmon catches were up 26% from 2002, but only 5% over the 5-year mean (Table 2, Appendix II).

Adult Salmon Surveys

Returns and escapement to the Baddeck River between 1994 and 2003 were typically estimated from snorkel counts and a maximum likelihood estimation procedure (Gazey and Staley 1986). A summary of the mark-recapture data for the Baddeck River can be found in Appendix V. Based on mark and recapture derived population estimates for six years between 1994 and 2003, catch rates for the recreational fishery were also estimated (see text table below). Mean catch rates averaged 0.57 (90% CI: 0.38-0.77) for small and 0.38 (90% CI: 0.27-0.50) for large salmon.

Recreational salmon fishery catch rates based on mark and recapture population estimates for small and large salmon in the Baddeck River, Victoria County, 1994 to 1998 and 2000.

	Catch rates	
Year	Small	Large
1994	0.46	0.43
1995	0.49	0.23
1996	0.59	0.53
1997	0.23	0.36
1998	0.92	0.54
2000	0.66	0.34
Mean	0.384	0.57
Sd	0.123	0.21

In 1999, no swim-thru was conducted and therefore no estimate of returns and escapement to the Baddeck River was derived by that method (Marshall et al. 2000). In 2001 and 2002, adverse water conditions prohibited the catch and marking of salmon necessary to calibrate the snorkel count data on the Baddeck River. Returns to the Baddeck River in 2001 were estimated from angling catch with calibrations from historical snorkel counts (DFO 2002). A count without applying marks was conducted in 2002 and a mean observation rate of 0.56 (range: 0.45-0.76, n=6, sd=0.1), derived from previous mark and recapture estimates in the years 1994 to 1998 and 2000 (see text table below), was used to estimate return values (DFO 2003).

Salmon observation rates by swim-thru snorkel divers as derived from mark-recapture estimates in the Baddeck River, Victoria County, 1994 to 1998 and 2000.

Year	Observation rate
1994	0.762
1995	0.445
1996	0.664
1997	0.602
1998	0.566
2000	0.630
Mean	0.559
Sd	0.168

A mark-recapture experiment, following the methodology described in previous assessments (Marshall et al. 1998, 1999) provided data for estimation of the Baddeck River population in 2003. A total of 15 tags were applied, 10 large and five small salmon, at three locations on the Baddeck River on Oct. 21 (Appendix V). Three additional locations were visited, but no fish were tagged. Heavy rains during the days following the marking run precluded any swim-thru attempts during that week. Divers returned to the Baddeck River on November 5th. Under good visibility and moderate water conditions, divers covered approximately an 8km section of the river. A total of 67 fish were observed (60 large and seven small) of which three large were marked. Input to the analysis therefore consisted of M=15; C=67; and R=3 (Appendix V).

Juvenile Surveys

No sampling for juvenile salmon was conducted on the Baddeck River in 2002 or 2003. Sampling at four sites since 1996 (Figure 3) consisted of three-four sweep removal estimates in barriered sections (Table 6, Appendix IV). Population estimates were derived in the same manner as those of the Middle River.

Monitoring at three main river sites (Upper Baddeck, North Branch and E-Ban) from 1996 to 2000 (Table 6, Figure 3) indicates that densities of age-0^+ parr fluctuated above while densities of age-1^+ and older parr fluctuated at or slightly below the Elson norms (Figure 8, Appendix IV).

Status

Population estimate from recreational fishery and catch rates

Returns to the Baddeck River were first derived from recreational catches. Estimated catch and release mortalities were based on a 3% hook and release mortality which applied to the reported catch indicated a mortality of four large and one small salmon. Using the mean catch rates (1994-1998 and 2000) (from text table above) and estimated recreational catches of 77 large and 24 small salmon, returns to the Baddeck River in 2003 were estimated to be 42 (90% CI: 31 – 63) small and 200 (90% CI: 155 – 285) large salmon for a total of 242 (90% CI: 189 - 335) fish (Table 9, Figure 7).

Population estimate from mark and recapture and swim-thru counts

Based on the November 5th 2003 swim-thru, the estimated number of salmon in the Baddeck River was 338 fish (90% CI: 206-2330). Proportioning of the estimate on the basis of small and large salmon count and additional estimated removals/mortalities of two large and one small salmon suggest a total wild return of 341 fish comprised of 305 large and 36 small salmon (Table 9, Figure 7).

Using the mark-recapture and removal estimates, the escapement to the Baddeck River in 2003, could have been 338 fish, comprised of 35 small and 303 large salmon (Table 9, Figure 7). Based on these numbers, small salmon escapement was 44% of requirement. Large salmon were about 67% of requirement, up 384% from 2002, but still over 30% below conservation requirements.

Biological characteristics and egg deposition

The estimate of spawner escapement relative to requirements based on biological characteristics can also be derived for the Baddeck River in the same manner as was described for Middle River. Based on numbers of Atlantic salmon collected and aged during the fall 2003 seining operations on the Baddeck River (Table 10), spawning escapement is estimated at 113 small and 225 large fish of which 53% are large female salmon (Table 11). Total female spawners escapement is estimated to be 201 fish, which yielded 65.7% of the egg requirement for the river in 2003 (Table 11).

Outlook

The forecast of returns to the Baddeck River in 2004, based on a 3 year average (2000, 2002 and 2003), is about 210 fish (90% CI: 47-407), 40% of conservation requirements. The probability of returns exceeding the conservation requirement of 530 salmon is near zero.

Discussion

The population estimate derived from the recreational catch and the prior catch rates indicated a population of 242 fish while the 2003 mark and recapture estimate indicated a population of 341, a 40% increase. Regardless, both estimates are substantially below the conservation requirement and both are low relative to other rivers in the area e.g. Middle and North rivers. It is interesting to note that the lower of the estimates was based on the recreational catch and a prior estimate of the catch rate. This suggests fewer salmon in the river during the recreational fishing season than during the swim-thru, an ongoing concern of assessments of fall runs. However, the low numbers of tags applied and recaptures observed in 2003 is insufficient to derive a well-defined population estimate. Section 5 of the river, Swimming Hole to the Red Bridge (Figure 3, Appendix I), a 4.3 km section, was, with the exception of the Swimming Hole, not covered in 2003. There is the possibility that this section may have contained a high proportion of the fish in the river. Counts by river section in three previous years revealed that 31% (range: 5-71%) of the observed fish were found in Section 5. If the mean diver observation rate of salmon (0.559) was used then the estimate would be (67/0.559 = 120) lower again. Based on these considerations we used the swim-thru data and the 341 fish estimate to assess the status of salmon in the Baddeck River in 2003.

North River

The North River, Victoria County, lies on the eastern slope of the Cape Breton Highlands (Figure 1). The watershed is bounded by the Baddeck, Middle and Barachois and on the north by the Margaree River (Figure 1). The river arises at an elevation of about 475 m and travels some 30 km to St. Ann's Harbour. Gradients are steep (Table 3) with many small falls and several barriers to upstream fish passage in the upper reaches of tributaries to the main river. Water quality is excellent for rearing of salmon (Amiro and Marshall 1990). The North River is unobstructed by man-made dams and the water chemistry is tolerant of acid precipitation. Agricultural practices are present but not extensive in the lower valley.

The salmon stock is known as early-run and is principally composed of large or two-sea-winter salmon. Stocking with hatchery fish of North River origin re-occurred in the late 1980s and concluded in 1995 (Marshall et al. 1999). There is currently no stocking of hatchery-reared salmon in this system.

The North River has on occasion had small numbers of farmed escapees coincident with reported escapees from industry grow-out sites in Bras d'Or Lakes (ICES 2003; Marshall et al. 2000). Occasional adult rainbow trout are observed but juvenile fish have not been observed during assessments by electrofishing.

Conservation Requirements

The conservation requirements for the North River are based on an estimate of salmon production area of 355,900 m^2 and 2.4 eggs per m^2 (Elson 1975; Marshall et al. 1998). The required 0.85 million eggs is expected from 200 large and 30 small salmon.

Methods and Results

Recreational Fishery

The recreational fishery on the North River is open for angling downstream from the area known as "The Benches" (Figure 4) to catch and release only with a season of June 1 - Oct. 31 (Table 1). The area upstream from 'The Benches" is closed to angling all year. Anglers expended an estimated average of 307 rod days per year on the North River in the last five years (Table 2). The estimated effort of 539 rod days in 2003 was 100% higher than the effort in 2002, and 76% higher than the 5-year mean (Table 2, Appendix II). Preliminary catch estimates in 2003, derived from 48 licence stub returns by anglers fishing to the Oct. 31 closure, were 162 large and 84 small salmon (Table 1). Both small and large salmon catches were up from 2002 with catches of large salmon being the highest since 1995 (Table 2, Appendix II). Total catches were 208% higher than those in 2002, and 133% higher than the previous five-year mean (Table 2, Appendix II).

Adult Salmon Surveys

Returns to North River in recent years have been based on snorkel counts and recreational catches. Returns from 1994 to 1998 were estimated by mark-and-recapture methods using snorkel survey counts of salmon, some of which were previously marked by seining a selection of pools throughout the river (Appendix VI). Based on the mark-and-recapture derived population estimates, catch rates for the recreational fishery were also estimated.

Catch rates for these five years averaged 0.75 (90% CI: 0.34-1.15) for small and 0.41 (90% CI: 0.14-0.69) for large (see text table below).

Recreational salmon fishery catch rates based on mark and recapture population estimates for small and large salmon in the North River, Victoria County.

	Catch rate	
Year	Small	Large
1994	0.54	0.29
1995	1.28	0.76
1996	0.53	0.51
1997	0.55	0.21
1998	0.82	0.29
Mean	0.74	0.41
Sd	0.32	0.22

In 1999 and 2000, adverse water conditions precluded swim-thru counts of adult returns to the North River (Appendix VI). Because swim-thru counts were not available, returns in these years were derived from recreational catch estimates and mean catch rates for small and large salmon in the recreational fishery (1994-1998).

In 2001 and 2002, adverse water conditions prohibited the catch and marking of salmon necessary to calibrate the snorkel count data on the North River (Appendix VI). A count without applying marks was however conducted in 2002, and a mean observation rate of 0.49 (90% CI: 0.39-0.60), derived from previous mark and recapture estimates in the years 1994-1998, was used to estimate returns (DFO 2003). Summer swim-thru counts of salmon on the North River were available for the calculation of a minimum population estimate in 2001 (DFO 2002).

Again in 2003, adverse water conditions precluded swim-thru counts of adult returns to the North River (Appendix VI). Recreational catch data and catch rates were therefore used to derive population estimates.

Juvenile Surveys

No sampling for juvenile salmon was conducted on the North River in 2002 or 2003. Sampling at six index sites between 1996 and 2001 (Figure 4) consisted of three-four sweep removal estimates in barriered sections (Table 6, Appendix IV). Population estimates were derived in the same manner as those of the Middle and Baddeck rivers.

Monitoring at two to four main river sites from 1996 to 2001(Table 6) indicates that densities of age-0^+ parr, which had typically been above or near the Elson norm in the late 1990s and 2000, had fallen below the norm in 2001. Conversely, densities of age-1^+ and older parr, which were below the Elson norm in the late 1990s, have fluctuated at or slightly above the norm since 1999 (Figure 10).

Status

Population estimate from recreational fishery and catch rates

The recreational catch of small and large salmon in 2003 was 84 and 162 fish respectively (Table 1). Based on these values and the average catch rates of 0.75 for small and 0.41 for large salmon determined from returns estimated by mark and recapture and catches estimated from license stub returns from 1994 to 1998, the estimated returns to the North River in 2003 were 113 small (90% CI: 73 and 244) and 395 large salmon (90% CI: 236 and 1,201) for a total of 508 fish (Table 12, Figure 9).

Small salmon escapement was about 333% of requirement, large salmon was about 195% of the requirement (Table 12). There was over a 99% probability that egg conservation requirements were met in 2003.

Outlook

The projected return of small and large salmon to North River in 2004, based on the 1999 to 2003 average number of returns derived from the recreational catch, is about 224 fish (90% CI:42-477), 97% of conservation requirements. The probability of returns exceeding the conservation requirement of 230 fish is 52%.

Discussion

The 2003 returns estimate was based on the mean catch rate determined in 1994 to 1998 when the average effort was 420 rod days (Appendix II). In 2003 a total of 539 rod days were exerted (Table 1). The increased effort in 2003 could indicate that the average catch rate was inappropriate for the higher effort exerted in 2003. However, it is likely that the additional effort was applied because there were proportionally more salmon present in 2003 than in 2002. In fact, there was a similar effort exerted in 1996 (494 rod days, Appendix II) and the population was estimated at 536 fish (Table 12). Increased numbers of large salmon were noted in the Middle and Baddeck rivers independent of angling, and therefore support the assessment of increased numbers of large salmon estimated for the North River in 2003.

Catch rates based on independent measures of the population, such as mark and recapture and recreational catch estimates, can and did exceed 1.0 in two cases. This is not only because catch and release angling can lead to multiple captures, but also because catch rate estimates are independent and subject to different annual biases. The high mean (1994-1998) catch rate for the recreational fishery for small salmon 0.75 (90% CI: 0.34-1.15) (see text table above) was influenced by the 1995 estimate of 1.28 (but is not greater than the 1998 estimate of 0.82).

Grand River

The Grand River lies in Richmond County of SFA 19 (Figure 1). It drains an area of 217 km^2 (Amiro and Longard 1990). The main stem flows southerly from Loch Lomond Lake a distance of 15.7 km to tidal waters of the Atlantic at Grand River.

Grand River is a low gradient river. The amount of area available for juvenile production is estimated at 549,100 m^2 of which 87,300 m^2 is less than 0.12 % orthograde (Table 3) (Amiro

and Longard 1990). Headwater elevation (~100m), gradient and tributaries accessible to salmon are, on average, the least of the rivers assessed in this document (Table 3).

Grand River is obstructed to salmon passage at low discharge by a falls located 10.2 km upstream of head-of-tide (Figure 11). About 45% of the total juvenile production potential is estimated to be upstream of the falls; 55% of the total river production is below the falls (Amiro and Longard 1990). A fishway at the falls is estimated to pass an average 57% of small and 43% of large salmon (Amiro and Longard 1990 and 1995).

Unlike most other Cape Breton Island populations, salmon of the Grand River are principally small (1SW) and of June/July run timing. The few large salmon are mostly repeat-spawning 1SW fish. Returns have declined despite significant hatchery supplementation with Grand River stock throughout the late 1980s and into the 1990s, and the elimination of south coast Newfoundland commercial fisheries in 1992 (Marshall et al. 1998). Stocking in Grand River ceased in 1997 (Marshall et al. 1999), and there are no stocked fish contributing to returns since 1999 (DFO 2000).

The Grand River fishway is not known to have passed farmed escapees, but the river does support a small population of resident brown trout (*Salmo trutta*).

Conservation Requirements

The conservation requirements for the Grand River are based on a substrate area of 461,800 m^2 >0.12% orthograde (Table 3) and 2.4 eggs per m^2 (Elson 1975, Marshall et al. 1999). Requirements number 1.1 million eggs (Amiro and Longard 1990) or 545 salmon in total of which 475,000 eggs or 234 salmon are required upstream of the fishway.

Methods and Results

Recreational Fishery

The recreational fishery on Grand River in 2003 was open to catch and release only with a season of June 1-July 15 and Sept. 1-Oct. 31. Anglers expended an estimated average of 93 rod days per year on the Grand River in the last five years (Table 2). The estimated effort of 65 rod days in 2003 is 23% less effort than in 2002 and 30% lower than the mean effort of the last five years (Table 2, Appendix II). Preliminary catches in 2003, derived from licence stub returns by anglers fishing to the Oct. 31 closure, were estimated to be three large and 17 small salmon (Table 1). Total catches were 35% lower than those in 2002 and 37% lower than the previous five-year mean (Table 2, Appendix II).

Adult Salmon Returns

Returns to Grand River were estimated from adult counts at the fishway 1988-1998 (Marshall et al. 1999), and from partial fishway counts in 1999 and 2000 (Marshall et al. 2000, DFO 2001). The salmon movements at the Grand River fishway have not been monitored since 2000. Returns to the river in recent years were estimated from recreational catch with an assumed catch rate of 0.5 (DFO 2002, DFO 2003), which is similar to that determined in other rivers. Annual estimates of combined small and large salmon returns, escapement, percent hatchery, wild escapement and wild returns to Grand River, 1988-2003, and percent of conservation requirements met are presented in Table 13.

Juvenile Surveys

Quantitative sampling for juvenile salmon has not been conducted on the Grand River since 2000. A few juveniles were captured and tissue sampled in 2002, but data were insufficient for calculating densities. Electrofishing sites on Grand River are large and were assessed in 1996-2000 by mark-recapture estimation methods in unbarriered sections (Table 6, Appendix IV) with one to four days between the marking and the recapture fishing effort. Mark-recapture experiments were conducted on both fry and parr at most locations between 1998 and 2000. Estimates of both life stages were calculated using the Peterson mark-recapture method and applying the individual capture efficiencies calculated for each life stage. In 1996 and 1997 fry were not marked and parr capture efficiencies were used to calculate fry estimates. A mean fry capture efficiency over three sites was used to calculate fry and parr estimates at a fourth site in 1998.

Monitoring at four index sites on the main river (two above and two below the falls) from 1996 to 2000 (Figure 11, Table 6, Appendix IV) indicates that juvenile densities, which had been declining since 1997, showed an increase in 2000 albeit below the Elson norms (Figure 13). Declining abundances of both life stages between 1997 and 1999 were consistent with estimated decreases in egg depositions since 1996.

Status

Population estimate from recreational fishery and assumed catch rate

Estimates of Grand River catch in 2003 from eight voluntary returned Nova Scotia Salmon License stubs were 17 small and three large salmon. Returns in 2003 were estimated at 40 fish (six large and 34 small salmon), down from 62 fish in 2002 and second lowest in the dataset (Table 13, Figure 12). Based on an assumed recreational catch rate of 0.5 these catches could indicate that 17% of the escapement was achieved in 2003.

The Grand River salmon did not meet the conservation requirement upriver of the fishway since 1999. Returns since 2000 are totally dependent on wild production, a component that has not met requirements since 1990.

Outlook

The forecast of wild salmon returns to the Grand River in 2004**,** based on a four-year average, is about 43 fish (95% CI:8-93), 18% of conservation requirements. The probability of returns exceeding the conservation requirement of 234 fish is near zero.

Discussion

Based on fishway count derived population estimates from 1988 to 1999, catch rates for the recreational fishery could also be estimated for Grand River. A mean catch rate estimated from these data averaged 0.79 (90% CI: 0.42-1.17) for small and large salmon combined (see text table below). If this catch rate was utilised in the assessment rather than the 0.5 value, returns would be even lower and further below conservation requirements. In order for returns in 2003 to meet conservation requirements, a catch rate of 0.085 would be needed, far lower than any observed in these or previous Cape Breton assessments.

Recreational salmon fishery catch rates based on fishway count derived population estimates from 1988 to 1999 for small and large salmon combined in the Grand River, Richmond County.

Year	Catch rate
1988	0.90
1989	0.73
1990	0.30
1991	0.30
1992	1.12
1993	2.13
1994	1.66
1995	0.54
1996	0.69
1997	0.61
1998	0.36
Mean	0.76
Sd	0.59

Other Rivers of SFA 19

Although there are only four rivers monitored annually in SFA 19, 30 rivers are known to support recreational angling for salmon (Table 1).

Habitat

Area by gradient has been measured for 18 rivers in Eastern Cape Breton. Summary of stream gradient by reach for these are presented in Table 3. Middle, Baddeck and Salmon (tributary of the Mira River) are large rivers, covering an average total salmon production area of 832,400 m^2. Gerrat River is the smallest of the 18 measured salmon rivers in Eastern Cape Breton with an area of less than 100,000 m^2.

Gradients for Eastern Cape Breton rivers vary. As would be expected for rivers draining the Cape Breton Highlands, the Ingonish, Barachois, North, Middle and Baddeck rivers of Victoria County, have higher proportions of steeper (>0.25%) gradients (Table 3). The relief of Richmond and Cape Breton county rivers is gentler. The River Tillard, Marie-Joseph and Framboise rivers of Richmond County, as well as Sydney, Frenchvale, and Lorraine rivers of Cape Breton County have a higher proportion of gentler gradients than that of neighbouring highland rivers (Table 3). Other Cape Breton county rivers, the Aconi, Catalone and Mira (including Salmon and Gaspereaux rivers), have the highest proportions of low gradient, which are the least suitable for the production of juvenile salmon (Table 3).

Methods

Juvenile Surveys

No juvenile salmon surveys were conducted in any SFA 19 river in 2003. Surveys were however conducted, between 1996 and 2002, at historic sites on the here-in assessed index rivers as well as on the Gaspereaux, Tillard, Inhabitants, Skye and Sydney rivers (Table 6, Figure 1). An extensive SFA-wide salmon tissue sampling tour for DNA analysis was conducted at single sites on the Barachois, Catalone, Deny's, Framboise, Frenchvale, Humes, Ingonish, Lorraine, MacAskills, Marie Joseph, and St. Esprit in 2001, and in Grantmire and Indian brooks, Cape Breton County, in 2002 (Table 6, Figure 1). A summary of the rivers sampled, sites, and years sampled between 1996 and 2002 is presented in Table 6.

Abundances of juvenile salmon in these 'other' SFA 19 rivers (Barachois, Catalone, Deny's, Framboise, Frenchvale, Gaspereaux, Grantmire, Humes, Indian Brook, Ingonish, Inhabitants, Lorraine, MacAskills, Marie Joseph, Skye, St. Esprit, Sydney and Tillard) were assessed by electrofishing at one to three sites per river (Table 6). Two methods were used to estimate juvenile abundances. Similar to the Middle, Baddeck and North rivers, sampling on the Inhabitants and Skye rivers consisted of three to four sweep removal estimates in barriered sections (Table 6, Appendix IV). The removal method was also used in unbarriered sections at single sites in 11 additional rivers in 2001 and in four rivers sampled in 2002 (Appendix IV). Population estimates were derived in the same manner as those of the Middle, North and Baddeck rivers.

Gaspereaux, Sydney and River Tillard were assessed at one to two sites between 1996 and 2000 by mark-recapture estimation in unbarriered sections (Table 6, Appendix IV). Mark-recapture experiments were conducted on parr only from 1996-1998, whereas fry were also marked on River Tillard in 1999 and 2000 and on Gaspereaux River in 2000. Estimates were calculated using the Peterson mark-recapture method and applying the individual capture efficiencies calculated for each life stage in applicable years. For those locations (marked with an asterisk in Appendix IV) where fry were not marked, capture efficiencies of older fish were used to calculate estimates of fry based on the initial or "marking run" count. In 2001 and 2002, these rivers were assessed at a single site by the three-sweep removal method.

In these 'other' rivers where river-specific salmon escapement information is absent but where quantitative electrofishing of juvenile salmon has been conducted, the status of stocks is assessed relative to the "normal index of abundance" (Elson norm) of 29 fry (age-0^+ parr) per $100m^2$ and 38 parr (age-1^+ and older parr) per $100m^2$ (Elson 1967).

Results

Recreational Fishery

Of the 30 rivers known to support recreational fishing in eastern Cape Breton, in addition to the four monitored rivers, 11 'other' rivers were reportedly fished for salmon in 2003 (Table 1). A total recreational fishing effort of 172 rod days were exerted in these 11 'other' SFA 19 rivers in 2003, a 39% increase in effort over 2002, but a 3% decrease over the 1998-2002 mean value (Table 2).

Estimated catches in these 'other' rivers in 2003 were 11 small and 29 large salmon (Table 1). Compared to 2002, the catch of small salmon in these rivers was down 35% but large

salmon catch was up 190% (Table 2). Compared to the 1998-2002 mean values, small salmon catch was down 56% and the large salmon catch was up 5% (Table 2).

Juvenile Abundance

Fry densities in these 'other' rivers have typically been below the Elson (1967) normal index of abundance for age-0^+ parr since 1998 (Figure 14). High densities of fry were however observed at a limited number of sites in recent years: the Gaspereaux (203.8 per $100m^2$), Sydney (166.4 per $100m^2$) and Tillard (40.8 per $100m^2$) rivers in 2000, the Deny's (28.3 per $100m^2$), Inhabitants (29.3 per $100m^2$) and Ingonish (51.9 per $100m^2$) rivers in 2001 as well as on Grantmire River in 2002 (324.3 per $100m^2$) (Figure 14, Appendix IV).

Parr densities in these 'other' rivers have also typically been below the Elson (1967) normal index of abundance for age-1^+ and older parr since 1998 (Figure 15). In 2000, only the Sydney River was near the norm with a density of 37.9 per $100m^2$, whereas in 2001 only two of the 14 rivers sampled were above the norm, Frenchvale with 57.0 per $100m^2$ and Deny's with 41.2 per $100m^2$ (Figure 15, Appendix IV). In 2002, all four rivers sampled were well below the Elson norm (Figure 15).

Discussion

Fry densities estimated in the most recent years of sampling (2001 and 2002) were above the normal value in only two of 18 'other' rivers sampled, with only two near and the remaining 14 below the Elson normal value. Higher densities of fry from a limited number of sites may be affected by their potential for limited distribution from spawning areas. Thus, high densities of fry observed at single sites are suspect as reliable indicators of the previous years' escapement. Parr (age-1^+ and older) densities, on the other hand, have had more time to distribute within the river, and are less susceptible to small sample size bias. Therefore, considered collectively, low fry and parr densities in these 'other' rivers suggest that egg conservation requirements were not generally met in most of these 'other' SFA 19 rivers in recent years.

Sydney River Fishway

Counts of adult Atlantic salmon moving upstream at the Sydney River Dam have been made by the Membertou First Nation Natural Resources Department since 1994. A trap installed and monitored in the fishway typically provides counts from mid-September to late November. Atlantic salmon passing through the trap are counted, sexed, measured (fork length) and scale sampled for age determination. Based on these samples we determined river age, post smolt age, spawning history, mean length and sex of Atlantic salmon put through the fishway from 1994 to 2003, excluding 1999 when no data was available (Table 14 and 15).

A total of 256 adult salmon were counted and sampled over the nine years for which data was available, 218 of which were assigned ages (Table 14). Of the total number of fish sampled, 69% were females and 31% males (Table 16). Lengths of 1SW fish averaged 55cm for females and 58cm for males. Large salmon ranged from 76 cm for 2-sea-winter females, to 88cm for 3-sea-winter, 91cm for 4-sea-winter and 93cm for 5-sea-winter females (Table 14).

Large MSW males averaged 76cm at postsmolt age-2, 85cm at postsmolt age-3 and 94cm by postsmolt age-4 (Table 14).

Proportioning aged fish by sex revealed that 5% of the fish moving up the Sydney River were one-sea-winter females, 10% one-sea-winter males, 67% multi-sea-winter females, of which 2.3% were repeat spawning and 19% multi-sea-winter males (Table 16).

Management Considerations

On the basis of adult escapement estimates, conservation requirements, which were generally not met in monitored rivers of Eastern Cape Breton in recent years, were achieved on the Middle and North rivers in 2003. Escapement of large salmon on the Baddeck River, although up nearly 400% from 2002, remained below the conservation requirement.

Despite the general increase in small salmon returns to rivers of the Maritime Provinces noted in 2002 (DFO 2003), and the increase in large salmon returns to some rivers observed in 2003, probabilities that returns to most rivers in SFA 19 in 2004 will meet conservation requirements remain low. This is because the forecast methodology is a five-year moving average and increased returns have been annually sporadic. Forecasts can only be favourable when a series of higher escapements have been observed.

The Grand River salmon has not met the conservation requirement upriver of the fishway since 1999. Returns since 2000 are totally dependent on wild production, a component that has not met requirements since 1990. Therefore, it is unlikely that conservation requirements will be met in 2004.

Although no juvenile surveys were conducted in any Eastern Cape Breton river in 2003 and not in the here-in assessed rivers since 2001, parr densities on Middle and North rivers (1999-2001) are consistent with the increased adult escapement on these rivers in 2003. However, based on collective observations of juvenile salmon, densities of fry and parr for most stocks support the conclusion that recent escapements have generally been below conservation requirements in SFA 19 rivers.

Considering the recent variable status of adult returns and the low probability of exceeding conservation requirements to monitored rivers in Eastern Cape Breton in recent years a conservative approach to management is recommended.

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Table 1. Recreational catch and effort for Atlantic salmon on rivers of Eastern Cape Breton Island, SFA 19 in 2003. Data is preliminary.

River		Season		Observed No. of	Numbers caught (including releases)								Catch per effort	Percent Large
					Grilse		Salmon		Total		Effort (rod days)			
Code	Name	Start	End	Anglers	Obs.	Est.	Obs.	Est.	Obs.	Est.	Obs.	Est.	(Fish/day)	Salmon
1	Aconi Brook	Jun-01	Oct-31	0										
4	Baddeck	Jun-01	Oct-31	49	17	24	55	77	72	101	145	220	0.50	76.4
5	Barachois	Jun-01	Oct-31	5	1	1	1	1	2	2	15	23	0.13	50
11	Catalone	Jun-01	Oct-31	5	3	6	2	4	5	10	10	15	0.5	40
124	Clyburne	Jun-01	Oct-31	2	0	0	0	0	0	0	12	18	0	0
28	Framboise	Jun-01	Oct-31	2	0	0	0	0	0	0	2	3	0	0
138	Frenchvale Brook	Jun-01	Oct-31	0										
30	Gaspereaux: C. Breton Co.	Jun-01	Oct-31	0										
34	Gerratt	Jun-01	Oct-31	0										
36	Grand	Jun-01	Oct-31	8	11	17	2	3	13	20	43	65	0.30	15.4
135	Grantmire Brook	Jun-01	Oct-31	2	0	0	3	4	3	4	6	9	0.5	100
41	Indian Brook	River	Closed	4	0	0	2	4	2	4	6	9	0.33	100
42	Ingonish	Jun-01	Oct-31	0										
44	Inhabitants	Jun-01	Oct-31	3	2	2	1	1	3	3	8	12	0.38	33.3
127	Little Lorraine	Jun-01	Oct-31	0										
56	Lorraine Brook	Jun-01	Oct-31	0										
133	MacAskill's Brook	Jun-01	Oct-31	0										
60	Marie Joseph	Jun-01	Oct-31	0										
66	Middle: Victoria Co.	Jun-01	Oct-31	73	16	24	95	144	111	168	220	334	0.51	85.6
67	Mira	Jun-01	Oct-31	2	0	0	0	0	0	0	5	8	0	0
78	North Aspy	Jun-01	Oct-31	4	0	0	11	11	11	11	33	50	0.33	100
77	North: Victoria Co.	Jun-01	Oct-31	48	58	84	112	162	170	246	355	538	0.48	65.9
120	Northwest Brook (River Ryan)	Jun-01	Oct-31	0										
129	River Bennett	Jun-01	Oct-31	0										
122	River Deny's	Jun-01	Oct-31	0										
89	River Tillard	Jun-01	Oct-31	1	0	0	1	1	1	1	6	9	0.17	100
93	Saint Esprit	Jun-01	Oct-31	0										
97	Salmon: Cape Breton Co.	Jun-01	Oct-31	3	2	2	2	2	4	4	10	15	0.4	50
123	Skye	Jun-01	Oct-31	0										
125	Sydney	Jun-01	Oct-31	0										
	SFA 19 Totals				110	160	287	414	397	574	876	1328	0.30	54.4

Table 2. Recreational catch and effort for Atlantic salmon on rivers of Eastern Cape Breton Island, 2003 Preliminary, 2002, and mean 1998-2002.

	2003 Preliminary				2002				1998 - 2002 Means							
	Grilse		Salmon		Grilse		Salmon		Grilse				Salmon		Effort	
River	retained	released	released	Effort	retained	released	released	Effort	retained	Stdev	released	Stdev	released	Stdev	roddays	Stdev
Aconi Brook	0	0	0	0	0	0	0	0	0	0	1.2	1.8	0.3	0.4	3.7	6.1
Baddeck	0	24	77	220	0	19	38	204	0.4	0.5	22.7	19.6	54.5	26.3	229	88.7
Barachois	0	1	1	23	0	0	0	8	0.3	0.4	1.9	2.9	0.9	0.8	17.4	13.0
Catalone	0	6	4	15	0	1	3	9	0	0	1	1.2	0.5	1.3	3.4	3.3
Clyburne	0	0	0	18	0	0	0	1	0	0	0.2	0.4	0.3	0.4	3.9	3.8
Framboise	0	0	0	3	0	5	0	20	0	0	3	3.5	0	0	18.2	11.5
Frenchvale Brook	0	0	0	0	0	0	0	0	0	0	0.5	1.3	0.8	1.8	4	8.9
Gaspereaux: Cape Breton Co.	0	0	0	0	0	0	0	3	0	0	1.9	3.5	0.2	0.4	11.1	18.5
Gerratt	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand	0	17	3	65	0	31	0	84	0	0	28.6	28.0	3.3	5.1	93.4	90.6
Grantmire Brook	0	0	4	9	0	0	0	0	0	0	1.2	1.7	3.2	5.6	6	6.5
Indian Brook	0	0	4	9	0	0	0	11	0	0	0.8	1.3	0.2	0.4	10.6	8.4
Ingonish	0	0	0	0	0	0	0	3	0	0	0.5	1.3	2.1	3.9	5.5	4.0
Inhabitants	0	2	1	12	0	4	1	13	0	0	5.7	5.9	8.8	10.2	25.9	14.3
Little Lorraine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lorraine Brook	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0.4
MacAskill's Brook	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Marie Joseph	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0.4
Middle:Victoria Co.	0	24	144	334	1	27	35	231	1.3	2.2	22.5	7.9	54.7	30.7	263.1	107.5
Mira	0	0	0	8	0	0	0	4	0	0	0.6	1.3	1.9	4.5	12.7	24.3
North Aspy	0	0	11	50	0	0	4	17	0	0	0.7	0.9	2.7	3.0	12.7	8.7
North: Victoria Co.	0	84	162	538	0	34	45	269	0	0	49.2	32.9	56.4	29.2	307	79.9
Northwest Brook (River Ryan)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
River Bennett	0	0	0	0	0	0	0	0	0	0	0.2	0.4	0	0	0.2	0.4
River Deny's	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
River Tillard	0	0	1	9	0	0	0	7	0	0	0.2	0.4	0	0	4.8	5.1
Saint Esprit	0	0	0	0	0	0	0	0	0	0	0.3	0.4	0.3	0.4	0.3	0.4
Salmon: Cape Breton Co.	0	2	2	15	0	7	1	11	0	0	5	3.7	5.4	5.1	35	48.0
Skye	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.8	1.8
Sydney	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	1.3
Totals	0	160	414	1328	1	128	128	893	2	3.1	147.8	120.3	196.4	129.5	1069.7	555.8

Table 3. Area (m^2 x 100) by percent orthogradient for 18 rivers of Eastern Cape Breton.

River	County	Orthograde (%)											Total Area x 100 m^2
		0-.12	.121-.249	.25-.49	.5-.99	1-1.49	1.5-1.99	2-2.49	2.5-2.99	3-3.49	3.5-5.0	>5.0	
Aconi	Cape Breton	519	189	115	548	67	96	15	10	4	0	2	1,564
Baddeck	Victoria	0	494	2,321	3,387	873	616	374	155	68	75	0	8,363
Barachois	Victoria	0	0	227	502	453	422	393	139	36	106	19	2,297
Catalone	Cape Breton	0	2,614	785	596	121	84	45	13	24	22	6	4,311
Framboise	Richmond	0	2,154	2,537	1,317	324	175	54	51	68	13	7	6,698
Frenchvale	Cape Breton	0	457	497	246	142	88	96	32	0	52	17	1,627
Gerratt	Cape Breton	0	0	247	386	86	51	36	16	10	4	7	842
Grand	Richmond	873	2,352	1,329	443	187	154	72	27	11	32	10	5,490
Ingonish	Victoria	0	0	157	268	373	505	198	124	119	134	57	1,934
Lorraine	Cape Breton	695	227	1,215	957	138	27	27	8	3	3	5	3,306
Marie Joseph	Richmond	565	1,160	1,392	1,297	262	63	9	24	13	10	0	4,796
Middle	Victoria	0	2,538	1,534	3,530	539	331	85	62	27	0	0	8,646
Mira	Cape Breton	6,422	2,721	2,210	1,196	306	180	91	42	21	17	5	13,212
Gaspereaux	Cape Breton	0	1,054	976	764	0	0	0	0	0	0	0	2,795
Salmon	Cape Breton	5,824	1,273	469	206	137	34	17	4	0	0	0	7,963
North	Victoria	0	0	391	1,413	859	201	419	121	220	161	43	3,827
Sydney	Cape Breton	1,135	1,084	872	874	474	131	51	41	25	36	28	4,750
Tillard	Richmond	0	279	329	330	139	43	0	4	0	3	2	1,129

Table 4. Densities of rainbow trout caught at Middle River electrofishing sites, 1998-2003. The 'catch' column denotes the number of fish caught per sweep (DFO, Diadromous Fish Division unpublished data).

					Rainbow Trout		
		Area		No. of	Density		
Year	Site name	(m^2)	Method	sweeps	Catch	Pop'n	($100m^2$)
1998	Twin Churches	369	Removal	4	12,6,0,1	19.3	5.2
1999	Twin Churches	326	Removal	3	1,0,0		0.3
2000	Twin Churches	307	Removal	3	6,0,1	7.1	2.3
2001	Twin Churches	364	Removal	4	34, 19, 11, 3	71.8	19.7
	Finlayson	550	Removal	4	10, 6, 5, 1	24.7	4.5
	MacKenzie	300	Removal	4	24, 3, 2, 2	31.3	10.4
	Mean						11.5
2002					no sampling		
2003					no sampling		

Table 5. Annual estimates of small and large salmon returns and escapement to Middle River, Victoria County, 1989-2003. Conservation requirements are 2.07 millions eggs met by 470 large and 80 small salmon. Returns from angling are based on a mean catch rate of 0.29 for large and 0.44 for small salmon determined from population estimates and recreational catches (see text).

	Recreational catch		Returns (Snorkel counts)		Returns (Angling)		Escapement		% Conservation Req'm	
Year	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large
1989	52	279	90	1030	119	974	14	641	18	136
1990	107	197	256	437	246	687	84	281	105	60
1991	27	186	73	445	62	649	18	254	23	54
1992	11	30	111	421	25	105	94	355	118	76
1993	30	48	34	110	69	168	6	93	8	20
1994	24	166	47	423	55	579	46	379	57	81
1995	37	51	51	328	85	178	46	319	57	68
1996	60	142	126	473	138	496	120	455	150	97
1997	18	80	68	346	41	279	65	335	82	71
1998	31	60	89	155	71	209	77	143	97	30
1999	30	95	90	362	69	332	84	351	105	75
2000	20	67	47	221	46	234	38	182	48	39
2001	10	15	47	131	23	52	47	130	58	28
2002	29	37	51	104	67	129	48	98	60	21
2003	24	144	61	554	55	503	60	550	75	117

Table 6. Electrofishing site name and number, use of barrier nets, years sampled, National Topographical map number, military grid reference (1:50 000 Canadian topographical series # A791), datum, latitute and longitude for rivers in Eastern Cape Breton (SFA 19) sampled 1996-2002. Asterick indicates no barriers used in 2001 and 2002.

River	Site name	site #	Barrier	Year sampled	Site location				
					Map	Grid Ref	Datum	Latitude (decimal degrees)	Longitude (decimal degrees)
Middle	Twin Churches	2	yes	1996-2001	11K2	601-133	NAD27	46.1570	60.9271
	Finlayson	3	yes	1996-2001	11K2	603-229	NAD27	46.2375	60.9225
	2nd Gold Bk	GB2	yes	1999-2001	11K7	617-237	NAD27	46.2494	60.9002
	MacKenzie Bk	SP14	yes	1996-2001	11K2	575-107	NAD27	46.1300	60.9533
	MacLeods Bk	SP11	yes	1996-1998	11K2	622-155	NAD27	46.1758	60.8875
Baddeck	Upper Baddeck	2	yes	1996-2001	11K2	756-184	NAD27	46.1990	60.7224
	North Branch	3	yes	1996-2001	11K2	717-158	NAD27	46.1768	60.7761
	Easach Ban	4	yes	1996-2001	11K2	714-186	NAD27	46.2027	60.7763
	Peters Bk	5	yes	1996-2001	11K2	719-121	NAD27	46.1428	60.7735
North	Church Pool	1	yes	1996-1997	11K7	832-307	NAD27	46.3017	60.6242
	MacDonalds	2	yes	1996-1998	11K7	820-315	NAD27	46.3067	60.6275
	MacLeans	3	yes	1997-2001	11K7	779-336	NAD83	46.3336	60.6878
	Benches	4	yes	1996, 1998-2000	11K7	775-341	NAD27	46.3300	60.7000
	Karr's	5	yes	1998-2001	11K7	827-312	NAD83	46.3108	60.6261
	Narrows	6	yes	1999-2001	11K7	811-321	NAD83	46.3178	60.6455
Grand	Mud Hole (above falls)	1	no	1996-2000, 2002	11F10	843-665	NAD83	45.7267	60.6288
	Fishway (above falls)	2	no	1996-2000	11F10	847-646	NAD83	45.7050	60.6250
	Crib Pool (below falls)	3	no	1996-2000	11F10	843-614	NAD83	45.6775	60.6283
	Frank MacDonald Rd. (below falls)	4	no	1996-2000, 2002	11F10	824-589	NAD83	45.6562	60.6555
	MacKillop Bk	na	no	2002	11F10	847-626	NAD83	45.6860	60.6268
	Murchison Bk	na	no	2002	11F10	823-595	NAD83	45.6587	60.6560
Barachois		na	no	2001	11K7	866-364	NAD83	46.3561	60.5738
Catalone		na	no	2001	11G13	297-965	NAD83	45.9837	60.0340
Deny's	Hwy 104	na	no	2001	11F14	362-797	NAD83	45.8579	61.2446
Framboise		na	no	2001	11F9	041-692	NAD83	45.7466	60.3759
Frenchvale		na	no	2001	11K1	052-119	NAD83	46.1306	60.3431
Gaspereaux	Victoria Bridge	1	no	1996, 1998-2001	11F16	073-885	NAD83	45.9190	60.3264
Grantmire		na	no	2002	11K1	077-118	NAD83	46.1268	60.1375
Humes		na	no	2001	11K2	593-022	NAD83	46.0550	60.9403
Indian Bk (Eskazoni)		na	no	2002	11K2	857-916	NAD83	45.1232	60.1012
Ingonish		na	no	2001	11K9	957-666	NAD83	46.6251	60.4427
Inhabitants	Main	1	yes*	1998-2001	11F14	294-735	NAD83	45.8029	61.3328
	Lamey Brook	2	yes	1998-2000	11F11	295-640	NAD83	45.7213	61.3317
	Northwest Arm	3	yes	1998-2000	11F11	284-593	NAD83	45.6767	61.3500
Lorraine		na	no	2001	11G13	718-906	NAD83	45.9317	59.9424
MacAskills		na	no	2001	11J4	711-149	NAD83	46.1500	59.9637
Marie Joseph	West Branch	na	no	2001	11F9	988-628	NAD83	45.6907	60.4456
Skye	Main	1	yes*	1997-2000, 2002	11F14	432-952	NAD83	45.9877	61.1515
	MacDonald Brook	2	yes	1997-1998	11K3	423-966	NAD27	46.0033	61.1583
	Mullach Brook	3	yes	1998-2000	11K3	432-965	NAD83	46.0033	61.1500
St. Esprit	Taylor Brook	na	no	2001	11F10	947-590	NAD83	45.6578	60.5006
Sydney	Meadows Brook	1	no	1996-2000	11K1	105-028	NAD83	46.0333	60.2792
	Woodbine Brook	3	no	2002	11K1	084-995	NAD83	46.0210	60.1353
Tillard	Main	1	no	1996-2001	11F10	614-585	NAD83	45.6607	60.9279
	East Branch	2	no	1996	11F10	599-605	NAD27	45.6750	60.9317
	East Branch	3	no	1999-2000	11F10	607-602	NAD83	45.6800	60.9350

Table 7. Age, spawning history and mean, maximum and minimum lengths of Atlantic salmon seined on Middle River, Victoria County, October 2003. Sea-age designation is post smolt age followed by spawning marks (sp).

			Length (cm)					
	Number		Mean		Max.		Min.	
Sea age	Males	Females	Males	Females	Males	Females	Males	Females
1	**6**		**54.6**		**57.0**		**52.4**	
2	**4**	**11**	**80.1**	**73.3**	**85.2**	**76.5**	**75.2**	**70.8**
4 sp 2		**1**		**89.0**				

Table 8. Spawning escapement relative to requirements based on number-at-age by gender, harvests, size-at-age, and fecundity of Atlantic salmon sampled and aged from the population estimate data collected on the Middle River in 2003.

Origin Post-smolt age	Gender	Number at age	Prop.	Broodstock removals	Removals	Mean length females (cm)	Mean fecundity (eggs)	Eggs contributed	Percent cont. to egg dep.	Required female spawners
Wild										
One-sea-winter	Female	0	0.00	0	0	0.0	0	0	0.0	0
	Male	166	0.27	0	1					
Multi-sea-winter	Female	333	0.55	0	3	74.6	6,148	2,065,458	100.0	338
	Male	111	0.18	0	1					
Hatchery										
One-sea-winter	Female	0	0.00	0	0	0.0		0	0.0	
	Male	0	0.00	0	0	0.0				
Multi-sea-winter	Female	0	0.00	0	0	0.0		0	0.0	
	Male	0	0.00	0	0	0.0				
Population estimate		610	1.00	0	5		3,074	2,065,458	100	
Escaped female spawners =		333		0	-3					329
Required female spawners =										338
Surplus (Deficit) =										**(338)**
Percent requirements met =										**98**

Table 9. Annual estimates of small and large salmon returns and escapement to Baddeck River, Victoria County, 1994-2003. Conservation requirements are 2.0 millions eggs met by 450 large and 80 small salmon. Returns from angling are based on a mean catch rate of 0.38 for large and 0.57 for small salmon determined from population estimates and recreational catches (see text).

	Recreational catch		Returns (Snorkel counts)		Returns (Angling)		Escapement		% Conservation Req'm	
Year	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large
1994	14	54	30	125	24	140	22	123	28	27
1995	53	62	108	265	92	161	98	262	123	58
1996	40	144	68	271	70	375	66	264	83	59
1997	14	64	60	177	24	166	59	174	74	39
1998	57	81	62	150	99	211	56	139	70	31
1999	15	79			26	206				
2000	12	55	18	162	21	143	13	134	16	30
2001	11	20			19	52				
2002	20	38	23	85	35	99	21	79	27	17
2003	24	77	36	305	42	200	35	303	44	67

Table 10. Age, spawning history and mean, maximum and minimum lengths of Atlantic salmon seined on Baddeck River, Victoria County, October 2003. Sea-age designation is post-smolt age.

	Number		Length (cm)					
			Mean		Max.		Min.	
Sea age	Males	Females	Males	Females	Males	Females	Males	Females
1	4	1	55.7	61.0	56.6		54.0	
2	2	8	75.5	77.6	78.8	88.3	72.2	72.9

Table 11. Spawning escapement relative to requirements based on number-at-age by gender, harvests, size-at-age, and fecundity of Atlantic salmon sampled and aged from the population estimate data collected on the Baddeck River in 2003.

Origin Post-smolt age	Gender	Number at age	Prop.	Broodstock removals	Removals	Mean length females (cm)	Mean fecundity (eggs)	Eggs contributed	Percent cont. to egg dep.	Required female spawners
Wild										
One-sea-winter	Female	23	0.07	0	0	61.0	3,572	81,012	6.0	34
	Male	90	0.27	0	1					
Multi-sea-winter	Female	180	0.53	0	2	77.6	6,937	1,263,275	94.0	272
	Male	45	0.13	0	0					
Hatchery										
One-sea-winter	Female	0	0.00	0	0	0.0		0	0.0	
	Male	0	0.00	0	0	0.0				
Multi-sea-winter	Female	0	0.00	0	0	0.0		0	0.0	
	Male	0	0.00	0	0	0.0				
Population estimate		338	1.00	0	3		5,255	1,344,287	100	
Escaped female spawners =		203		0	-2					201
Required female spawners =										306
Surplus (Deficit) =										**(105)**
Percent requirements met =										**65.7**

Table 12. Annual estimates of small and large salmon returns and escapement to North River, Victoria County, 1994-2003. Conservation requirements are 0.85 millions eggs met by 200 large and 30 small salmon. Returns from angling are based on a mean catch rate of 0.41 for large and 0.74 for small salmon determined from population estimates and recreational catches (see text).

	Recreational catch		Returns (Snorkel counts)		Returns (Angling)		Escapement		% Conservation Req'm	
Year	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large
1994	74	97	136	331	99	236	133	327	444	163
1995	168	209	131	276	226	509	123	267	409	134
1996	174	124	328	245	234	302	320	240	1067	120
1997	70	137	127	644	94	334	123	637	408	319
1998	108	104	132	364	145	253	129	361	430	180
1999	35	45			47	110				
2000	32	27			43	66				
2001	37	60	92	152	50	146	91	151	302	75
2002	34	46	19	57	46	112	14	39	48	20
2003	84	162			113	395	100	390	333	195

Table 13. Annual estimates of combined small and large salmon returns and escapement to Grand River, Richmond County, 1988-2003. Conservation requirements are 1.1 millions eggs met by 234 fish above falls (545 fish for total river).

	Recreational catch		Small and large fish combined					
Year	Small	Large	Returns	Escap	% Hatc	Wild Esc	Wild Rtns	% Req'm
1988	324	101	694	626	0%	626	694	268
1989	312	75	607	453	0%	453	607	194
1990	413	101	626	442	43%	252	357	108
1991	128	18	442	348	45%	191	243	82
1992	160	44	186	133	38%	82	115	35
1993	139	25	132	97	45%	53	73	23
1994	72	20	208	201	14%	173	179	74
1995	5	12	281	281	32%	191	191	82
1996	90	25	345	345	61%	135	135	58
1997	31	6	152	147	31%	101	105	43
1998	75	12	245	241	73%	65	66	28
1999	17	3	103	93	34%	62	68	26
2000	20	1			0%			
2001	1	0	2	2	0%	2	2	1
2002	31	0	62	46	0%	46	62	20
2003	17	3	40	39	0%	39	40	17

Table 14. Summary of post-smolt ages and mean lengths with standard deviations (s.d.) by sex of Atlantic salmon put through the Sydney River Dam fishway, 1994-2003, excluding 1999.

			Fork Length (cm)							
Post	Number		Mean		s.d.		Min.		Max.	
smolt age	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
1	21	10	58.0	55.1	3.7	3.2	50.8	50.8	64.0	61.0
2	36	120	76.3	75.6	3.6	4.1	68.6	59.7	84.0	88.5
3	4	13	84.6	87.7	5.3	6.6	78.5	78.0	89.0	99.0
4	2	9	93.7	90.6	11.3	3.7	85.7	83.8	101.7	96.5
5	-	3	-	93.2	-	7.3	-	89.0	-	101.6
Unaged	16	22	78.7	76.8	10.4	12.4	52.0	57.0	92.9	96.0
Total	79	177								

Table 15. Summary of post-smolt ages, spawning history and mean lengths with standard deviations (s.d.) by river age and sex of Atlantic salmon put through the Sydney River Dam fishway, 1994-2003, excluding 1999.

				Fork Length (cm)							
		Number		Mean		s.d.		Min.		Max.	
River age	Post-smolt age	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
2	**1**	4	6	57.3	54.8	4.7	3.9	53.3	50.8	64.0	61.0
2	**2**	10	25	76.3	74.8	3.2	2.6	68.6	71.0	79.6	81.3
2	**2 sp 1**		1		60.3		-		60.3		60.3
2	**3 sp 1**		1		91.4		-		91.4		91.4
2	**3 sp 2**	1	6	88.9	91.4	-	7.2	88.9	81.3	88.9	99.0
2	**4 sp 1, 2**	1		85.7			-	85.7		85.7	
2	**4 sp 2**		1		83.8		-		83.8		83.8
2	**4 sp 2,3**		1		87.0		-		87.0		87.0
2	**4 sp 3**	1	1	101.7	91.4	-	-	101.7	91.4	101.7	91.4
2	**5 sp 2, 4**		1		89.0		-		89.0		89.0
3	**1**	9	3	58.8	55.9	2.3	2.5	54.8	53.4	62.2	58.4
3	**2**	15	55	75.1	75.2	2.9	3.3	68.8	63.0	78.8	84.0
3	**2 sp 1**		1		59.7		-		59.7		59.7
3	**3**		1		89.0		-		89.0		89.0
3	**3 sp 2**	1	3	89.0	83.4	-	1.9	89.0	81.3	89.0	85.0
3	**4 sp 2**		4		93.3		2.4		91.4		96.5
3	**4 sp 2,3**		1		91.0		-		91.0		91.0
4	**2**		3		76.4		4.3		73.8		81.4
-	**1**	8	1	57.4	55.0	4.8	-	50.8	55.0	64.0	55.0
-	**2**	11	35	78.1	77.6	4.4	4.2	70.0	71.1	84.0	88.5
-	**3 sp 2**	2	2	80.2	80.7	2.3	3.9	78.5	78.0	81.8	83.5
-	**4 sp 2**		1		89.0		-		89.0		89.0
-	**5 sp 2,3,4**		1		89.0		-		89.0		89.0
-	**5 sp 2,4**		1		101.6		-		101.6		101.6
	Total	63	155								

Table 16. Proportion of adult Atlantic salmon sampled at the Sydney River Dam fishway, 1994-2003, excluding 1999, for each category by sex. "N" is the number of fish.

Category	Sex	N	Prop.
All fish	Female	177	0.69
	Male	79	0.31
One-sea-winter	Female	10	0.05
	Male	21	0.10
Multi-sea-winter	Female	145	0.67
	Male	42	0.19
Repeat spawners	Female	5	0.023
	Male	1	0.005
Unaged	Female	22	0.09
	Male	16	0.06

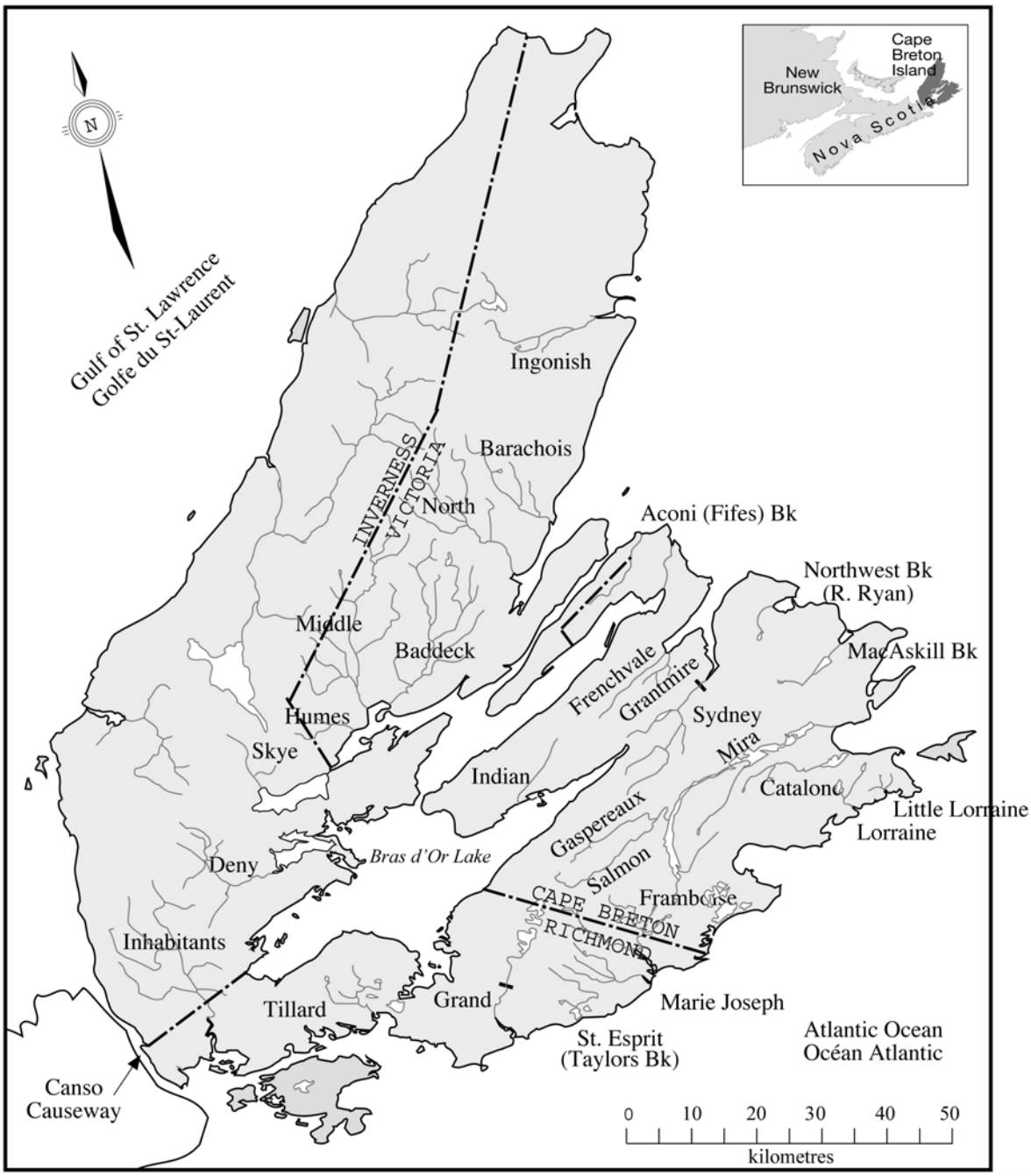


Figure 1. Selected rivers of Eastern Cape Breton, SFA 19.

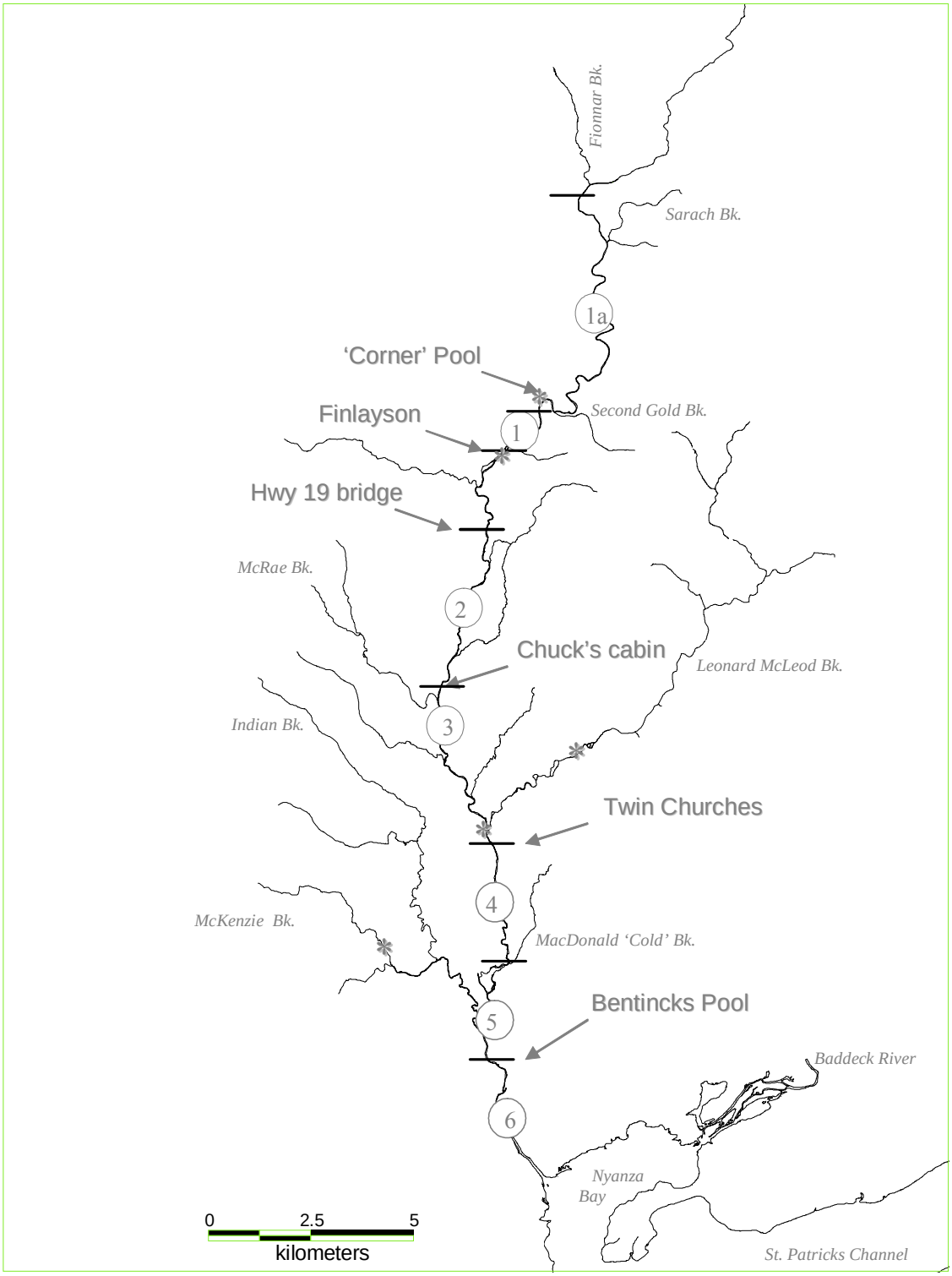


Figure 2. Middle River, Victoria County, showing names and locations of angling pools mentioned in the text and swim-thru sections (slash marks section boundary). Asterick (*) marks index electrofishing sites (1996-2001).

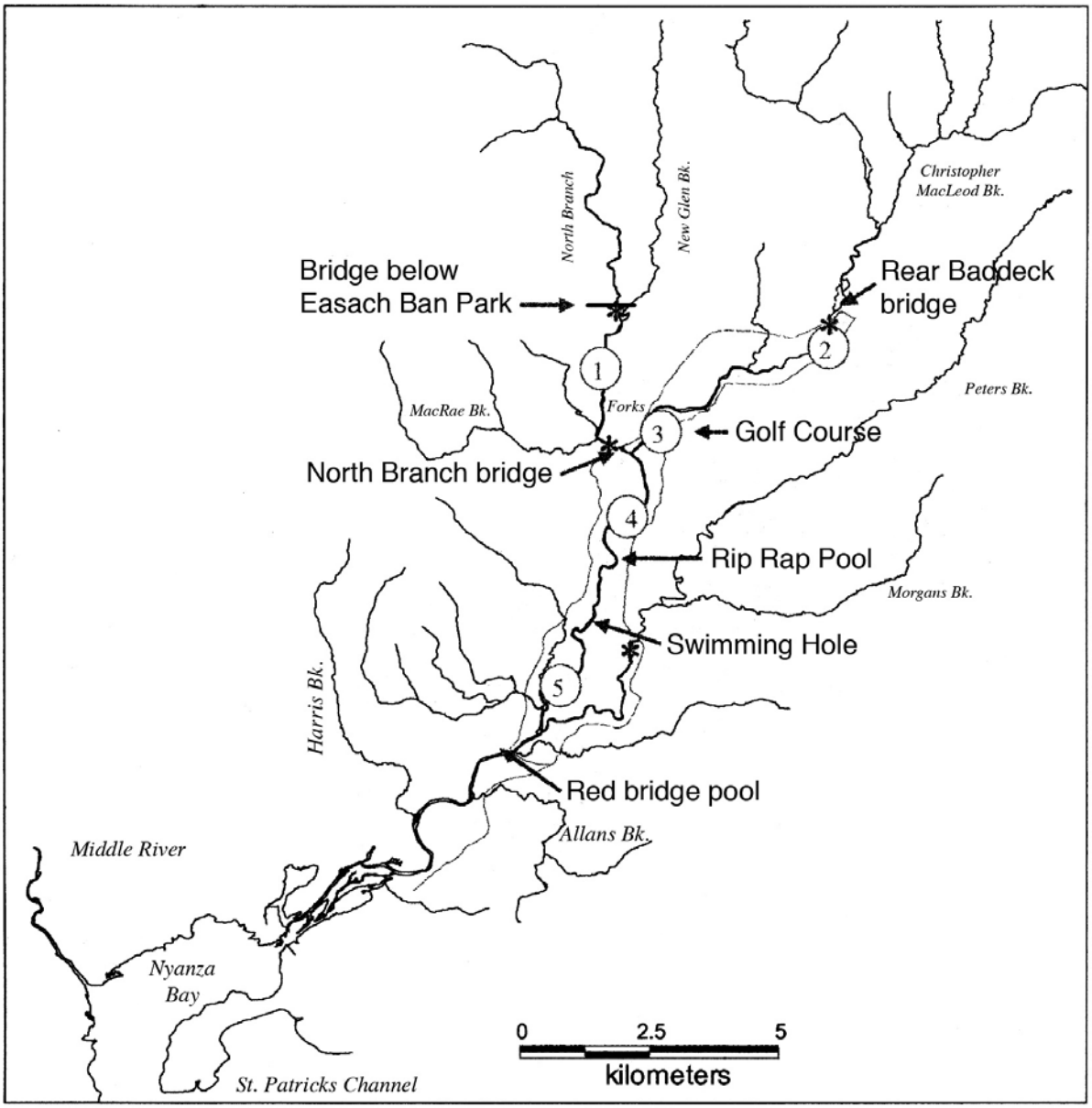


Figure 3. Baddeck River, Victoria County, showing swim-thru sections, names and locations of angling pools mentioned in the text. Asterick (*) marks index electrofishing sites (1996-2001).

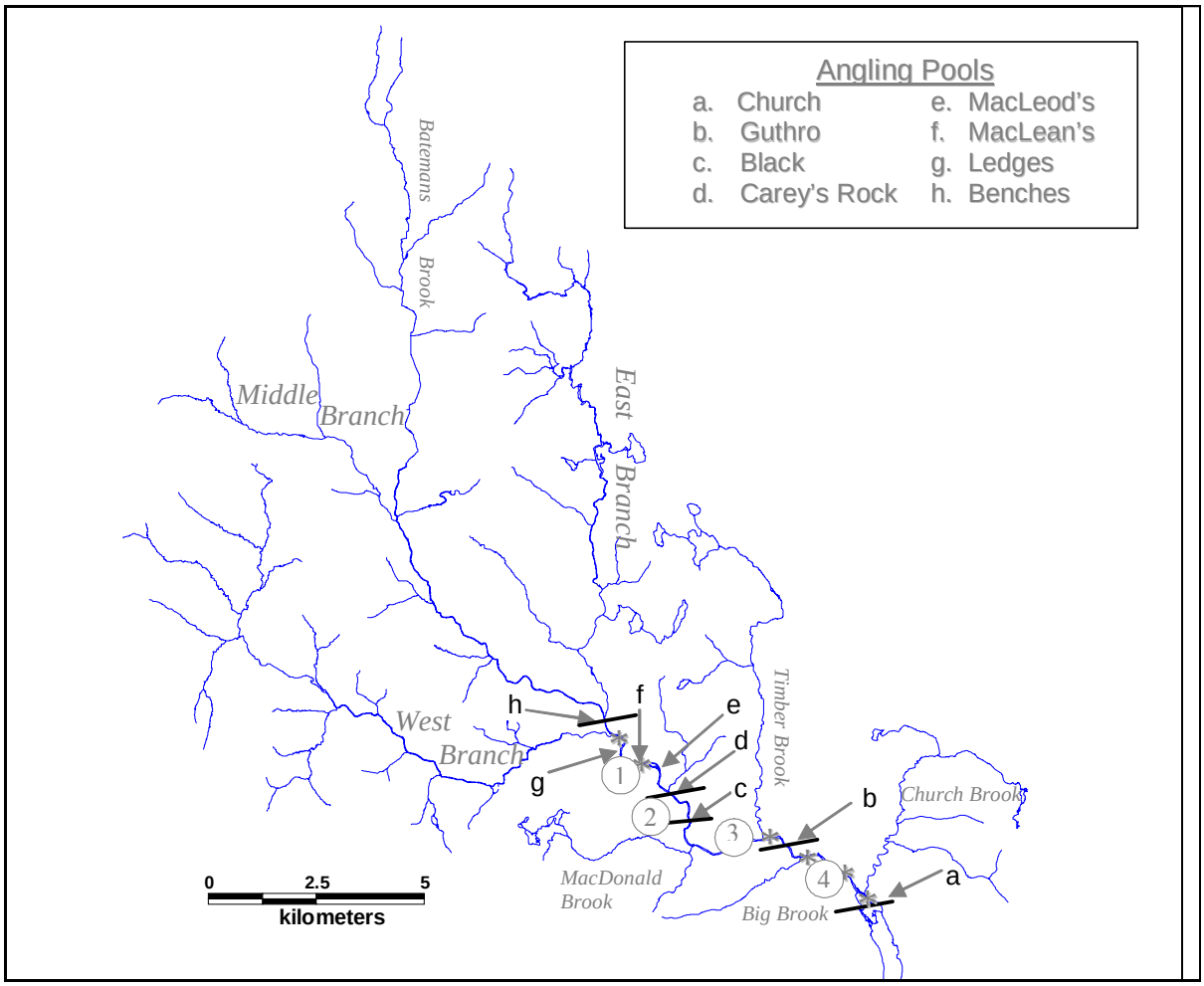
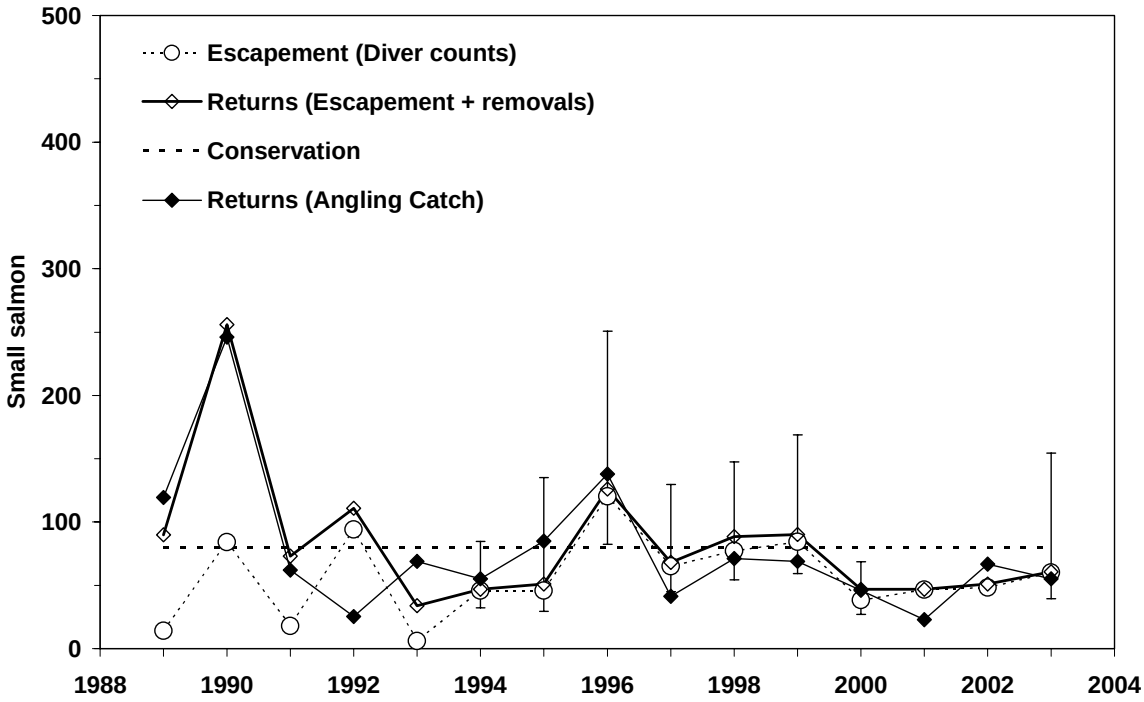


Figure 4. North River, Victoria County, showing names and locations of angling pools mentioned in the text and swim-thru sections (slash marks section boundary). Asterick (*) marks index electrofishing sites (1996-2001).



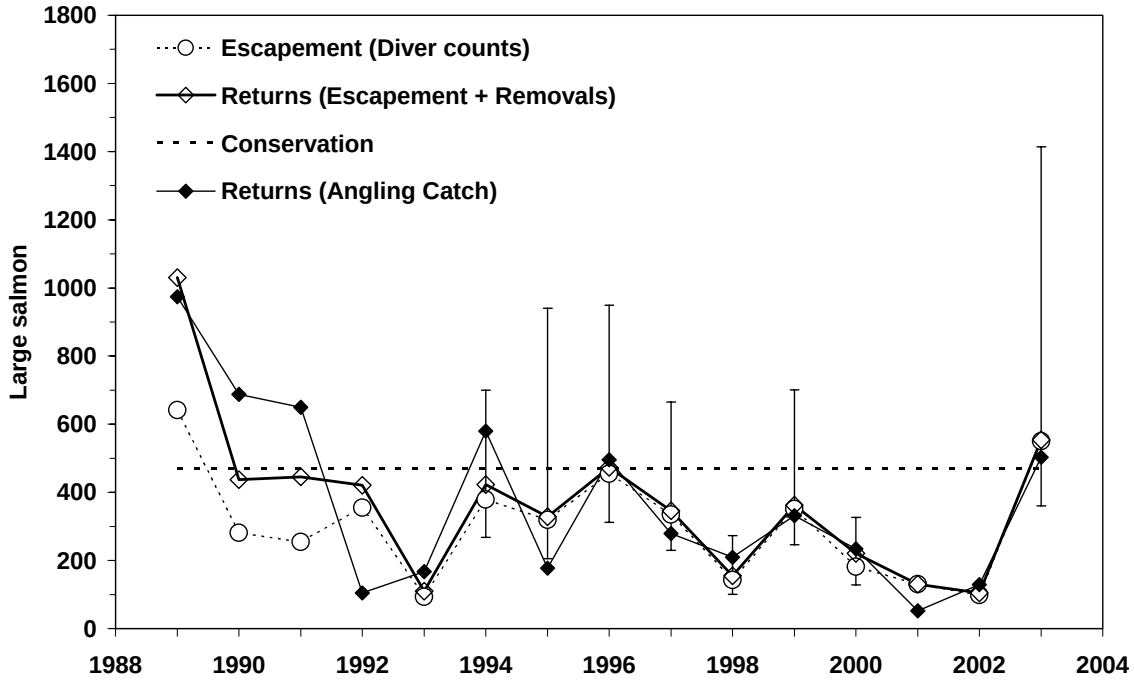


Figure 5. Estimates of small and large salmon returns and escapement to Middle River, Cape Breton Island (1989 – 2003). Whiskers represent the 5th and 95th percentiles.

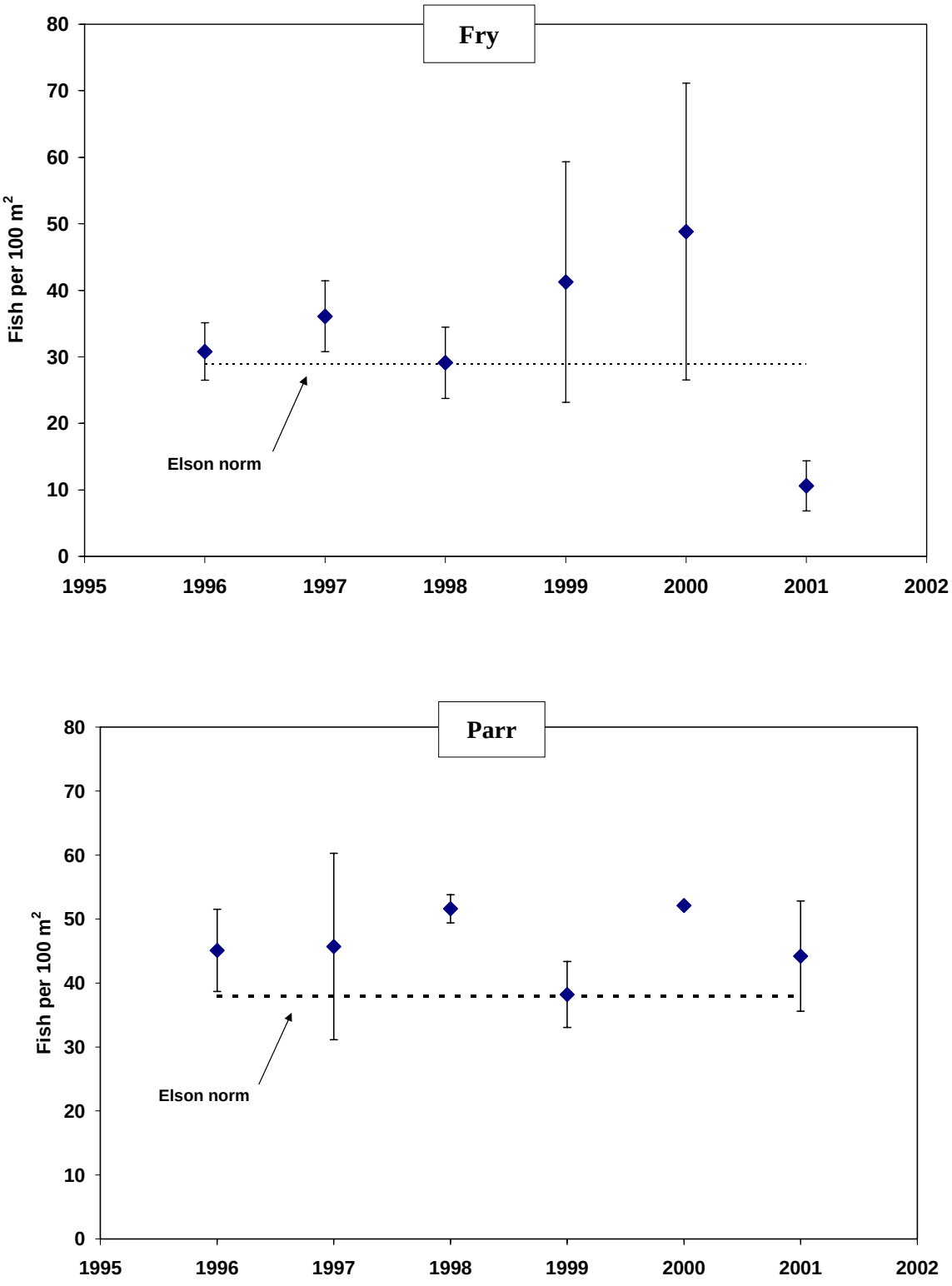
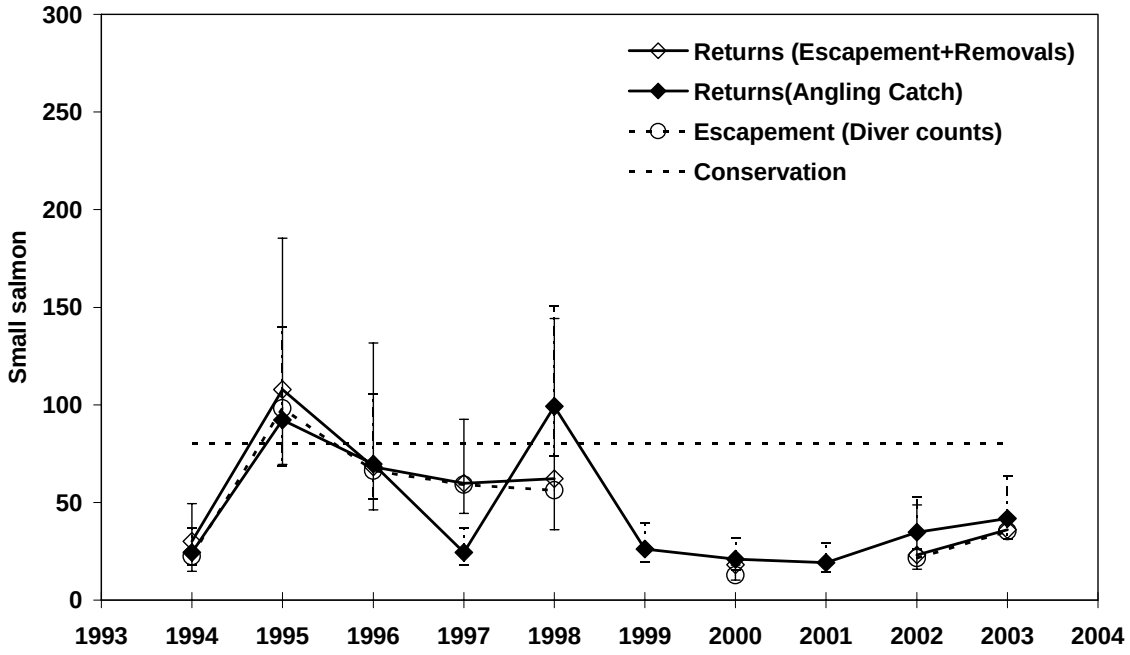


Figure 6. Age-0^+ (fry) and age-1^+ and older (parr) mean densities (whiskers are the standard error) at two mainstem sites on the Middle River, 1996-2001.



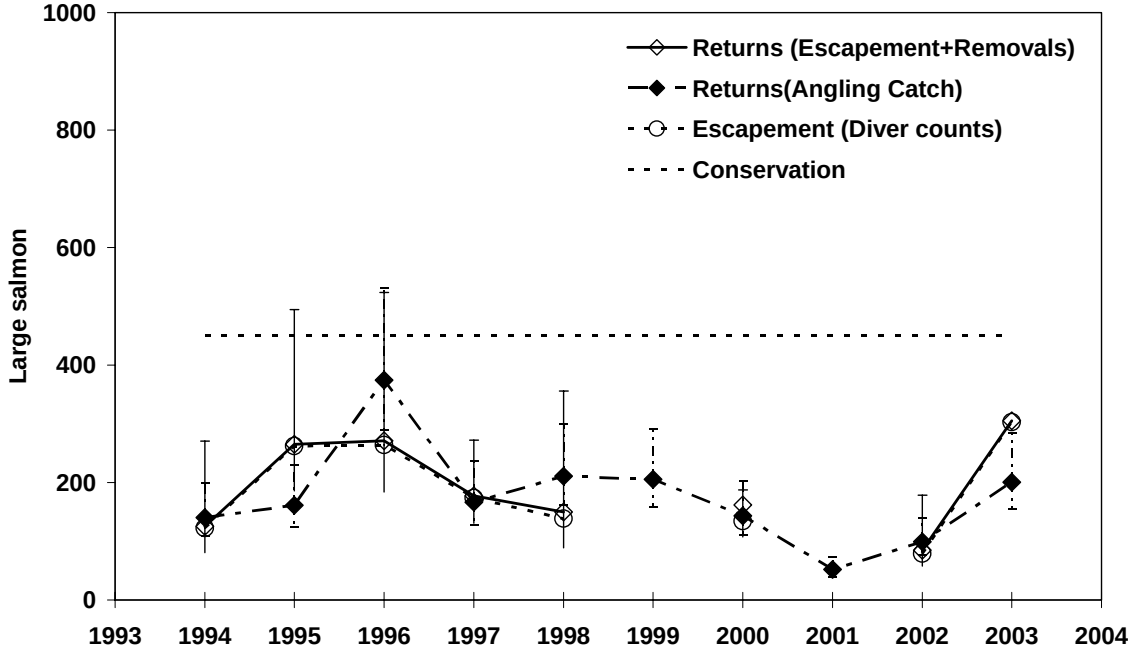


Figure 7. Estimates of small and large salmon returns and escapement to Baddeck River, Cape Breton Island (1994 – 2003). Whiskers represent the 5th and 95th percentiles.

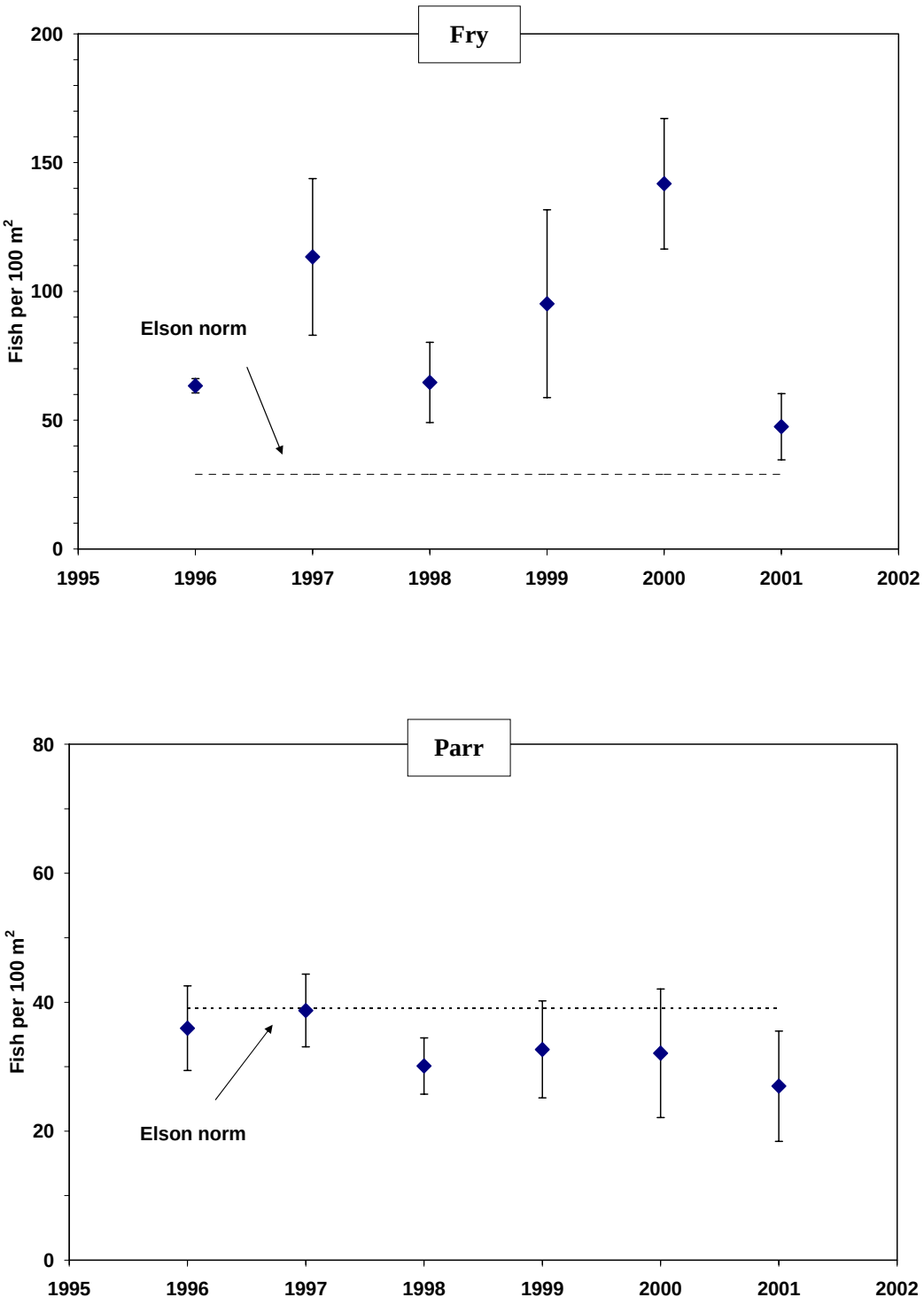


Figure 8. Age-0^+ (fry) and age-1^+ and older (parr) mean densities (whiskers are the standard error) at three main river sites on the Baddeck River, 1996-2001.

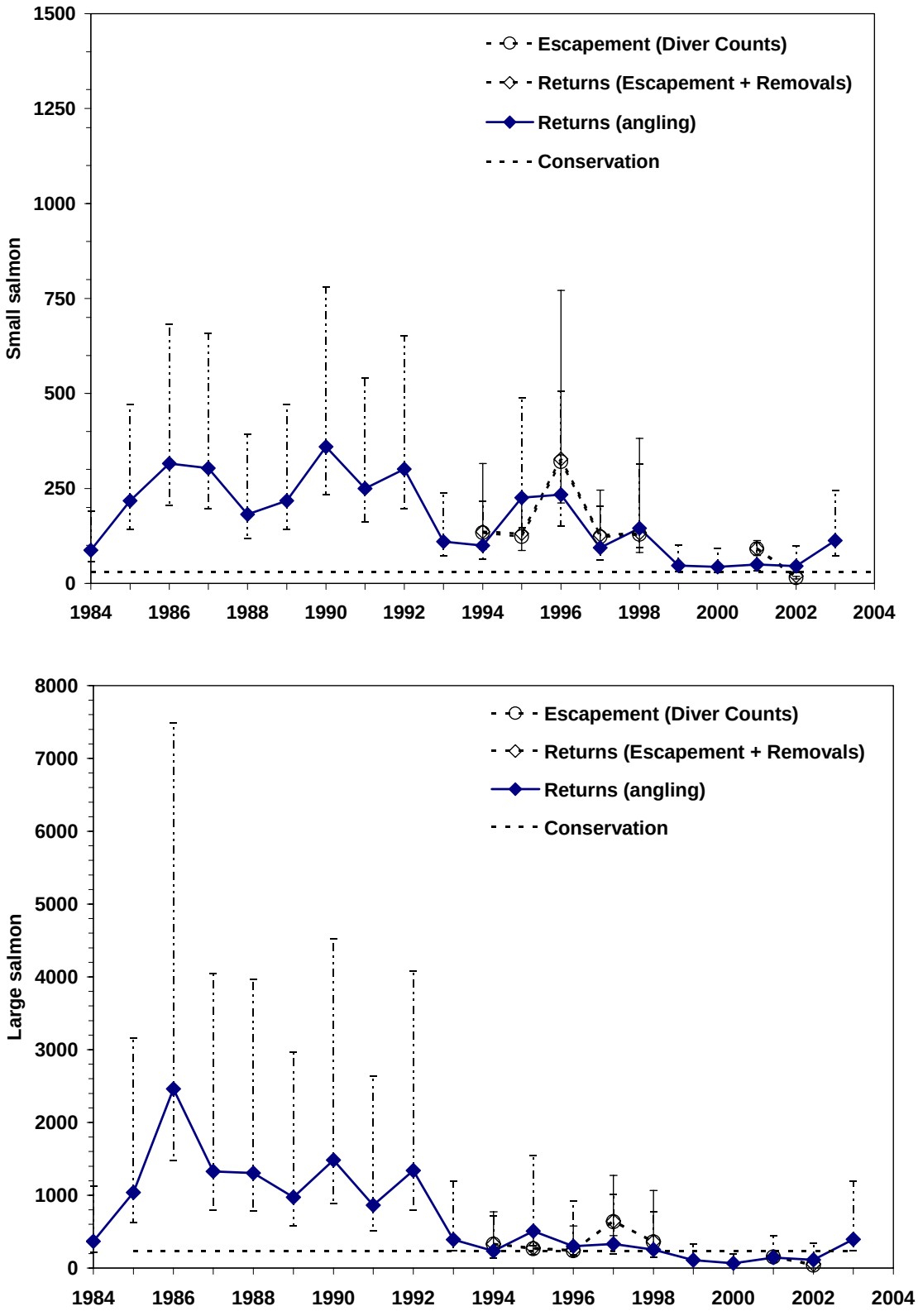


Figure 9. Estimates of small and large salmon returns and escapement to North River, Cape Breton Island (1984 – 2003). Whiskers represent the 5th and 95th percentiles.

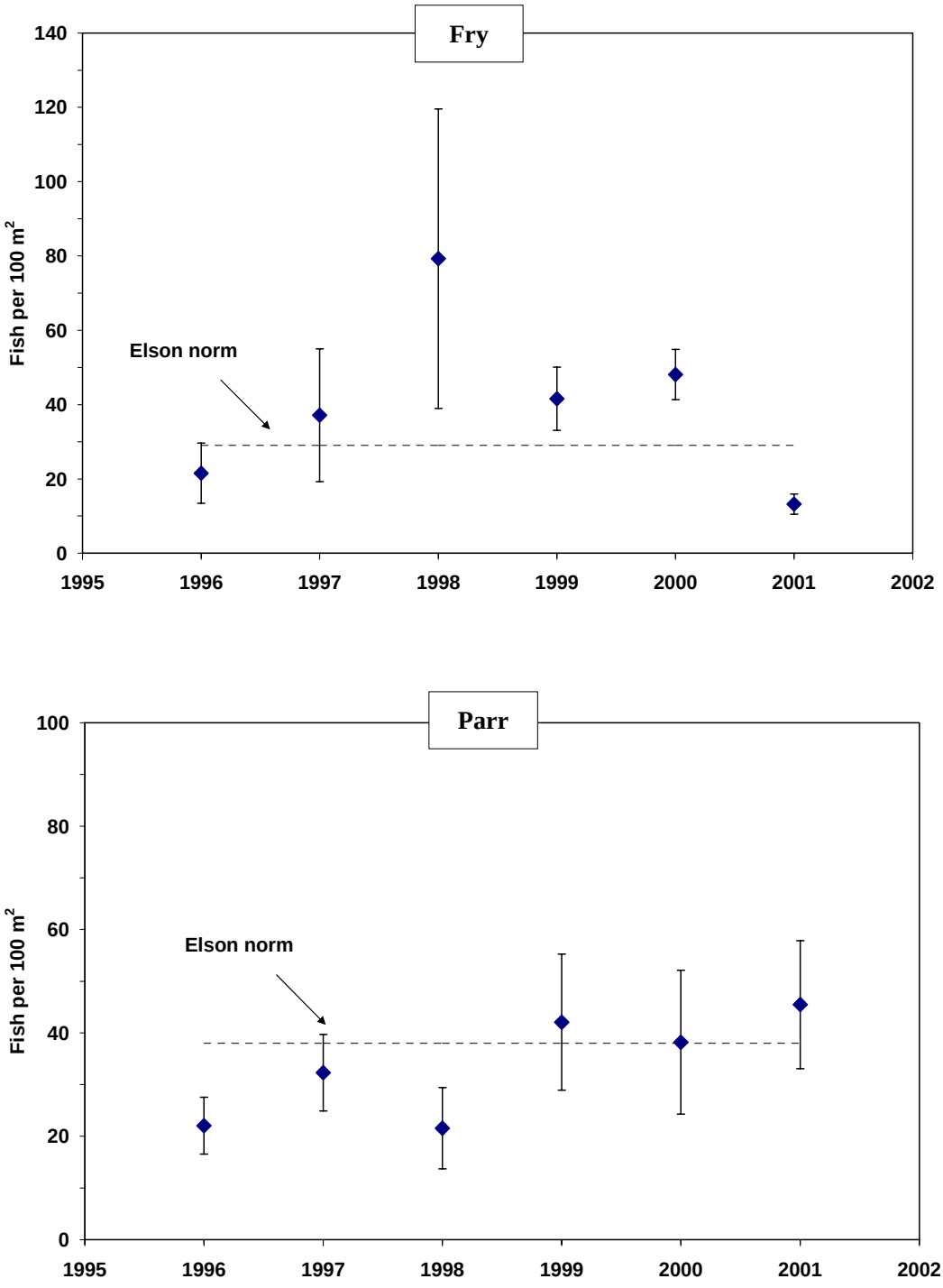


Figure 10. Age-0^+ (fry) and age-1^+ and older parr mean densities (whiskers are the standard error) at two to four main river sites on the North River, 1996-2001.

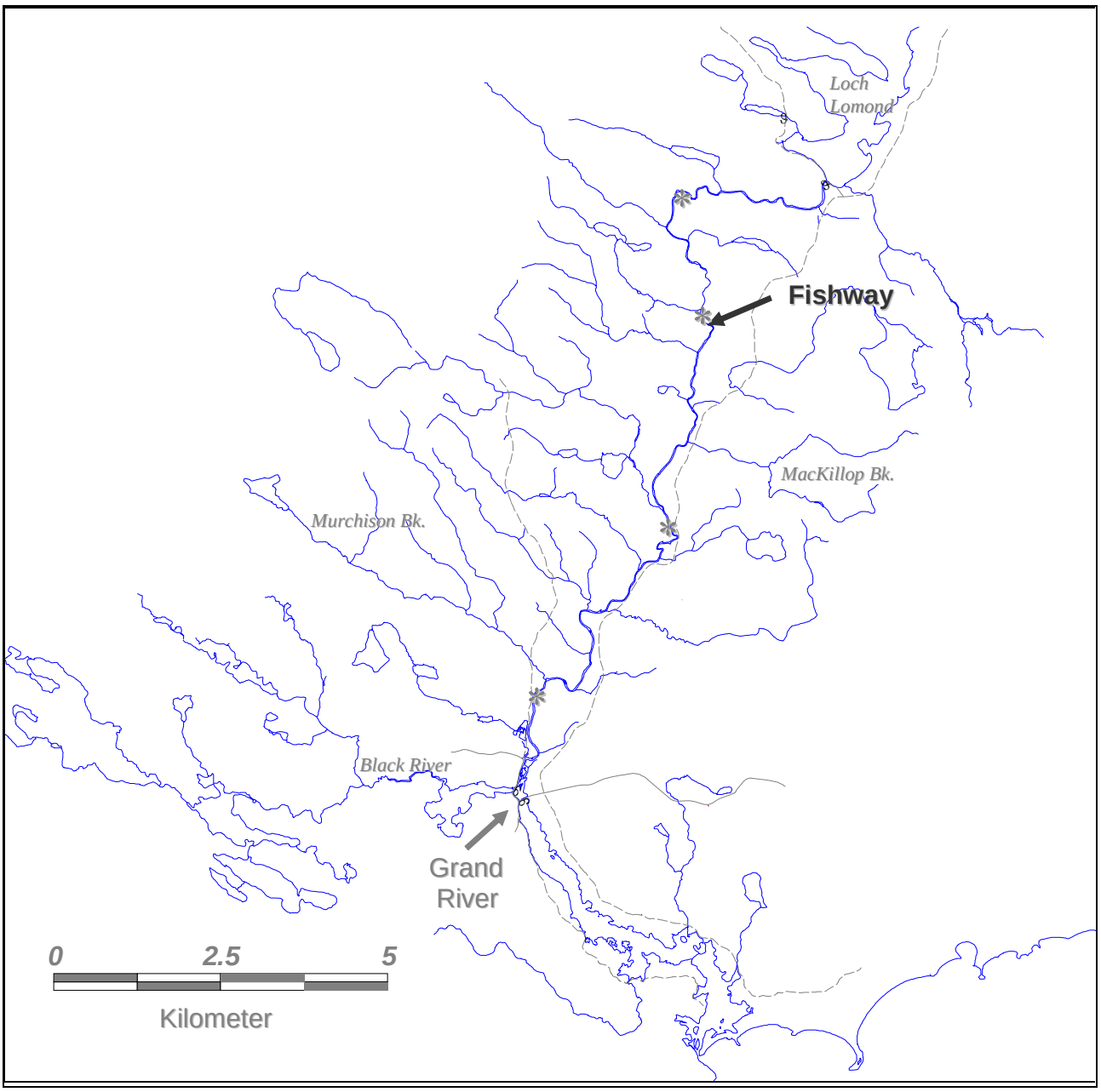


Figure 11. Grand River, Richmond County, showing location of Grand River Falls fishway and place names mentioned in the text. Asterick (*) marks index electrofishing sites (1996-2000).

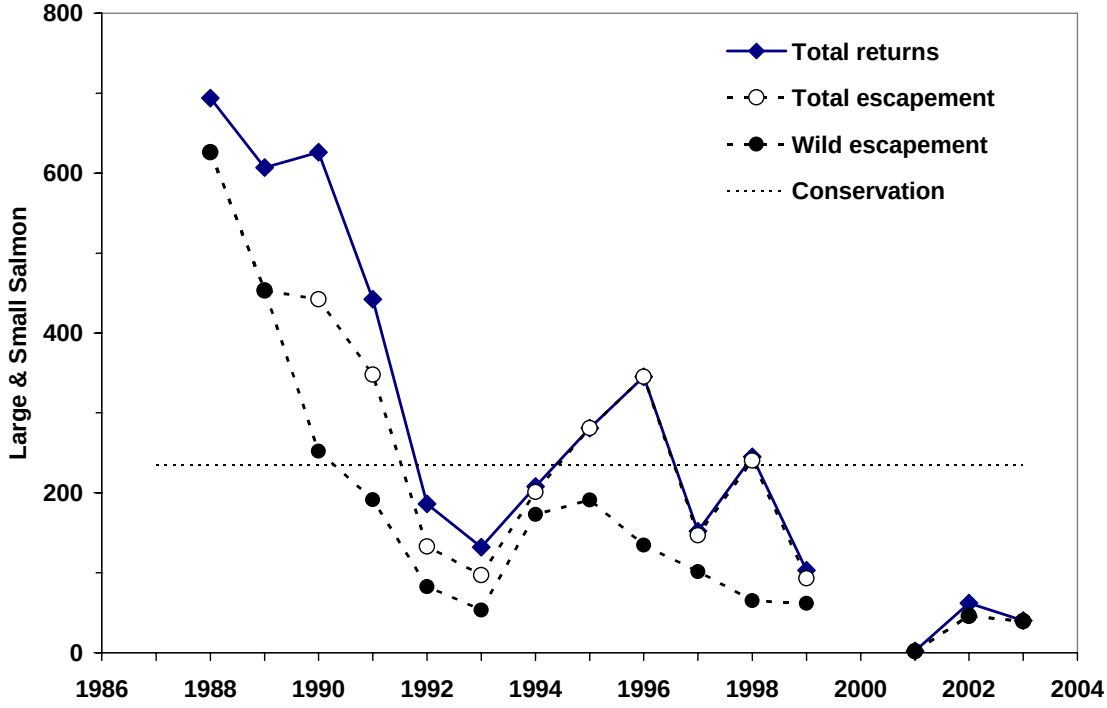


Figure 12. Estimates of small and large salmon returns and escapement to Grand River, Cape Breton Island (1988 – 2003).

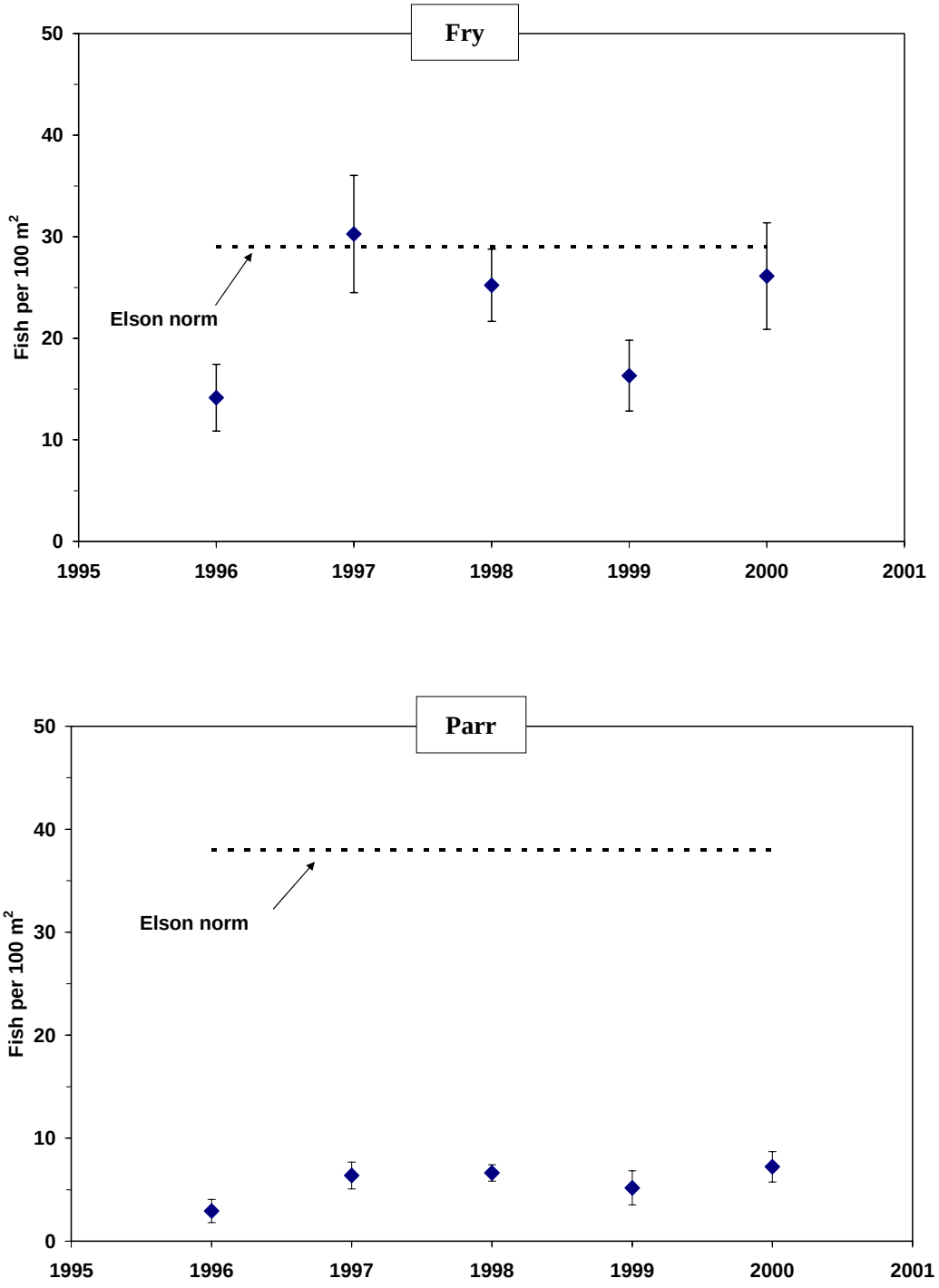


Figure 13. Age-0^+ (fry) and age-1^+ and older parr mean densities (whiskers are the standard error) at four main river sites on the Grand River, 1996-2000.

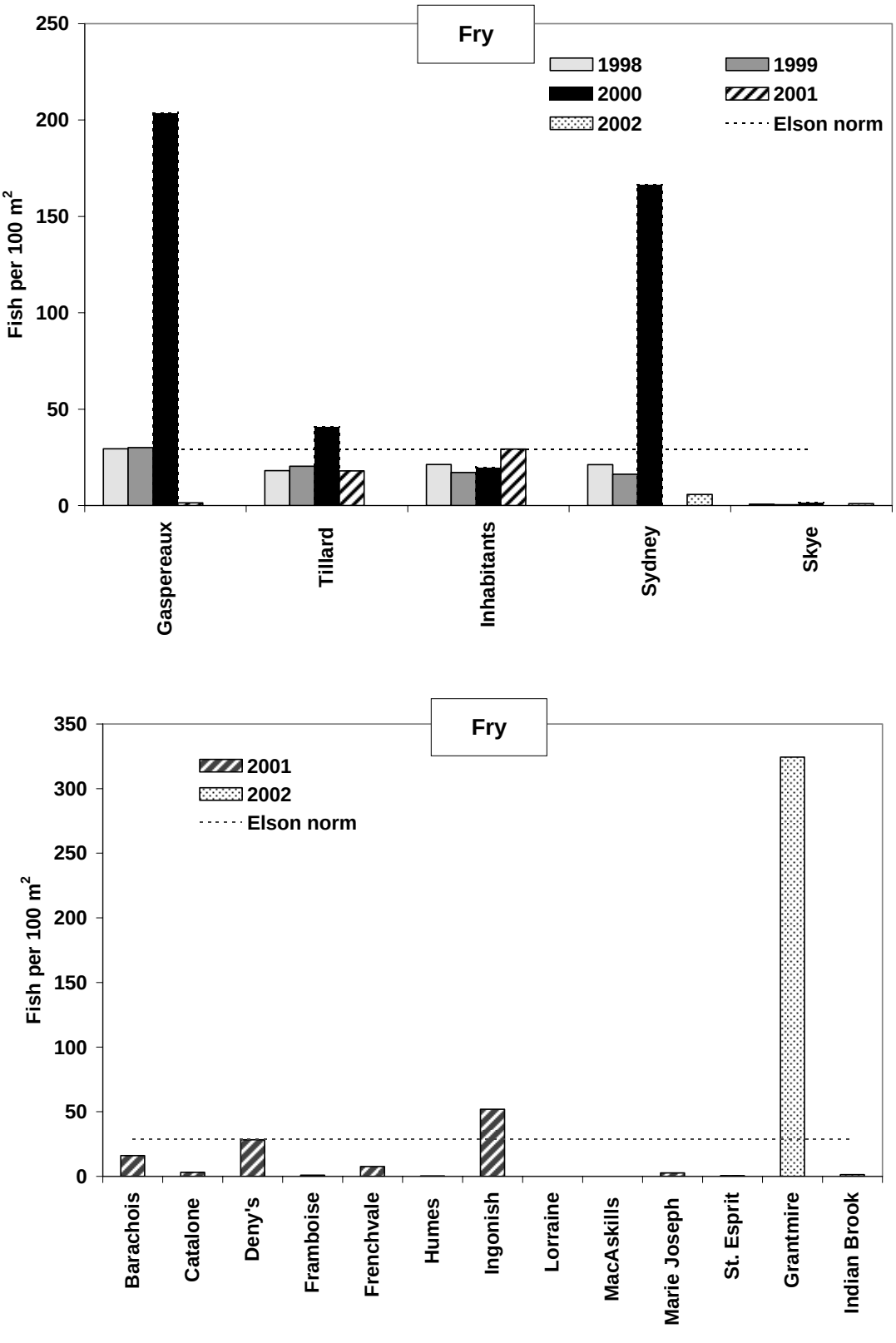


Figure 14. Mean densities of age-0^+ juvenile Atlantic salmon (fry) sampled in 'other' Eastern Cape Breton rivers from 1998 to 2002. Data and sample sizes as provided in Appendix IV.

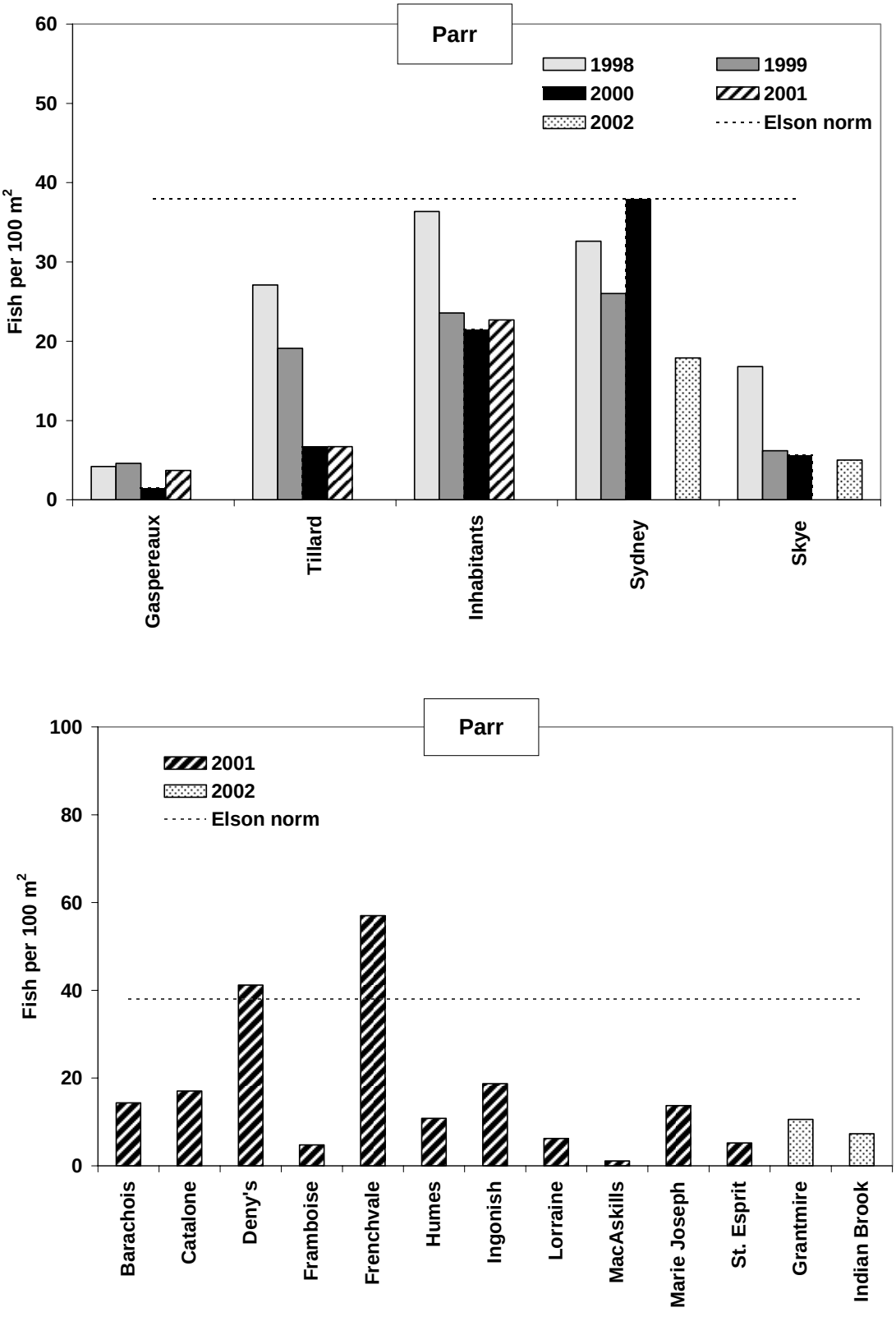


Figure 15. Mean densities of age-1^{+} and older juvenile Atlantic salmon (parr) sampled in 'other' Eastern Cape Breton rivers from 1998 to 2002. Data and sample sizes as provided in Appendix IV.

Appendix I: Swim-thru river sections on the Middle, Baddeck and North rivers, Eastern Cape Breton.

River	Section	Topo Map	Description	Location (NAD 83)		Section Length (km)
				Start	End	
Middle	1a	11K7	Headwaters: below Fionnar Brook to Corner Pool below 2^{d} Gold Brook	618-287	612-241	10.5
	1	11K7 & 11K2	Corner pool to Findlayson	612-241	603-233	1.5
	2	11K2	Hwy 19 bridge to Chuck's camp	598-212	588-173	4.2
	3	11K2	Chucks's camp to Twin Churches	588-173	602-135	4.5
	4	11K2	Twin Churches to McDonald (Cold) Brook	602-135	606-105	3.2
	5	11K2	McDonald Brook to Bentincks (Pipe) pool	606-105	607-082	2.8
	6	11K2	Bentincks pool to Nyanza Bay	607-082	616-055	4.2
Baddeck	1	11K2	North Branch: Easach Ban/'Upside Down bridge' to North branch bridge	715-190	717-160	4.0
	2	11K2	Upper Baddeck: Rear Baddeck bridge/ 'Girl Guide bridge' to pool half km downstream	757-186	754-180	0.5
	3	11K2	Golf course pools (3 pools)	723-166		
	4	11K2	North Branch bridge to Rip Rap pool	717-160	717-138	4.2
	5	11K2	Swimming Hole on Main River to Red Bridge pool	713-128	697-101	4.3
North	1	11K7	Benches to Carey's rock	772-345	790-328	3.2
	2	11K7	The Gorge: Carey's rock to Black's pool	790-328	792-321	1.0
	3	11K7	Black's pool to Guthro's	792-321	817-316	3.4
	4	11K7	Guthro's to Church	817-316	835-307	2.1

Appendix II. Annual summaries of catch, effort and estimated small and large salmon retained (Ret.) and released (Rls.) from NS license stub returns for assessed rivers of Eastern Cape Breton, 1984-2003. Change or percent increase and decrease in 2003 is calculated as [(2003 data– 2002 data or 5yr mean (1998-2002))/2002 data or 5yr mean (1998-2002)] * 100.

		Catch (Numbers)											
	No.	Small (Grilse)			Large (Salmon)			Total			Effort		%
Year	Anglers	Ret.	Rls.	Total	Ret.	Rls.	Total	Ret.	Rls.	Total	(Rod-Days)	CPUE	Large
BADDECK													
1984	60	4	2	7	2	44	46	7	46	53	275	0.189	87.5
1985	34	4	0	4	0	13	13	4	13	18	100	0.17	75
1986	67	19	6	26	0	126	126	19	132	151	289	0.54	83.1
1987	90	26	14	40	0	126	126	26	140	166	436	0.404	75.9
1988	86	16	15	32	0	153	153	16	168	184	375	0.492	82.8
1989	98	7	8	16	0	215	215	7	223	231	413	0.559	93.2
1990	103	35	26	62	0	158	158	35	185	220	492	0.446	72
1991	110	25	20	45	0	187	187	25	207	231	543	0.427	80.6
1992	129	44	6	50	0	144	144	44	150	194	592	0.327	74.4
1993	146	33	15	48	0	107	107	33	122	155	786	0.212	69.2
1994	74	1	13	14	0	54	54	1	67	68	257	0.265	79.4
1995	61	6	47	53	0	62	62	6	108	115	285	0.403	53.8
1996	70	0	40	40	0	144	144	0	184	184	317	0.58	78.2
1997	43	0	14	14	0	64	64	0	79	79	206	0.39	81.7
1998	87	0	57	57	0	81	81	0	139	139	335	0.442	58.6
1999	96	1	14	15	0	79	79	1	93	94	290	0.335	83.7
2000	54	1	11	12	0	55	55	1	66	67	212	0.363	82
2001	31	0	11	11	0	20	20	0	32	32	104	0.321	64
2002	59	0	19	19	0	38	38	0	57	57	204	0.303	66
2003	49	0	24	24	0	77	77	0	101	101	220	0.497	76.4
+/- 2002 (%)	(-17)		(22)	(22)		(104)	(104)		(76)	(76)	(8)	(64)	(16)
+/- 5-Year Mean (%)	(-25)	(-100)	(5)	(3)		(41)	(41)	(-100)	(30)	(30)	(-4)	(41)	(8)
GRAND													
1984	270	348	53	402	5	30	35	354	83	437	3009	0.148	8
1985	312	472	71	543	0	132	132	472	203	676	3093	0.224	19.6
1986	326	299	62	361	0	194	194	299	257	555	3019	0.18	35
1987	262	309	34	343	0	107	107	309	141	450	2078	0.208	23.8

Appendix II. *(Continued).*

GRAND (Con't)													
1988	277	264	18	282	0	88	88	264	106	370	2795	0.132	23.8
1989	247	253	19	272	0	65	65	253	84	337	2281	0.148	19.3
1990	240	291	68	359	0	88	88	291	156	447	2410	0.185	19.7
1991	178	101	11	112	0	16	16	101	27	128	1684	0.076	12.5
1992	182	130	10	140	0	39	39	130	48	178	1633	0.109	21.9
1993	183	119	22	141	0	25	25	119	47	166	1496	0.111	15.1
1994	44	0	63	63	0	17	17	0	80	80	346	0.231	21.3
1995	4	0	4	4	0	11	11	0	15	15	41	0.366	73.3
1996	26	0	78	78	0	22	22	0	99	99	245	0.404	22.2
1997	20	3	28	31	0	6	6	3	34	37	173	0.214	16.2
1998	20	0	75	75	0	12	12	0	86	86	246	0.350	14.0
1999	7	0	17	17	0	3	3	0	20	20	47	0.426	15.0
2000	14	0	20	20	0	1	1	0	21	21	81	0.259	4.8
2001	6	0	1	1	0	0	0	0	1	1	9	0.111	0.0
2002	11	0	31	31	0	0	0	0	31	31	84	0.369	0.0
2003	8	0	17	17	0	3	3	0	20	20	65	0.308	15.0
+/- 2002 (%)	-27		-45	-45					-35	-35	-23	-17	
+/- 5-Year Mean (%)	-31		-41	-41		-6	-6		-37	-37	-30	2	122
MIDDLE													
1984	83	24	11	35	1	77	78	25	87	112	509	0.220	69.6
1985	39	15	6	21	0	29	29	15	34	49	160	0.306	59.2
1986	76	36	8	44	0	108	108	36	116	152	388	0.392	71.1
1987	114	53	4	57	0	116	116	53	120	173	725	0.239	67.1
1988	131	32	11	43	0	124	124	32	135	167	605	0.276	74.3
1989	144	36	9	45	0	243	243	36	253	289	731	0.395	84.1
1990	153	69	24	93	0	171	171	69	196	265	847	0.313	64.5
1991	169	16	8	24	0	163	163	16	171	187	726	0.258	87.2

Appendix II. *(Continued).*

Year	No. Anglers	Catch (Numbers) Small (Grilse) Ret.	Rls.	Total	Large (Salmon) Ret.	Rls.	Total	Total Ret.	Rls.	Total	Effort (Rod-Days)	CPUE	% Large
MIDDLE (Con't)													
1992	66	7	3	10	0	26	26	7	30	37	184	0.201	70.3
1993	110	25	5	30	0	48	48	25	54	79	406	0.195	60.8
1994	122	0	20	20	0	145	145	0	165	165	420	0.393	87.9
1995	72	0	32	32	0	44	44	0	77	77	243	0.317	57.1
1996	125	2	52	54	0	123	123	2	175	177	427	0.415	69.5
1997	52	3	15	18	0	80	80	3	95	98	175	0.560	81.6
1998	99	5	26	31	0	60	60	5	86	91	312	0.292	65.9
1999	138	0	30	30	0	95	95	0	125	125	369	0.339	76.0
2000	92	0	20	20	0	67	67	0	88	88	311	0.283	76.1
2001	25	0	10	10	0	15	15	0	25	25	92	0.272	60.0
2002	60	1	27	28	0	35	35	1	62	63	231	0.273	55.6
2003	73	0	24	24	0	144	144	0	168	168	334	0.503	85.7
+/- 2002 (%)	22	-100	-11	-14		311	311	-100	171	167	45	84	54
+/- 5-Year Mean (%)	-12	-100	6	1		165	165	-100	118	114	27	73	28
NORTH													
1984	163	57	9	66	96	58	154	153	67	220	1182	0.186	70.0
1985	170	149	13	162	0	425	425	149	439	588	1012	0.581	72.3
1986	297	185	50	235	0	1010	1010	185	1060	1245	2050	0.607	81.1
1987	263	177	50	227	0	546	546	177	596	773	1668	0.463	70.6
1988	202	103	14	117	0	467	467	103	481	584	1336	0.437	80.0
1989	162	106	35	141	0	348	348	106	383	489	1131	0.432	71.2
1990	219	176	57	233	0	531	531	176	588	764	1556	0.491	69.5
1991	172	129	34	163	0	311	311	129	345	474	1181	0.401	65.6
1992	205	161	35	196	0	481	481	161	516	677	1564	0.433	71.0
1993	217	63	20	83	0	164	164	63	183	246	1246	0.197	66.7
1994	73	0	65	65	0	84	84	0	149	149	342	0.436	56.4
1995	77	1	146	147	0	183	183	1	329	330	435	0.759	55.5

Appendix II. *(Concluded).*

Year	No. Anglers	Catch (Numbers) Small (Grilse) Ret.	Rls.	Total	Large (Salmon) Ret.	Rls.	Total	Total Ret.	Rls.	Total	Effort (Rod-Days)	CPUE	% Large
NORTH (Con't)													
1996	81	0	151	151	0	108	108	0	260	260	494	0.526	41.5
1997	58	1	69	70	0	137	137	1	206	207	384	0.539	66.2
1998	84	0	108	108	0	104	104	0	212	212	448	0.473	49.1
1999	79	0	35	35	0	45	45	0	80	80	292	0.274	56.3
2000	49	0	32	32	0	27	27	0	59	59	261	0.226	45.8
2001	46	0	37	37	0	60	60	0	97	97	264	0.367	61.9
2002	44	0	34	34	0	45	45	0	80	80	269	0.297	56.3
2003	48	0	84	84	0	162	162	0	246	246	539	0.456	65.9
+/- 2002 (%)	9		147	147		260	260		208	208	100	53	17
+/- 5-Year Mean (%)	-21		71	71		188	188		133	133	76	39	22

Appendix III. Middle River mark- recapture (M/R) data during fall adult salmon assessment swim-thrus (1994-2003). River sections described in Table 2 and shown in Figure 2.

Year	Dates M/R	Swim conditions	River Section	Tags applied (M) Large	Small	Total	Tags observed (R) Large	Small	Total
1994	Oct.-16		2	8		8	7		7
	Oct.-17		3	1		1	1		1
			4	8		8	5		5
				Totals		17			13
							Recovery rate = 0.765		
				Swim-thru count **C**=324; **M**=17; **R**=13 Grilse (35/324) = 0.108 of total.					
1995	Oct.-17	Water low relative	2			3	1		1
	Oct.-18	to 1996	3			5		2	2
		Visibility good	4			2	3		3
			5			2			
				Totals		12			6
							Recovery rate = 0.500		
				Swim-thru count **C**=183; **M**=12; **R**=6 Grilse (23/183) = 0.126 of total.					
1996	Oct.-18,19	Water relatively high	2	4		4	2		2
	Oct.-22	Good visibility	3	3	4	7	1		1
		Gauge est 1.90 ft	4	4	1	5	6	1	7
				Totals		16			10
							Recovery rate = 0.625		
				Swim-thru count **C**=359; **M**=16; **R**=10 Grilse (75/359) = 0.209 of total.					
1997	Oct.-18,19	Water low	1-2	2	8	10	4	3	7
	Oct.-20, 22	Ideal visibility	2	2	1	3			
		Gauge at 1.22 ft	3	4		4	3	1	4
			5-6	28	4	32	12	2	14
				Totals		49			25
							Recovery rate (all) = 0.510		
							Recovery rate (3 sections) = 0.647		
				Premise - 1 day between **M** and **R** is inadequate for recent river entrants (Mean of previous 3 years = 0.630).					
				Swim-thru count **C**=258; & use **M**=17; **R**=11 Grilse (42/258) = 0.163 of total.					

Appendix III. Middle River. *(Continued).*

Year	Dates M/R	Swim conditions	River Section	Tags applied (M) Large	Small	Total	Tags observed (R) Large	Small	Total
1998	Oct.-17,18	Water moderate	1-2	6	1	7	4	3	7
	Oct.-19, 20	Good visibility	2	3	3	6			
		Gauge at 1.40 ft	3				1		1
			4	3	2	5	4		4
				Totals		18			12
							Recovery rate = 0.667		
							Swim-thru count **C**=148; **M**=18; **R**=12		
							Grilse (52/148) = 0.351 of total		
1999	Oct.-18								
	Nov.-3	Excellent visibility		no tags applied					
		Gauge at 1.6 ft							
				[1]Totals		15			11
							Recovery rate = 0.733		
							Swim-thru count **C**=232; **M**=15; **R**=11		
							Grilse (45/232) = 0.194 of total		
2000	Oct.-23	Water moderate	1	5	1	6			2
	Oct.-25	Excellent visibility	2	6	1	7			3
		Gauge at 1.66 ft	3	5	1	6			4
			4	3	1	4			3
			5						1
				Totals		23			13
							Recovery rate = 0.565		
							Swim-thru count **C**=124; **M**=23; **R**=13		
							Grilse (28/124) = 0.226 of total		
2001	Nov.-5, 6, 7	Water low to fair							
		Low visibility		no tags applied					
		Gauge at 0.90 ft on Nov. 5							
		Gauge at 1.50 ft on Nov. 7							
							Swim-thru count **C**=110		
							Grilse (29/110) = 0.264 of total		
2002	Oct.-21	Fair visibility		no tags applied					
	Oct.-23	Gauge at ~2.0 ft							
							Swim-thru count **C**=91		
							Grilse (30/91) = 0.330 of total		

[1] Hypothetical mark and recapture data based on previous recovery efficiency (Marshall et al. 2000)

Appendix III. Middle River. *(Concluded).*

Year	Dates M/R	Swim conditions	River Section	Tags applied (M) Large	Small	Total	Tags observed (R) Large	Small	Total
2003	Oct.-20	Good visibility	1				1		1
	Nov.-4	Gauge at 1.80 ft	2	14	5	19	4		4
			3					1	1
			4	2		2	1		1
			5		1	1			
				Totals		22			7
							Recovery rate = 0.318		

Swim-thru count **C**=193; **M**=22; **R**=7
Grilse (19/193) = 0.098 of total

Earlier versions of this table are presented in Marshall et al. 1998 and 1999. Some revisions were necessary. It is now considered correct to the best of our knowledge.

Appendix IV. Results of electrofishing surveys for juvenile Atlantic salmon at removal and mark-recapture (M/R) sites in Eastern Cape Breton rivers, 1996-2002. The "catch" column denotes the number of fish caught per sweep at removal sites or the number of fish marked/recaptured/total caught during recapture run at mark-recapture sites. Asterick (*) at certain mark-recapture sites indicates that fry were not marked and parr efficiencies were used to calculate population estimates.

River	Site name	Area (m^2)	Method	No. of sweeps	Age-0$^+$ Catch	Age-0$^+$ Pop'n	Age-0$^+$ Density ($100m^2$)	Age-1$^+$ and older Catch	Age-1$^+$ and older Pop'n	Age-1$^+$ and older Density ($100m^2$)
2002										
Grantmire		252	Removal	3	172, 114, 113	816	324.3	12,6,4	27	10.6
Indian Bk [Eskazoni]		317	Removal	3	3, 1, 0	4	1.3	16,3,3	23	7.3
Skye	Main	310	Removal	3	2, 1, 0	3	1.0	10,4,1	16	5.0
Sydney	Woodbine Brook	226	Removal	3	12, 0, 1	13	5.8	18,11,5	41	17.9
2001										
Middle	Twin Churches	364	Removal	4	20, 9, 6, 7	52	14.2	103,46,23,18	205	56.4
	Finlayson	550	Removal	4	16, 10, 4, 4	39	7.0	64,38,21,21	176	32.0
	2nd Gold Brook	331	Removal	4	1, 0, 2, 1		1.2	69,37,26,12	162	48.9
	MacKenzie Brook	300	Removal	4	19, 6, 11, 3	46	15.4	38,20,8,12	91	30.2
	Mean, 3 main river sites						7.5			45.8
Baddeck	Upper Baddeck	333	Removal	4	47, 13, 14, 10	94	28.1	36,12,9,12	82	24.6
	North Branch	452	Removal	4	93, 85, 50, 34	356	78.7	5,14,5,3	45	10.1
	Easach Ban	400	Removal	4	34, 22, 19, 16	142	35.6	85,35,29,16	185	46.2
	Peters Brook	236	Removal	4	64, 46, 21, 17	174	73.6	51,23,13,5	97.1	41.1
	Mean, 3 main river sites						47.5			27.0
North	MacLeans	481	Removal	4	32, 8, 10, 7	64	13.3	120,96,62,21	353	73.3
	Karr's	881	Removal	5	16, 14, 9, 4, 7	54	6.1	54,33,26,26,11	187	21.2
	Narrows	256	Removal	3	30, 8, 7	49	19.0	54,24,15	107	41.8
	Mean, 3 sites						12.8			45.4
Barachois		314	Removal	3	10, 13, 5	50	16.0	30,8,5	45	14.4
Catalone		455	Removal	3	3, 5, 1	14	3.1	16,13,10	78	17.1
Deny's	Hwy 104	280	Removal	3	40, 21, 9	79	28.3	32,25,16	115	41.2
Framboise		336	Removal	3	1, 1, 1	-	0.9	8,4,2	16	4.8
Frenchvale		296	Removal	3	8, 1, 5	22	7.6	78,36,26	169	57.0
Gaspereaux	Victoria Bridge	409	Removal	3	2, 1, 1	6	1.4	11,4,0	15	3.7
Humes		375	Removal	3	1, 0, 0	-	0.3	20,12,4	41	10.8
Ingonish		358	Removal	3	74, 46, 26	186	51.9	31,13,11	67	18.7
Inhabitants	Main	244	Removal	3	23, 17, 10	72	29.3	29,10,9	55	22.7
Lorraine		336	Removal	3	0, 0, 0	-	0.0	11,6,2	21	6.3
MacAskills		449	Removal	3	0, 0, 0	-	0.0	4,1,0	5	1.1
Marie Joseph	West Branch	227	Removal	3	3, 1, 1	6	2.6	9,13,9	-	13.7
St. Esprit	Taylor Brook	175	Removal	3	0, 0, 1	-	0.6	7,2,0	9	5.2
Tillard	Main	266	Removal	3	9, 7, 6	48	18.0	12,3,2	18	6.7
2000										
Middle	Twin Churches	307	Removal	3	103, 40, 12	162	52.8	117,28,13	162	52.8
	Finlayson	540	Removal	4	148, 62, 16, 11	242	44.8	170,52,31,16	278	51.4
	2nd Gold Brook	330	Removal	4	267, 63, 28, 18	381	115.4	147,45,29,16	247	74.7

Appendix IV. *(Continued).*

River	Site name	Area (m^2)	Method	No. of sweeps	Age-0+ Catch	Age-0+ Pop'n	Age-0+ Density ($100m^2$)	Age-1+ and older Catch	Age-1+ and older Pop'n	Age-1+ and older Density ($100m^2$)
	MacKenzie Brook	97	Removal	4	12, 3, 2, 1	18	18.9	15,6,7,3	36	37.3
	Mean, 3 main river sites						71.0			59.6
Baddeck	Upper Baddeck	343	Removal	4	255, 67, 44, 15	389	113.6	26,8,4,5	46	13.3
	North Branch	359	Removal	4	479, 152, 69, 20	732	203.9	72,17,6,4	100	27.8
	Easach Ban	375	Removal	3	251, 81, 47	405	108.0	141,45,14	207	55.1
	Peters Brook	261	Removal	4	238, 107, 77, 35	499	191.2	18,7,7,1	35	13.5
	Mean, 3 main river sites						141.8			32.1
North	MacLeans	438	Removal	3	147, 44, 27	232	52.8	226,87,38	375	85.6
	Benches	324	Removal	3	128, 45, 28	219	67.8	57,20,13	98.6	30.5
	Karr's	314	Removal	4	96, 23, 3, 2	124	39.5	44,4,5,4	58	18.4
	Narrows	261	Removal	3	72, 9, 3	84	32.3	38,5,4	48	18.3
	Mean, 4 sites						48.1			38.2
Grand	Mud Hole	666	M/R		106/36/92	293	44.0	20/5/21	76	11.4
	Fishway	801	M/R		45/10/40	175	21.8	14/3/12	48	6.0
	Crib Pool	523	M/R		20/5/25	90	17.2	7/2/6	18	2.8
	Frank MacDonald Rd.	479	M/R		47/24/49	103	21.5	24/10/16	39	8.1
	Mean, 4 sites						26.1			7.1
Gaspereaux	Victoria Bridge	343	M/R		182/56/217	699	203.8	1/1/5	5	1.5
Inhabitants	Main	361	Removal	3	47, 17, 5	72	19.9	53,16,6	78	21.5
	Lamey Brook	444	Removal	4	110, 29, 12, 1	153	34.5	49,18,10,7	89	20.0
	Northwest Arm	408	Removal	3	15, 4, 4	25	6.2	13,0,1	14	3.4
	Mean, 3 sites						20.2			15.0
Skye	Main	271	Removal	3	3, 1, 0	4	1.5	13,1,1	15	5.6
	Mullach Brook	179	Removal	3	0, 0, 0	0	0.0	4,1,0	5	2.8
	Mean, 2 sites						1.5			4.2
Sydney	Meadows Brook	372	M/R*		123/84	619	166.4	28/8/43	141	37.9
Tillard	Main	549	M/R		99/43/95	224	40.8	21/10/18	37	6.7
	East Branch	470	M/R		28/13/38	86	18.3	36/18/27	55	11.7
	Mean, 2 sites						29.6			9.2
1999										
Middle	Twin Churches*	326	Removal	3	157, 36, 10	206	63.3	61,22,11	101	30.9
	Finlayson	545	Removal	4	62, 22, 10, 7	105	19.2	119,52,34,21	248	45.5
	2nd Gold Brook	356	Removal	4	146, 71, 35, 16	284	79.7	101,31,13,7	155	43.5
	MacKenzie Brook	99	Removal	4	28, 12, 7, 6	59	59.2	20,15,4,7	55	55.2
	Mean, 3 main river sites						54.1			40.0
Baddeck	Upper Baddeck	465	Removal	3	48, 19, 6	77	16.5	79,33,9	127	27.4
	North Branch	599	Removal	4	628, 211, 113, 45	1025	171.1	64,23,14,11	120	20.0
	Easach Ban	382	Removal	4	196, 91, 50, 18	374	98.0	93,65,13,12	193	50.6
	Peters Brook	300	Removal	3	103, 40, 22	181	60.3	33,14,3	52	17.4
	Mean, 3 main river sites						95.2			32.6
North	MacLeans	443	Removal	4	168, 36, 23, 23	258	58.3	221,79,31,34	382	86.2
	Benches	324	Removal	4	76, 38, 15, 17	160	49.5	61,21,8,5	97	30.0
	Karr's	340	Removal	3	106, 26, 16	154	45.3	29,16,6	57	16.9
	Narrows	388	Removal	3	37, 10, 3	51	13.2	103,22,9	136	35.2
	Mean, 4 sites						41.6			42.1
Grand	Mud Hole	893	M/R		84/33/87	222	24.9	6/0/4	34	3.8
	Fishway	994	M/R		73/16/46	207	20.8	4/1/1	4	0.4
	Crib Pool	667	M/R		11/4/19	47	7.0	6/0/7	55	8.2
	Frank MacDonald Rd.	649	M/R		32/11/29	82	12.6	9/1/10	54	8.3
	Mean, 4 sites						16.3			5.2
Gaspereaux	Victoria Bridge	435	M/R*		46/66	131	30.1	7/2/7	20	4.6

Appendix IV. *(Continued).*

River	Site name	Area (m^2)	Method	No. of sweeps	Age-0+ Catch	Age-0+ Pop'n	Age-0+ Density ($100m^2$)	Age-1+ and older Catch	Age-1+ and older Pop'n	Age-1+ and older Density ($100m^2$)
Inhabitants	Main	361	Removal	4	41, 11, 9, 0	62	17.1	44,23,10,4	85	23.6
	Lamey Brook	410	Removal	3	95, 48, 27	199	48.6	33,16,9	67	16.4
	Northwest Arm	330	Removal	3	5, 3, 2	13	4.0	17,12,7	50	15.1
	Mean, 3 sites						23.2			18.4
Skye	Main	245	Removal	3	1, 0, 0	-	0.4	6,4,2	15	6.2
	Mullach Brook	167	Removal	3	0, 0, 0	-	0.0	6,3,1	11	6.5
	Mean, 2 sites						0.2			6.4
Sydney	Meadows Brook	371	M/R*		15/9	60	16.2	23/7/31	96	26.0
Tillard	Main	554	M/R		35/9/29	113	20.4	59/31/56	106	19.1
	East Branch	492	M/R		8/4/10	19	3.9	62/29/59	125	25.4
	Mean, 2 sites						12.2			22.3
1998										
Middle	Twin Churches*	369	Removal	4	94, 28, 9, 3	135	36.7	127,38,19,12	201	54.7
	Finlayson	556	Removal	4	65, 25, 15, 8	119	21.5	136,67,31,19	270	48.5
	MacKenzie Brook	101	Removal	3	5, 4, 0	10	9.5	34,12,2	49	48.9
	MacLeods Brook	132	Removal	4	10, 6, 3, 2	24	17.8	29,4,7,4	46	35.0
	Mean, 3 sites						22.5			50.7
Baddeck	Upper Baddeck	456	Removal	4	116, 33, 33, 14	208	45.7	94,34,16,5	153	33.5
	North Branch	515	Removal	3	159, 54, 14	234	45.5	60,27,8	101	19.6
	Easach Ban	419	Removal	3	237, 96, 55	431	102.8	80,48,13	156	37.2
	Peters Brook	217	Removal	3	90, 32, 11	139	64.0	39,11,5	57	26.3
	Mean, 3 main river sites						64.7			30.1
North	MacDonalds	404	Removal	3	13, 6, 4	27	6.7	44,21,7	78	19.3
	Karr's	444	Removal	3	32, 13, 6	55	12.4	36,20,5	66	14.9
	MacLeans	438	M/R*		288/168	442	100.9	13/08/13	23	4.8
	Benches	530	M/R*		249/152	1092	206.0	57/11/51	250	47.2
	Mean, 4 sites						81.5			21.6
Grand	Mud Hole	864	M/R		56/17/46	154	17.8	22/7/12	36	4.2
	Fishway	876	M/R*		97/72	316	36.0	24/2/14	75	8.6
	Crib Pool	635	M/R		35/10/42	174	27.4	09/2/12	42	6.6
	Frank MacDonald Rd.	563	M/R		37/12/25	112	19.9	10/7/28	40	7.1
	Mean, 4 sites						25.3			6.6
Gaspereaux	Victoria Bridge	308	M/R*		42/42	91	29.5	6/2/5	13	4.2
Inhabitants	Main	385	Removal	3	46, 20, 9	82	21.3	107,23,8	140	36.4
	Lamey Brook	527	Removal	3	15, 5, 3	25	4.7	119,29,10	161	30.6
	Northwest Arm	358	Removal	3	57, 22, 6	89	24.8	19,7,1	28	7.7
	Mean, 3 sites						16.9			24.9
Skye	Main	306	Removal	3	2, 0, 0	-	0.7	23,11,8	51	16.8
	MacDonald Brook	132	Removal	3	0, 0, 0	-	0	9,6,2	20	14.9
	Mullach Brook	256	Removal	3	14, 8, 1	24	9.5	7,2,1	10	4.1
	Mean, 3 sites						3.4			10.5
Sydney	Meadows Brook	430	M/R*		22/21	91	21.2	32/8/37	140	32.6
Tillard	Main	524	M/R*		53/49	95	18.1	72/43/81	142	27.1
1997										
Middle	Finlayson	533	Removal	3	103, 33, 11	152	28.6	208, 90, 32	353	66.3
	Twin Churches	364	Removal	4	91, 37, 16, 9	159	43.6	66, 20, 2, 3	92	25.1
	MacLeods Brook	260	Removal	4	118, 28, 14, 5	167	64.1	73, 36, 23, 11	156	60.1
	MacKenzie Brook	122	Removal	4	0, 0, 0, 0	0	0.0	98, 25, 15, 10	152	124.2
	Mean, 2 main river sites						36.1			45.7

Appendix IV. *(Concluded).*

River	Site name	Area (m^2)	Method	No. of sweeps	Age-0$^+$ Catch	Age-0$^+$ Pop'n	Age-0$^+$ Density ($100m^2$)	Age-1$^+$ and older Catch	Age-1$^+$ and older Pop'n	Age-1$^+$ and older Density ($100m^2$)
Baddeck	Upper Baddeck	397	Removal	4	120, 29, 23, 18	200	50.3	97, 33, 24, 8	169	42.5
	North Branch	457	Removal	3	511, 186, 77	819	179.2	53, 28, 16	116	25.3
	Easach Ban	372	Removal	4	251, 91, 43, 16	412	110.7	87, 39, 25, 14	180	48.3
	Peters Brook	161	Removal	4	134, 27, 15, 11	190	118.2	37, 11, 3, 5	58	35.8
	Mean, 3 main river sites						113.4			38.7
North	Church	414	Removal	3	1, 3, 2	6	1.4	0, 1, 0	1	0.2
	MacDonalds	430	Removal	3	15, 6, 2	24	5.6	90, 28, 16	142	33.1
	MacLeans	352	Removal	3	51, 32, 38	314	89.4	66, 37, 16	137	38.9
	Benches	350	Removal	3	31, 18, 4	57	16.4	56, 20, 7	87	24.9
	Mean, 3 riverine sites						37.1			32.3
Grand	Mud Hole	739	M/R*		96, 95	346	46.8	10, 4, 16	36	4.9
	Fishway	795	M/R*		30, 53	116	14.6	7, 4, 19	31	3.9
	Crib Pool	560	M/R*		38, 45	152	27.1	15, 4, 18	60	10.7
	Frank MacDonald	485	M/R*		98, 90	158	32.6	18, 4, 7	29	6.0
	Mean, 4 sites						30.3			6.4
Skye	Main	201	Removal	3	27, 7, 5	41	20.5	13, 8, 2	25	12.6
	MacDonald's Brook	133	Removal	3	13, 5, 2	21	16.1	2, 0, 0	-	1.5
	Mean, 2 sites						18.3			7.1
Sydney	Meadows Brook	342	M/R*		49, 21	160	46.8	81, 9, 33	278	81.3
Tillard	Main	503	M/R*		73, 44	159	31.6	89, 37, 83	198	39.4
1996										
Middle	Finlayson	530	Removal	4	140, 34, 15, 5	196	36.9	174, 58, 37, 10	287	54.2
	Twin Churches	333	Removal	3	43, 17, 12	82	24.7	72, 21, 17	120	36.0
	MacLeods Brook	224	Removal	4	39, 10, 4, 2	56	24.8	78, 31, 15, 14	147	65.8
	MacKenzie Brook	103	Removal	4	123, 37, 15, 0	176	171.0	39, 14, 6, 5	67	64.6
	Mean, 2 main river sites						30.8			45.1
Baddeck	Upper Baddeck	368	Removal	4	112, 54, 38, 22	254	69.1	85,32,20,9	153	41.7
	North Branch	491	Removal	4	128, 76, 47, 10	281	57.3	44,17,18,8	99	20.1
	Easach Ban	378	Removal	4	154, 44, 29, 8	240	63.6	99,44,16,9	174	46.1
	Peters Brook	168	Removal	4	164, 54, 18, 12	253	150.1	9,13,8,9	39	23.2
	Mean, 3 main river sites						63.3			36.0
North	MacDonalds	408	Removal	3	30, 6, 4	41	10.1	77, 22, 15	121	29.8
	Church	357	Removal	3	85, 28, 3	118	33.0	31, 17, 1	51	14.3
	Mean, 2 main river sites						21.6			22.1
Grand	Mud Hole	1130	M/R*		36, 38	46	4.1	7, 3, 4	9	0.8
	Fishway	996	M/R*		26, 43	13	13.1	3, 1, 7	15	1.5
	Crib Pool	953	M/R*		46, 31	207	21.7	6, 0, 3	27	2.8
	Frank MacDonald	633	M/R*		32, 38	112	17.7	12, 2, 9	42	6.6
	Mean, 4 sites						14.2			2.9
Gaspereaux	Victoria Bridge	265	M/R*		53, 44	53	20.0	11, 3, 3	11	4.2
Sydney	Meadows Brook	343	M/R*		24, 33	94	27.4	44, 6, 26	173	50.4
Tillard	Main	282	M/R*		43, 41	56	19.9	48, 28, 37	63	22.3
	East Branch (2)	307	M/R*		8, 7	24	7.8	17, 8, 25	51	16.6

Appendix V: Baddeck River mark-and-recapture data during fall adult salmon assessment swim-thrus (1994-2003). River sections described in Table 2 and shown in Figure 3.

Year	Dates M/ R	Swim conditions	River Section	Tags applied (M) Large	Small	Total	Tags observed (R) Large	Small	Total
1994	Oct-19		2-3	6		6	6		6
	Oct-20		4	5	1	6	3		3
				Total		12			9
							Recovery rate=		*0.762*
				Swim-thru count **C**=110; **M**=12; **R**=9					
				Grilse (17/110) = 0.154 of total.					
1995	Oct-21		2-3	10	4	14	5	2	7
	Oct-22	Visibility diminished with	4	10	4	14	3	2	5
		increasing cloud and		Total		28			12
		rain thru afternoon							*Recovery rate = 0.445*
				Swim-thru count **C**=154; **M**=28; **R**=12					
				Grilse (42/154) = 0.273 of total.					
1996	Oct-20	Good visibility	1	4	1	5	1		1
	Oct-21	Flows moderate/high	2	3		3	5		5
		from melt of Oct. 16 snow.	3	4		4	2		2
			4	2	1	3	1		1
			5	1	1	2	2		2
				Total		17	11		11
									Recovery rate = 0.664
				Swim-thru count **C**=214; **M**=17; **R**=11					
				Grilse (43/214) = 0.2001 of total.					
1997	Oct-19	Low water	2	5	1	6	2	1	3
	Oct-22	Excellent visibility	3-4	9	3	12			
		Gauge = 1.28 ft	5	11	3	14	11	5	16
				Total		32			19
									Recovery rate = 0.602
				Swim-thru count **C**=138; **M**= 32;**R**= 19					
				Grilse (35/138) = 0.254 of total.					
1998	Oct-18	Water moderate	2	6	2	8	1	2	3
	Oct-21	Fair visibility	4	3	2	5	3	1	4
		Gauge = 1.76 ft		Total		13			7
									Recovery rate = 0.566
				Swim-thru count **C**=104; **M**=13; **R**=7					
				Grilse (30/104) = 0.289 of total					

Appendix V: Baddeck River. *(Concluded).*

Year	Dates M/ R	Swim conditions	River Section	Tags applied (M) Large	Small	Total	Tags observed (R) Large	Small	Total
1999				No swim-thru conducted					
2000	Oct.-24	Water moderate	1	4		4			2
	Oct.-26	Excellent visibility	2			0			
		Gauge at 1.90 ft	3			0			
			4	16	2	18			3
			5	18	3	21			22
				Total		43			27
									Recovery rate = 0.630
				Swim-thru count **C**=92; **M**=43; **R**=27					
				Grilse (8/92) = 0.087 of total					
2001				No swim-thru conducted					
2002	Oct.-22								
	Oct.-24	Visibility fair		Only 1 MSW tagged					
				Swim-thru counts **C=56**					
				Grilse (12/56) = 0.214 of total					
2003	Oct.-21	Good visibility	1						
	Nov.-5	Gauge at 1.7 ft	2	2	1	3	1		1
			3				1		1
			4	8	4	12	1		1
			5						
				Total		15			3
									Recovery rate = 0.2
				Swim-thru count **C**=67; **M**=15; **R**=3					
				Grilse (7/67) = 0.104 of total					

Earlier versions of this table are presented in Marshall et al. 1998 and 1999. Some revisions were necessary. It is now considered correct to the best of our knowledge.

Appendix VI: North River mark-and-recapture data during fall adult salmon assessment swim-thrus (1994-2003). River sections described in Table 2 and shown in Figure 4.

Year	Dates M/ R	Swim conditions	River Section	Tags applied (M) Large	Small	Total	Tags observed (R) Large	Small	Total
1994	Oct.-17		2	20	2	22	8		8
	Oct.-18-19			Total		22			8
							Recovery rates = 0.364		
				Swim-thru counts total **C**=235; **M**=22; **R**=8, but use MSW only, i.e., C=167; M=20; R=8 Grilse (68/235) =0.2894 of total and (1-0.2894) used to raise est. of MSW to total population					
1995	Oct.-21	Discharge and water	2	16	4	20	9	1	10
	Oct.-22	clarity excellent	4	1	7	8	1	2	3
		Gorge not done		Total		28			13
							Recovery rates = 0.464		
				Swim-thru counts **C**=181; **M**=28; **R**=13 Grilse (57/181) = 0.315 of total.					
1996	Oct.-22	Water levels higher than	4	3	11	14	3	5	8
	Oct.-23	1997 and possibly 1995		Total		14			8
		Overcast					*Recovery rates = 0.571*		
		Gorge not done							
				Swim-thru counts **C**=322; **M**=14; **R**=8 Grilse (184/322) = 0.571 of total (many of hatchery origin).					
1997	Oct.-21	Low water	2	14	3	17	3	1	4
	Oct.-23	Excellent visibility	4	2		2	2		2
		Count includes Oxford	5	5	1	6	2		2
		and Twin Falls.		Total		25			8
							Recovery rates = 0.320		
				Swim-thru count **C**=335; **M**=25; **R**=11 Grilse (54/335) = 0.161of total.					
				Recoveries at MacLeans were inexplicably low (some concern about new bag holding technique) and therefore adjust R upwards on basis of mean R at MacLeans '94 & '95 (0.432) by 3 tags.					
1998	Oct.-20	Water dropping but higher	2	11	2	13	6		6
	Oct.-22	than 1997		Total		13			6
		Partly cloudy					*Recovery rates = 0.462*		
		Ligth showers							
				Swim-thru counts **C=**224; **M**=13; **R**=6 Grilse (59/224) = 0.263 of total					

Appendix VI: North River. *(Concluded).*

Year	Dates M/ R	Swim conditions	River Section	Tags applied (M) Large	Small	Total	Tags observed (R) Large	Small	Total
1999				No swim-thru conducted					
2000				No swim-thru conducted					
2001	July -14			no tags applied					
				Swim-thru counts **C=117** Grilse (44/117) = 0.376 of total					
2002	Oct.-25	High water Medium visibility		no tags applied					
				Swim-thru counts **C=26** Grilse (7/26) = 0.269 of total					
2003				No swim-thru conducted					

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