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Canadian Stock Assessment Secretariat
Research Document 99/108

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Secrétariat canadien pour l'évaluation des stocks
Document de recherche 99/108

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Follow-up to the assessment of Atlantic salmon in selected rivers of Cape Breton Island, 1998

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ISSN 1480-4883
Ottawa, 1999

Canada

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ABSTRACT

Assessments of the stock status of Atlantic salmon were conducted on the Margaree, Middle, Baddeck, North, and Grand rivers of SFAs 18 and 19, Cape Breton Island. These rivers account for 90+% of the total recreational fishing effort exerted on the Island's 33 rivers reportedly fished for salmon in 1998. Juvenile salmon abundance was assessed on the Sydney, Tillard, Skye, Cheticamp, Inhabitants, Gaspereaux, and Mabou rivers.

Returning salmon were counted at fishways or estimated by mark-and-recapture techniques. Estimated returns of 2,949 large and 757 small salmon to the Margaree, 358 large and 74 small salmon to the North, and 23 large and 221 small to Grand River Falls contributed to the attainment, in total, of 268, 177 and 102% of respective conservation requirements. Returns of 155 large and 82 small fish to the Middle River and 146 large and 54 small fish to the Baddeck River contributed to the attainment of 70 and 52% of the respective conservation requirements of those rivers.

Prognoses for 1999, based on forecast models and juvenile salmon densities, contain a large element of uncertainty. However, large salmon of the Margaree and North rivers have achieved conservation requirements consistently for over a decade and should continue to do so in 1999; the abundance of small salmon relative to conservation requirements is less certain. Returns to the Grand, Middle and Baddeck rivers are unlikely to exceed those of 1998 and are unlikely to meet conservation requirements in 1999.

Comparison of now similarly derived conservation requirements for the Margaree, Middle, Baddeck and North rivers does not resolve the similarities/differences between estimated escapements, resultant juvenile densities and proximity of densities to the Elson (1967) norm. It does highlight the facts that adult numbers are only a "fair" proxy for assessing the attainment of conservation requirements and that, where possible, the assessment of that attainment should be based on eggs.

RÉSUMÉ

Des évaluations de l'état des stocks de saumon de l'Atlantique ont été réalisées pour les rivières Margaree, Middle, Baddeck, North et Grand des ZPS 18 et 19 de l'Île-du-Cap-Breton. Ces rivières s'accaparent plus de 90 % de tout l'effort de la pêche récréative exercé sur les 33 rivières signalées comme ayant fait l'objet d'une pêche du saumon en 1998. L'abondance des saumons juvéniles a été évaluée dans les rivières Sydney, Tillard, Skye, Cheticamp, Inhabitants, Gaspereaux et Mabou.

Les remontées de saumon ont été déterminées aux passes à poisson ou estimées par techniques de marquage-recapture. Il a été estimé que les remontées de 2 949 grands et 757 petits saumons de la Margaree, de 358 grands et 74 petits saumons de la North et de 23 grands et 221 petits saumons de Grand River Falls ont permis d'atteindre les besoins de conservation de ces rivières à, respectivement, 268 %, 177 % et 102 %. Les remontées de 155 grands et 82 petits saumons de Middle River et de 146 grands et 54 petits saumons de Baddeck River ont permis d'atteindre les besoins de conservation, respectivement, 70 % et 52 %.

Les prévisions pour 1999, fondées sur des modèles de prévision et les densités de saumons juvéniles, souffrent d'un fort degré d'incertitude. Cependant, les remontées de grands saumons de Margaree River et North River ont permis d'atteindre les besoins de conservation de façon constante depuis plus d'une décennie et ces besoins devraient encore être atteints en 1999; cela est par ailleurs moins certain pour les petits saumons. Les remontées des rivières Grand, Middle et Baddeck ne seront sans doute pas supérieures à celles de 1998 et il est peu probable que les besoins de conservation soient atteints en 1999.

La comparaison des besoins de conservation maintenant déterminés de façon semblable pour les rivières Margaree, Middle, Baddeck et North ne permet pas d'expliquer les similitudes ou les écarts notés pour les échappées estimées, les densités de juvéniles résultantes et la proximité des densités à la valeur de la norme Elson (1967). Cela souligne le fait que le nombre d'adultes constitue une approximation tout au plus « acceptable » pour l'évaluation de l'atteinte des besoins de conservation et que, lorsque cela est possible, cette évaluation doit être fondée sur la ponte.

STOCK: **Margaree River**, Inverness Co. (SFA 18)
CONSERVATION REQUIREMENT: 6.7 million eggs (1,036 large, 582 small salmon)

Year	1993	1994	1995	1996	1997	1998	MIN[1]	MAX[1]	MEAN[1]
Angling catch[2]									
Large	1,102	1,479	1,060	1,864	2,098	1,327	1,060	2,098	1,519
Small	777	429	333	918	316	349	316	918	554
First Peoples' harvest									
Large	58	50	4	89	124	24	-	-	-
Small	8	14	2	7	20	1	-	-	-
Total estimated return									
Large	3,358	2,900	2,365	2,792	4,662	2,949	2,365	4,662	3,215
Small	2,087	708	737	1,685	712	757	708	2,087	1,186
Estimated spawning escapement									
Large	3,224	2,759	2,308	2,579	4,400	2,780	2,308	4,400	3,054
Small	1,504	394	528	1,343	464	534	394	1,504	847
% of large attained	311	266	223	249	425	268	223	311	295
Juveniles per 100m^2									
No. of sites	3	3	3	3	3	3	3	3	3
Fry	122	117	186	114	143	167	117	186	136
Parr	79	69	77	81	70	69	50	79	75

[1] Min, Max and Mean are for 1993-1997.
[2] All angling catches are NS license stub estimates. Angling catches for large salmon are hook-and-release estimates; small salmon include retained and released fish.

Harvests: Harvests were restricted to a reported 25 fish taken by First Peoples, and an estimated 206 small salmon taken in the retention recreational fishery, Jun 1-Oct 31.

Data and Methodology: Adult salmon returns were estimated from historical (1991-1996) estimates of returns based on adult investigations at Levi's trap, recreational catch data from NS License stub-returns and logbook data. No adults were trapped, counted or marked for the purpose of determining run-size in 1998. Densities of juvenile salmon were estimated at one mainstem and four tributary sites.

State of the Stock: Estimated large salmon returns of 2,949 fish were 37% lower than those of 1997; small salmon (757) were up 6% from numbers caught in 1997. Egg depositions by large salmon were down 157% from 1997 but were 268% of the conservation requirement. Escapement of small salmon was only 92% of requirement, the spawning requirement for small salmon has not been met in 7 of the last 14 years. Juvenile densities of 167 age 0^+ parr and 69 age 1^+ and 2^+ parr per 100 m^2 (four ongoing tributary sites) are consistent with recent high levels of egg deposition.

Forecast for 1999: Forecasts of returns for 1999 range from 3,250 to 4,640 large salmon i.e. 3.1 to 4.5 times the conservation requirements. High parr densities in 1995-96 and historic spawning escapements indicate conservation requirements for large salmon should be exceeded in 1999. There will be few returns of small hatchery salmon (formerly about 25% of the summer fish). Mean returns of hatchery and wild small salmon over the last five years have averaged 940 fish; removals have averaged less than 500 fish. The five-year average return for small salmon has about an 80% probability of meeting conservation requirement.

Management considerations: Returns of large salmon have about a 99% probability of exceeding conservation requirements, small salmon have about an 80% probability of meeting requirements. It is highly improbable that either current allocations or harvests will affect the attainment of conservation in 1999.

STOCK: **Middle River**, Victoria Co. (SFA 19)
CONSERVATION REQUIREMENT: 2.07 million eggs (470 large, 80 small)

Year	1993	1994	1995	1996	1997	1998	MIN[1]	MAX[1]	MEAN[1]
First Peoples' harvest (small + large)									
In-river	0	15	0	0	0	0	0	15	3
Estuarial[2]	20	59	8	20	18	0	0	59	25
Angling catch									
Small (retained)	30(25)	24	37	60(2)	17(3)	27(5)	17	60	34
Large[5]	48	166	51	142	85	62	48	166	98
Swim-thru counts									
Small	2	35	23	75	42	47	2	75	35
Large	32	324	160	284	216	96	32	324	203
Aquaculture						5			
Total estimated returns[3,4]									
Small + Large	144	529	379	599	414	237	144	599	413
Proportion of holding area covered in swim-thru counts									
	0.55	0.83	0.83	0.83	1.0	1.0	0.55	1.00	0.81
Estimated spawning ecapement									
Large	93	415	324	458	331	143	93	458	324
Total	99	460	371	579	396	213	99	579	381
% of large attained	20	88	69	97	70	30	20	97	69
Juveniles per 100m^2									
No. Sites			2	2	2	2			
Fry			26.3	30.8	36.1	29.1			
Parr			107.6	45.1	45.7	51.6			

[1] Min, Max and Mean are for 1993-1997.
[2] 50% of the Wagmatcook FN harvest assumed to be of Middle River origin; all of 1996 and 1997 assumed to be of Middle R. origin.
[3]Swim-thru counts divided by proportion area covered, 1990-1993; mark-and-recapture modal values (no tag loss) 1994-1998, taken as 100% of area.
[4]Values, 1992-93, now raised by mean swim-thru count efficiency of 0.622 in 1994-96 (Marshall et al. 1997).
[5]Preliminary values; final values would change estimates of escapement by up to four fish.

Harvests: The recreational fishery was confined to hook-and-release and there was no reported harvest by First Peoples.

Data and Methodology: Counts of tagged and untagged adult salmon were conducted on Oct 19 and 20, 1998, by teams of divers floating virtually all of the river's salmon-holding areas. (Tags had been applied to 18 fish on Oct 18 and 19.) Petersen mark-and-recapture principles and a Bayesian estimation procedure were used to describe an estimate of the probable populations. Juvenile salmon densities were estimated at two mainstem sites.

State of the Stock: Returns were estimated at 237 fish. The escapement of large salmon was only 30% of requirement. Age 1^+ and 2^+ parr densities at two mainstem sites averaged 29.1 fish per unit, age 0^+ densities averaged 51.6 fish per unit; these values equal and exceed an Elson "Normal" abundance index and are similar to densities on the Middle River in various years since 1957.

Forecast for 1999: Prognoses of returns were based on the previous five-year mean. The combined mean of small and large returns is 432 fish with a 29% chance that the mean would exceed a requirement of 550 salmon.

Management considerations: Conservation requirements are unlikely to be met (29% chance) despite past juvenile densities approximating an Elson norm. Fishing of an allocation by First Peoples would increase the risk of not achieving conservation by 8%; hook-and-release mortality would increase the risk by 1-2%.

STOCK: **Baddeck River**, Victoria Co. (SFA 19)
CONSERVATION REQUIREMENT: 2.0 million eggs (450 large, 80 small)

Year	1993	1994	1995	1996	1997	1998	MIN[1]	MAX[1]	MEAN[1]
First Peoples' harvest (small + large)									
In-river	0	0	0	0	0	0	0	0	0
Estuarial[2]	20	59	7	0	18	0	0	59	21
Angling catch									
Small (retained)	48(33)	16(1)	61(7)	46	15	61	15	61	37
Large	108	62	71	165	64	86	62	165	94
Swim-thru counts									
Small	-	17	34	43	35	27	17	43	32
Large	-	93	110	170	103	74	93	170	119
Aquaculture			10	1(H)	0	3			
Total estimated returns[3]									
Small + Large	-	226	368	329	251	200	226	368	294
Estimated spawning escapement									
Large	-	140	269	263	174	135	140	269	212
Total	-	166	361	329	233	183	166	361	272
% of large attained	-	31	60	58	39	30	31	60	47
Juveniles per 100m^2									
No. of sites				3	3	3			
Fry				63.3	113.4	64.7			
Parr				36.0	38.7	30.1			

[1] Min, Max and Mean are for 1993-1997.
[2]Estimated Wagmatcook First Nation harvest of Baddeck river origins.
[3]Based on mark-and-recapture modal (include 1994) values, no tag loss and assumed 100% coverage of adult holding areas.

Harvests: The recreational fishery remained hook-and-release only; there was no reported harvest by First Peoples.

Data and Methodology: Counts of tagged and untagged adult salmon were conducted on Oct 21, 1998. Tags were applied to eight large and five small salmon at three locations on Oct 18. Mark-and-recapture principles and a Bayesian estimation procedure were used to describe an estimate of the probable populations; the count data were used to apportion the estimate into small and large components. Juvenile salmon densities were estimated at three mainstem sites.

State of the Stock: Escapement was estimated at 200 fish. Estimated returns of small and large salmon are fewer than any year since 1994, 78% of those of 1997 and 66% of the previous four-year mean. Angling catch (no retention) was 186% of 1997 catches. Age 1^+ and 2^+ parr densities at three main river sites averaged 30.1 fish per unit; age 0^+ densities averaged 64.7 fish per 100 m^2. Monitoring since 1996 indicates that densities of fry fluctuate above the Elson norm while densities of parr fluctuate around it.

Forecast for 1999: The mean adult return 1994-1998 is 294 (range 200-368) fish, 52% of conservation requirements; however, juvenile densities in 1997 and 1998 have exceeded or approximated a normal abundance. The probability of the mean exceeding the 530 fish conservation requirement is less than 1%.

Management considerations: Conservation requirements have not been achieved on the Baddeck River in recent years and are unlikely to be met in 1999. Fishing of an allocation by First Peoples would increase the risk of not achieving conservation by 11%; hook-and-release mortality would increase the risk by 2-3%.

STOCK: **North River**, Victoria Co. (SFA 19)
CONSERVATION REQUIREMENT: 0.85 million eggs (200 large, 30 small)

Year	1993	1994	1995	1996	1997	1998	MIN[1]	MAX[1]	MEAN[1]
First Peoples' harvest (small + large)									
In-river	0	0	0	0	0	0			
Angling catch									
Small (retained)	82(62)	74	168(1)	174	69(1)	113	69	174	113
Large	161	97	209	124	135	109	97	209	145
Swim-thru counts									
Small		68	47	138	54	34	47	138	77
Large		167	120	184	281	165	120	281	188
Aquaculture			14			25			
Total estimated returns[2]									
Small + Large	486	590	388	566	758	488	388	758	558
Estimated spawning escapement									
Small	102	171	120	243	122	68	102	243	152
Large	322	419	268	323	636	353	268	636	394
% of large attained	161	210	134	162	318	177	134	318	197
Juveniles per 100m^2									
No. of sites				2	3	4			
Fry				21.6	37.1	79.3			
Parr				22.1	32.3	21.6			

[1]Min, Max and Mean are for 1993-1997.
[2]1994-1998, modal values of Bayesian mark-and-recapture estimate (no tag loss: 100% of area); 1992-1993 based on sport catch and angling exploitation rate of 0.5 (Amiro and Harvie MS 1996)

Harvests: The recreational fishery remained hook-and-release only, First Peoples did not exercise their right to fish the quota.

Data and Methodology: Counts of tagged and untagged adult salmon were conducted on Oct 22, 1998. Tags were applied to 11 large and two small salmon at MacLean's Pool on Oct 20. Mark-and-recapture principles and a Bayesian estimation procedure were used to describe an estimate of the probable populations; the count data were used to apportion the estimate into small and large components. Juvenile salmon densities were estimated at four mainstem sites, two each above and below the gorge.

State of the Stock: Returns were estimated at 488 fish. Escapement was an estimated 353 large, 68 small salmon and 55 farmed escapees. Large salmon requirements are estimated to have been exceeded in each of the last 15 years. Estimated returns of small salmon have averaged in excess of 100 fish over the last several years, greater than triple the conservation requirement of 30 fish. Age 1^+ and 2^+ parr densities at two mainstem sites averaged 21.6 fish per unit; age 0^+ densities averaged 79.3 fish per unit. Parr densities approximate an Elson "Normal" abundance, fry densities are the highest of the three years of record.

Forecast for 1999: Returns to the North River, 1994-1998, have averaged 558 fish or more than twice the conservation requirement. The Bayes-derived probability of the five-year mean exceeding the 230 fish requirement is greater than 99%. It is highly improbable that continuation of either the taking of the current allocation by First Peoples or angler hook-and-release mortality will affect the attainment of conservation in 1999.

Management considerations: Conservation requirements have been achieved on the North river for over a decade and should continue to do so in 1999. Low marine survival, affecting many stocks in Atlantic Canada, may affect the abundance of North River small salmon.

STOCK: **Grand River**, Richmond Co. (SFA 19)
CONSERVATION REQUIREMENT: 1.1 million eggs (545 salmon total river; 234 above Falls)

Year	1993	1994	1995	1996	1997	1998	MIN[2]	MAX[2]	MEAN[2]
First Peoples' harvest									
In-river	0	0	0	-	0	0	-	-	-
Estuarial	0	0	0	-	0	0	-	-	-
Angling catch (total river)									
Small (retained)	139(118)	72	5[2]	90	32(3)	57	5	139	68
Large	25	20	12	25	5	21	5	25	17
% caught and retained above the fishway									
	31	0	-	0	0	0	-	-	-
Broodstock[3]	0	7	0	0	0	0	0	7	7
Count at fishway									
Small	91	64	157	200	28[4]	106	28	200	108
Large	5	5	8	5	5	8	5	8	6
% hatchery	45	14	32	61	30	73	14	61	36
Fish which by-pass the fishway									
Small	32	130	105	132	-	88	32	132	100
Large	4	9	11	7	-	7	4	11	8
Population estimate above the fishway									
Small + Large	132	208	281	345	152	244	132	345	224
Estimated escapement above the fishway									
Small + Large	97	201	281	345	152	239	97	345	215
% of fish required above fishway									
	41	86	120	147	65	102	41	147	92
Juveniles per 100m^2									
No. of sites			4	4	4	4			
Fry			7.5	14.2	30.3	25.2			
Parr			7.7	2.9	6.4	6.6			

[1] Min, Max and Mean are for 1993-1997. [2]Closed to all fishing.
[3] Only broodstock collected at or above fishway. [4]Incomplete.

Harvests: River open only to hook-and-release fishing, there was no allocation to First Peoples.

Data and methodology: Partial counts are obtained from a trap in a fishway at Grand Falls - 10.2 km from the head-of-tide. River discharge was low in 1998 and trap counts were less complete than usual. Total returns are estimated as Count/[1 - by-pass rate] where by-pass rates (0.4 for small and 0.57 for large) were estimated from the proportions of marked and unmarked fish found in broodstock collections above the Falls. Juvenile salmon densities were estimated at four sites, two sites each above and below the Falls.

State of the stock: Escapement of wild and hatchery salmon above the fishway in 1998 were 100% of requirement, the third highest of the previous seven years. Wild returns accounted for 30% of the conservation requirement. Hatchery fish comprised 73% of returns. Juvenile densities (25 and 7 age 0^+ and age 1^+ and 2^+ parr per unit, respectively) were similar to those of 1997 but are low in comparison to most other Cape Breton Island rivers. A doubling of age 0^+ densities between 1995-1996 and 1996-1997 is consistent with increased escapements 1994-1996.

Forecast for 1999: There is no precedent for forecasting returns to the Grand River. Returns to the fishway 1994-1998 have averaged 246 fish i.e. 105% of conservation requirement. However, an average 42% of these returns have been of hatchery-origin smolts. Stocking hatchery smolts in the Grand ended in 1997 and hatchery-source returns will be few in 1999. Returns in 1999 are uncertain, but the mean of wild returns 1994-1998 is 135 fish. Based on wild returns alone in 1999, there is only a 2% probability that conservation requirements will be met above the fishway. Current densities of juveniles are low. Grand River returns are unlikely to exceed those of 1998 and are unlikely to meet conservation requirement.

Management considerations: The wild salmon component has been below requirement and few hatchery returns are expected in 1999. Densities of juveniles are low with respect to concepts of a "normal" abundance.

INTRODUCTION

This document presents data background to earlier assessments, outlook and management considerations (Marshall et al. MS 1999 and Anon. MS 1999) for Atlantic salmon management in Cape Breton Island in 1999. Data presented here-in for Cape Breton Island (Fig. 1) continue the format of Marshall et al. (MS 1998); methodology and interpretations are largely contained in Marshall et al. (MS 1999). New is the summary re-derivation of conservation requirements for the Margaree, Middle, Baddeck and North rivers using standardized estimates of production area and recent biological characteristics of the respective stocks. The main elements of this document are updates of the assessed numbers of salmon that returned in 1998 to the Margaree, Middle, Baddeck, North and Grand rivers, the numbers that spawned relative to conservation requirements and, in the case of the Margaree, additional prognosis of returns in 1999. Returns are assessed using mark-and-recapture techniques on the Middle, Baddeck and North rivers, trap counts on the Grand River and angling catches and catch rates on the Margaree.

Procedures for the Middle, Baddeck and North river assessments were the same as in 1997; the Margaree was asessed as in 1997, using estimated angler catch from Nova Scotia Salmon Licence stubs in 1998 and the relationship between estimates of angler catch 1992 -1996 and total population estimates, 1992 -1997. Similar data were available for assessment of returns and escapement to the Grand River in 1998. In 1998, assessments of juvenile salmon were conducted on the Margaree, Middle, Baddeck, North, Sydney, Grand, Tillard, Skye, Gaspereaux, Inhabitants, Cheticamp and Mabou rivers.

In 1997, conservation requirements for the Margaree and North rivers were met or exceeded. Requirements were not met on the Baddeck, Middle and Grand rivers. The prognoses for 1998, for most rivers, were not optimistic i.e. returns would at least be similar or fewer from those of 1997. Meetings between fishery managers and First Peoples resulted in: i) allocations of salmon from the Margaree River and North rivers to First Peoples; ii) a retention recreational fishery for small salmon or grilse (<63cm) captured June 1 - Oct 31 on the Margaree (Sept 1-Oct 31 on the Mull and Judique rivers); iii) split season (June 1-July 15 and Sept 1-Oct 31) hook-and-release-only recreational fishery for salmon on all remaining rivers of the island excluding rivers of Cape Breton Highlands National Park which are regulated by Parks Canada.

Description of the Fisheries

Aboriginal Fisheries

The fishing of salmon with trapnets was licensed in the Margaree River estuary. Angling, snaring, spearing, and dipnetting were also permitted methods of achieving site-specific quotas for each of five First Nations and non-site-specific allocations to member harvesters of the Native Council of Nova Scotia. Allocations to First Peoples totalled 180 small and 700 large salmon. Fifty small and 50 large salmon were allocated from the North River and 130 small and 650 large salmon were allocated from summer and fall returns to the Margaree. Ten tags for either small or large salmon were available to each of 182 members of the Native Council of Nova Scotia resident in SFAs 18 and 19 (Table 1).

Commercial

The commercial salmon fishery, shortened in 1983 and closed in 1984, remained closed in 1998. Only two commercial salmon fishing licenses held on Cape Breton Island, one at Margaree Harbour and one at Mabou, remain eligible for re-entry.

Recreational Fishery

The salmon angling season for most of the islands' rivers is now June 1 to Oct 31 (Table 2). Retention of salmon (≥ 63cm) and grilse (< 63cm) was varied to no fish. Open dates were varied to June 1-July 15 and Sept 1-Oct 31 in all open rivers except the Margaree, Mabou/Mull and other small coastal streams tributary to the Gulf of St. Lawrence exclusive of those in Cape Breton Highlands National Park. In non-Park Gulf rivers, a licensed angler could retain two small salmon daily; a total of eight fish could be retained over the year from any Nova Scotia river where retention was legal.

Fishery data

Aboriginal Harvests

Despite significant allocations of salmon to First Peoples of Cape Breton Island, fewer than 150 "salmon" have been accorded as harvested by First Peoples. Most interest has been shown by Wagmatcook and Membertou FNs fishing Nyanza Bay and Margaree River. Approximately 100 "grilse"-sized fish were reportedly taken from Wycocomagh Bay, Bras d'Or.

Poaching

Estimated losses to poaching in Cape Breton Island have not been reported to date but traditionally would exceed harvests by Aboriginal Peoples. Past losses on the Margaree have been conservatively estimated at 100 fish; losses from the Mabou/Mull and Judique Interval rivers have been suggested to be about 100 salmon.

Recreational Catches

In 1998, anglers spent an estimated 12,066 rod days on the island's rivers (Table 2). Estimated catches (including releases) were 668 small and 1,683 large salmon. Only 215 small salmon were reported being retained (Table 3). Compared to 1997, the estimated effort was up 21%; estimated catches of small salmon were up 38% and estimated catches of large salmon were down 32% (Table 3). Compared to the 1993-1997 mean values, effort was down 18%, small catch was down 30% and the large salmon catch was down 18%. Recreational effort had already dropped an average of 58% between 1993 and 1994 for those rivers (essentially all but the Margaree) in which regulations changed from retention to hook-and-release of small salmon (Table 4). Effort, as estimated from NS Salmon Angling Licence stub returns, remains low for Cape Breton Island salmon rivers. However it is purported that more salmon anglers, who only hook-and-release their catch, buy only a Nova Scotia General Fishing License and forego tags for retained salmon and the opportunity to input to salmon angling statistics as required by the Salmon Angling License.

MARGAREE RIVER

The Margaree River, Inverness County, lies in Salmon Fishing Area 18 (SFA 18). The two principal branches, the Northeast Margaree and Southwest Margaree, unite at Margaree Forks to flow north and west into the Gulf of St. Lawrence. Salmon of the Margaree River have traditionally been considered to be of separate early- or summer-run (thru Aug 31) and fall-run components. The magnitude of the component appearing in-river in the summer months is somewhat dependent on river discharge and, in all probability, on cool water temperatures.

Annual assessments of Atlantic salmon stocks of the Margaree River have been prepared since 1985 (e.g., Chaput et al. MS 1994; Claytor et al. MS 1995 and Marshall et al. MS 1996, MS 1997 and MS 1998). Assessments prior to 1992 are published in the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC) research document series; those since 1992 have been published in the Department of Fisheries and Oceans series of Atlantic Fisheries Research Documents and Canadian Stock Assessment Secretariat.

Conservation requirements for egg depositions are estimated to have been exceeded in every year since 1985. Forecasts made in 1998 suggested that returns of large salmon could number 1,656 to 4,160 large fish, i.e., egg depositions were certain to surpass the 1,036 large fish requirement for conservation.

Returns

Estimation procedures

In 1997 and 1998 no adult investigations were conducted on the Margaree, i.e., no adults were trapped, counted or marked for the purpose of determining run-size. In 1998, returns were estimated from historical estimates of returns based on adult investigations at Levi's trap and ongoing recreational catch data from NS Salmon Licence stubs (with additional insight from logbooks completed by volunteer anglers).

Returns of small salmon in 1998 were estimated from the equation Rtns = -67.02 + 2.36 Angl Ctch (n=6; R^2 adj = 0.66; p = 0.03). Returns of small salmon for the years 1991-1996 (Table 5) were derived in conjunction with the estimation of large salmon using mark-and-recapture techniques. The recent history of Margaree mark-and-recapture experiments with tagging at the Levi's estuarial trap net are described in Claytor et al. (MS 1995) and Marshall et al. (MS 1996 and MS 1997). The recreational catch data are the estimates of retained and released fish from the NS Licence stubs (Table 4).

Recent returns of large salmon (Table 5), as estimated from mark-and-recapture experiments and NS Licence stub estimates of large catch (Table 4) were not significantly correlated. Returns of large salmon in 1998 were estimated from the equation: Rtns = Angl Ctch 1998/ $\text{Ctch Rate}_{\text{Modal Value 1991-96}}$ where $\text{Ctch Rate}_{\text{Modal Value 1991-96}} = \text{Angl Ctch}_{1991\text{-}96} / \text{Rtns}_{1991\text{-}96}$. The modal value and 90% CLs were estimated by Bayes procedures (Gazey and Staley 1986).

Estimates of Returns

Solution of the equation Rtns = -67.02 + 2.36 Angl Ctch for a NS Licence Stub estimate of 349 small salmon [retained (206); and released (143)] provides an estimated return of **757** (349-1,636) small salmon. This value is similar to the 712 final value for 1997 and to low returns of small salmon ascribed to the Margaree in 1989, 1994 and 1995 (Table 5; Fig. 3). The estimate is consistent with catch per effort (CPUE) data from 69 volunteer anglers who submitted logbooks of their fishing activity on the Margaree in 1998 and those who submitted data, 1991-1997 (Table 6).

The estimate of large salmon returns is **2,949** (2,067-3,438) where "Ctch Rate" is 0.45 (0.642-0.386) and the estimate of large salmon catch (NS Licence Stub) is 1,327 fish. The 1998 value is down 37% from the estimate of 4,662 large fish in 1997 and the fifth lowest value of the last decade (Table 5; Fig. 3). The lower estimate of large salmon catch is also consistent with the relatively low CPUE value derived from logbooks (Table 6).

Conservation Requirements

The conservation requirement for the entire Margaree River system is based on an egg deposition of 2.4 eggs per m^2, historical biological characteristics, and a rearing area of 27,976 units of habitat of 100 m^2. The product of egg deposition rate and rearing units equates to a total egg requirement of 6.7 million eggs. Spawners to provide those eggs are based on biological characteristics, from the 1970's, with all eggs expected to be derived from large salmon, and sufficient small salmon to provide a 1:1 male:female ratio for female large salmon. Eggs per female were based on a value of 1,764 eggs per kg fish weight (Elson 1975). The requirement is 582 small and 1,036 large salmon (Claytor et al. MS 1995).

Escapement

Fish not harvested from among estimated returns are considered escapement. Fish lost to poaching and disease are spawners by definition in the requirement for 2.4 eggs per m^2.

Known/estimated losses before spawning on the Margaree in 1998 total 169 large and 223 small salmon. Losses included harvests by First Peoples and recreational fishers and a broodstock collection by "ADAM". Losses to hook-and-release mortality were assumed to be 0.05 of 1,327 large and 143 small salmon, i.e., 66 large and seven small fish.

Escapement of large salmon was 268% of the 1,036 fish requirement; small salmon escapement was 92% of the 582 fish requirement (Table 5). Escapements of large salmon, 1985 to 1997, have ranged from 133% to 601% of requirement with the 1998 value being the seventh highest of the period. Escapements of small salmon over the same period have ranged from 56% to 258% (Table 5) with the 1998 value being the seventh highest of the period. Large salmon escapements have now been met in each of the last 14 years; small salmon spawning escapements have been met in seven of the last 14 years (Table 5).

Abundance of Juvenile Salmon

Estimation of juvenile densities continued at four tributary and the mainstem 'Old Bridge' site on the main Northeast. Sampling consisted of three- or four-sweep removal estimates in barriered sections. Population estimates were derived by exact solution for four sweeps (Junge and Libosvarsky 1965) and by an iterative solution to Zippin's (1956) maximum-likelihood technique for four or more sweeps (Amiro and Longard MS 1995).

Fry (age 0^+) densities of 26-245 fish per 100 m^2 were up, on average, from those of 1997 and 1996 but slightly less than those of 1995 (Table 7). Parr densities (age 1^+ and 2^+) of 48-83 fish per 100m^2 were, on average, similar to those of 1997. Recent abundances of fry and parr are two to three times the densities in the mid-1970s (Chaput and Claytor MS 1989 and Fig. 4). Densities (wild fish only) of 166 fry per 100 m^2 and 73 parr per 100 m^2 at the "Old Bridge" site are comparable to values in 1995-1997 and may be representative of a large proportion of mainstem production area. "Old Bridge" fry densities exceeded those of any previous sampling, 1957-1986; parr densities exceeded those of the 1950s, 1970s and 1986 but not those of the 1960s (Chaput and Claytor op cit). A "normal" abundance (Elson 1967) for 129 unsprayed sites on New Brunswick rivers (mostly the Miramichi) in the 1950's, was 29 fry and 38 small and large parr per 100 m^2.

Forecasts

Stock-recruitment relationships have been the basis of previous pre-season prognoses on the Margaree River. The stock-recruitment relationship assumes a five-year lag between spawning and subsequent return of large salmon recruits to the river, i.e., a predominance of 2-year old smolts. Spawners and recruits (Table 8) were developed by Chaput and Jones (MS 1992) and have been annually carried forward from Claytor et al. (MS 1995).

Stock-recruitment relationships were examined using four models, Tabular, Ricker, Beverton-Holt, and the Mean (Claytor et al. MS 1995). For the Tabular approach the spawning stock was divided into four intervals of 600 spawners and recruits into 11 intervals of 1200 recruits. The number of times each level of recruitment occurred at each spawning level was entered into the table. The average number of spawners and recruits at each spawning stock level is calculated and the average yield (recruits minus spawners) and recruit per spawner (recruits divided by spawners) is estimated for each level.

The Ricker (Ricker 1975) curve was developed using the relationship:

$$R = S x\ e^{a(1-S/b)}$$

where ***R*** is the number of recruits, ***S*** is the number of spawners, e^a is the initial slope of the curve, and ***b*** is the value at which spawners equal recruits or the value at which the stock will just replace itself (Hilborn and Walters 1992). The ***a*** and ***b*** parameters were estimated using the Microsoft EXCEL (1993) solver function (Claytor et al. MS 1995).

The Beverton-Holt model was developed using the relationship:

$$R = \frac{aS}{b + S}$$

where ***R*** and ***S*** are as in the Ricker model, ***a*** is the maximum number of recruits produced, and ***b*** is the recruitment (on average) equal to ***a/2*** (Hilborn and Walters 1992). The ***a*** and ***b*** parameters were estimated using the EXCEL (1993) solver function (Claytor et al. MS 1995).

Forecasts of returns in 1999 from an estimated 3,082 MSW spawners in 1993 range from 3,250 (Mean) to 4,640 (Ricker) large salmon (Tables 9 and 10). A prognosis of 3,130 large returns in 1999, based on mean returns, 1994-1998, indicated a 99% probability that conservation requirements will be met (Marshall et al. MS 1999). Margaree 1SW fish in year i have not been successfully correlated with 2SW returns in year i+1 (same smolt class) as has been the case for many stocks of Atlantic Canada. The mean return of 920 1SW fish, 1994-1998, and Bayes probabilities suggest an 80% probability that 1SW returns will meet requirement in 1999. 1SW returns in 1999 will be largely devoid of hatchery fish (Table 11).

MIDDLE RIVER

The Middle River, Victoria County, lies in Salmon Fishing Area 19 (SFA 19). The watershed is surrounded by those of the Margaree, North and Baddeck rivers (Fig. 1). The mainstem arises in the Cape Breton Highlands and flows in a southward direction to its confluence with Nyanza Bay, St

Patrick's Channel, of Great Bras d'Or at Wagmatcook First Nation. The Middle River has a more gentle gradient profile than the neighbouring Baddeck and North watersheds; gradient and implied production profile with respect to neighbouring rivers are re-tabled in Table 14. In recent times, the summer component has all but disappeared. An effort to redevelop the run with summer-run stock (Table 11) from the North River, 1985-1989, was largely unsuccessful.

Autumn swim-thru counts of adult salmon have been made annually in the main river since 1989 (Marshall et al. MS 1996; Amiro and Longard MS 1995). Spawning escapement in 1997 was estimated to have been 70% of large salmon conservation requirement. The prognosis for 1998 was that returns were unlikely to exceed those of 1997. Densities of juvenile salmon were extensively examined in the late 1950s and 1960s; the most recent efforts were in 1977, 1978, 1985, 1994-1996 (Amiro and Longard MS 1995; Marshall et al. MS 1998) and in 1998.

Swim-thru counts of small and large salmon have been conducted in mid- to late- October, by teams of two divers assigned to most of six sections (Fig. 5; App. 1; Marshall et al. MS 1998). Mark-and-recapture estimates began in 1994; streamer tags were applied to fish netted the day previous to the swim-thru. A Bayesian estimator has been used to derive an estimate of the probable populations (Marshall et al. MS 1997; Amiro and Longard MS 1995). Adult and juvenile assessments were again conducted in 1998.

Estimation of Returns

A mark-and-recapture experiment provided data for estimation of the population on Oct 17-20, 1998. Marks, orange streamer and yellow disk (14 mm diameter) tags, were applied to salmon captured by drift-netting (mono and multi-filament 3.5-inch stretched mesh) or seining in the three upper sections of the river. The numbers of marked and unmarked fish, by small and large size categories, were tallied by three teams of divers floating the "floatable" portion of mainstem and the main up-river holding pools at and below the Gold brooks (Fig. 5). The total number of small and large fish in the river was estimated using mark-and-recapture techniques and the Bayesian estimator; no tags were considered to have been lost. The count data were used to apportion the estimate into small and large components.

Estimates of Returns

Despite good weather, moderate flows and visibility, 1.5 days of seining yielded only six small and 12 large salmon for tagging that were useable in the swim-thru. The swim-thru, on Oct 19, (top pools on Oct 20) under bright sky and good water of moderate flow produced a total count of only 148 fish (52 small, of which five were of aquaculture origin, and 95 large) of which three small and nine large fish were tagged. Input to the analyses consisted of **M**=18; **C**=148 and **R**=12 (App. 1).

The most probable estimate of total salmon in the Middle River, Oct 19-20, was **222** fish (Fig. 6; 90% CL 157-421) including nine fish of aquaculture origins. Proportioning of the estimate on the basis of the small and large salmon count and additional estimated removals/mortalities of 12 large and 12 small salmon suggested a total wild return of 237 fish comprised of **155** large and **82** small salmon.

A return of 237 fish is 57% of 1997 returns and the second lowest since 1989 (Fig. 3). Estimated catches (Table 4) by anglers fishing to the Oct 31 closure were 62 large and 32 small fish i.e. respective catch rates of 0.40 and 0.39. Catches of large salmon were 22% lower than 1997; small catches were 88% higher than those of 1997 but still 5% lower than the previous five-year mean (Table 4).

Conservation Requirements

Conservation requirements for the Middle River are based on a substrate area of 8,646 *100 m^2 and 2.4 eggs per m^2. Egg requirements of 2.07 million are to be provided, on average, by **470** large and **80** small salmon (Marshall et al. MS 1992).

Escapement

Estimated losses, including angling removals, illegal removals and 5% mortality from angling, total 12 small and 12 large salmon. The wild escapement is estimated to be **143** large and **70** small salmon, 30% and 87% of conservation requirements. The 550 total fish conservation requirement had less than 1% chance of being met.

Abundance of Juvenile Salmon

Electrofishing of juvenile salmon was conducted at four sites in 1998. Sampling consisted of three-sweep removal estimates in unbarriered sections- the same technique as in previous years. Population estimates were derived in the same manner as those of the Margaree.

Main river sites, Two Churches and Finlayson, had densities of age 0^+ (29.1 per $100m^2$) and age 1^+ and 2^+ parr (51.6 per 100 m^2) that were comparable to values in 1997 (Table 12). Age 1^+ and 2^+ values exceeded the Elson (1967) "normal index of abundance", age 0^+ parr at three of four sites were less the index.

Forecast

The mean adult return, 1994-1998, is 432 fish (range; 237-599), 70% of conservation requirements. "Normal" and "above normal" juvenile densities in the last few years at some sites suggest long-term potential for improvement. The 44% reduction in Middle River returns in 1998 from those of 1997 and the notable decline in 1997 (31%) indicate a less certain future. Prognoses for returns in 1999, based on the past five-year returns are of 432 fish, the Bayes probability that the mean will exceed the conservation requirement of 550 fish is about 29% (Marshall et al. MS 1999).

BADDECK RIVER

The Baddeck River, Victoria County, lies in Salmon Fishing Area 19 (SFA 19). The watershed is bounded by those of the Middle and North rivers (Fig. 1). The river arises in the Cape Breton Highlands at about 1,350 ft elevation and flows in a south and westward direction to its confluence with Nyanza Bay, St Patrick's Channel of Great Bras d'Or at a point < 4 km east of the confluence of Middle River and Nyanza Bay. The gradient profile of the Baddeck River accessible to salmon is, on average, steeper and potentially of greater potential for production of juvenile salmon per unit area than that of the Middle River (Table 14). The stock has been, at least in recent times, principally of fall-run characteristics. There has been no recent effort to supplement the stock with hatchery-origin fish.

Fall counts of adult salmon began in 1994 (Amiro and Longard MS 1995). Mark-and-recapture estimates indicated that 31%, 60%, 58% and 44% of the conservation requirements had

been met in 1994, 1995 and 1996, and 1997 respectively. The prognoses for 1998 was that returns were unlikely to exceed those levels of 1996-1997.

Densities of juvenile salmon were examined in 1977 and 1978, and, with less precision, in 1994. Estimates of age- 0^+, 1^+, and 2^+ juvenile salmon (combined) at four of six sites in 1994 were greater than modest densities in 1977 and 1978 (Amiro and Longard MS 1995). Adult and juvenile assessments were made in 1996, 1997 (Marshall et al. MS 1998) and again in 1998.

Estimation of Returns

A mark-and-recapture experiment provided data for estimation of the population on Oct 21, 1998. Marks, orange streamer amd yellow disk (14 mm diameter) tags, were applied to salmon captured by drift-netting (mono/multi-filament 3.25 - 3.5 in stretched mesh) and seining at locations on the North Branch and mainstem on Oct 18. Marked and unmarked fish, small and large were enumerated by three teams of divers floating the same sections as in 1998 (Fig. 7; Marshall et al. MS 1998). The total number of fish in the river was estimated from mark-and-recapture data and Bayesian estimation procedures derived by Gazey and Staley (1986) to describe the modal value. The count data was used to apportion the estimate into small and large components.

Estimates of Returns

Salmon were netted and tagged at two locations on Oct 18; three additional locations yielded zero fish. Thirteen tags were applied to nine large and four small salmon for use in the population estimate. The swim-thru, on Oct 21, under moderate water conditions and fair visibility, provided a total count of 104 fish (30 small, of which 3 were of aquaculture origin, and 74 large) of which three small and four large were tagged (App. ii). Data submitted to mark-and-recapture analysis were: **M=13**; **C=104** and **R=7**.

The most probable number of total salmon in the Baddeck River, Oct 21, was **195** fish (Fig. 6; 90% CL 127-503) including five fish of aquaculture origins. Proportioning of the estimate on the basis of the small and large salmon count and the addition of estimated removals suggests a return comprised of **54** small and **146** large salmon of Baddeck River origin. Estimated returns of small and large salmon are fewer than any year since 1994. Small salmon were down 13% from 1997; large salmon were down 20% from 1997. The estimated catch (no retention) by anglers through Oct 31 (Tables 2, 3 and 4) was 61 small and 86 large salmon, 307% and 34% of the small and large salmon catch in 1997. These data infer that catch rates for small and large salmon were 1.0 and 0.59 respectively.

Conservation Requirements

Conservation requirements for the Baddeck River are based on a substrate area of 8,363 *100 m^2 and 2.4 eggs per m^2. Egg requirements of 2.0 million are to be provided, on average, by **450** large and **80** small salmon (Amiro and Longard MS 1995).

Escapement

Preliminary estimates of removals (angling mortality and illegal catch) of 11 large and 6 small suggest a wild escapement of **183** fish, **135** large and **48** small salmon. There was less than a 1%

chance that requirements were met. An escapement of 183 salmon is **35%** of the 530 fish conservation requirement. Large salmon were about 30% of requirement. The 35% overall value is down 21% from that of 1997.

Abundance of Juvenile Salmon

Electrofishing at three main river sites in 1998 (more comparable to tributary sites on the Middle and Margaree rivers) yielded average age 0^+ and age 1^+ and 2^+ densities of 64.7 and 30.1 fish per 100 m^2 respectively (Table 12). Age 1^+ and 2^+ densities approached "normal" abundance index; age 0^+ densities exceed those of the mainstem Middle River and some Margaree sites. Densities in 1998 were lower than 1997, comparable to 1996 and exceeded those of 1977-1978.

Forecast

The mean adult return 1994-1998, is 275 fish (range; 200-368), 52% of conservation requirements. "Normal" and "above normal" juvenile densities in 1996, 1997 and 1998 suggest long-term potential for improvement. A 17% reduction in Baddeck River returns in 1998 from those of 1997 indicate a less certain future. Prognoses for returns in 1999, based on returns in the past five years, are 275 fish. The Bayes probability of these returns exceeding the 530 conservation requirement is <1% (Marshall et al. MS 1999).

NORTH RIVER

The North River, Victoria County, lies in Salmon Fishing Area 19 (SFA 19) on the eastern slope of the Cape Breton Highlands. The watershed is bounded by the Baddeck, Middle, Margaree rivers (Fig. 1) and on the east, by the Barachois River. The river arises at an elevation of 1,450 ft and travels some 30 km to St. Ann's Harbour. Gradients are steep with many small falls and several barriers to upstream fish passage; water quality is pristine (Amiro and Marshall MS 1990).

The substrate of the North River is calculated to have the greatest potential for production of juvenile salmon, per unit area, of the three rivers previously evaluated by orthogradient measure (Marshall et al. MS 1996). The stock is known as early-run and is principally composed of large (2SW) salmon; a late-run component has been suggested but such may well be the result of low summer (and fall) discharges. Recent stocking with hatchery fish of North River origin occurred in the late 1980s and concluded in 1995 (Table 11).

Fall counts of adult salmon on the North River had been attempted since 1990 but have only been completed since 1994. Fall estimates in 1994, 1995 and 1996 and 1997 suggested escapements of 255%, 169%, 246% and 330% of the 230 fish conservation requirements (Marshall et al. MS 1998). Based on 1997 stock status, hatchery stocking and a stock-recruit relationship, similar or greater returns were forecast for 1998. An allocation of 50 small and 50 large salmon was made to First Nations (Table 1); the recreational fishery remained hook-and-release only. Adult (fall only) and juvenile assessments were conducted in 1998.

Estimation of Returns

A mark-and-recapture experiment was conducted on Oct 22. Streamer tags and yellow disks (14 mm diameter) were applied to fish captured at MacLean's Pool on Oct 20. Thirteen tags were

applied to 11 large salmon and two small salmon for use in the population estimate. The swim-thru, on Oct 22, under moderate water conditions and fair visibility provided a total count of 224 fish (59 small, of which 25 were of aquaculture origin, and 165 large; including about 12 fish in two pools in the gorge) six of which were tagged (Fig. 8; App. iii). The count in 1997 was 335 fish. Data submitted to mark-and-recapture analysis were: **M=13**; **C=224** and **R=6**.

The total number of fish in the river on Oct 22 was estimated using mark-and-recapture techniques and Bayesian estimation procedures derived by Gazey and Staley (1986) to describe the most probable (modal) estimate. The count data were used to apportion the estimate into small and large components.

Estimates of Returns

The most probable number of total salmon in the North River, Oct 23, was **488** fish (Fig. 6; 90% CL 311 - 1,438), estimated to be comprised of **359** large, **74** small salmon and 55 small salmon of aquaculture origin. Small salmon were down 39%; large salmon were down 44% from those of 1997 and constitute the lowest estimate since 1992 (Fig. 3).

The estimated catch (no retention) by anglers through Oct 31, (Tables 2, 3 and 4) was 113 small and 109 large salmon, 157% and -19% of the respective small and large salmon catches in 1997. Inferred respective catch rates are 0.88 and 0.30. In 1996 and 1997, several dozens of fish were counted within tidal influence during the Oct swim-thru census; in 1998 these numbers were many fewer with a significant portion (45%) observed to be aquaculture escapees.

Conservation Requirements

Conservation requirements for the North River are based on a substrate area of 3,827 *100 m^2 and 2.4 eggs per m^2. Egg requirements of 0.85 million are to be provided, on average, by **200** large and **30** small salmon (Amiro and Marshall 1990; Marshall et al. 1992).

Escapement

Removals (5% angling mortality) were estimated to be six large and six small fish, resulting in an escapement of the **421** salmon (plus aquaculture fish) estimated to be in the river on Oct 23; this is **183%** of the 230 fish requirement. This value is lower than that of 1997 (Fig. 3) but comparable to 1993-1996 estimates. Large salmon were **177%** of the requirement.

Abundance of Juvenile Salmon

Juvenile densities were determined at two sites each above and below the gorge. Mean densities, exclusive of the tidal-influenced site were of 79 age 0^+ and 22 age 1^+ and 2^+ parr (Table 12) . Age 0^+ densities exceed a normal abundance; age 1^+, and 2^+ parr declined to less than normal abundance (Elson 1967).

Forecast

Previous documents (including Marshall et al. MS 1998) provided forecasts based on Bayes techniques, (Amiro and Harvie MS 1996) and probabilities for potential returns of North River stock from a Ricker stock-and-recruit function. This model was abandoned in 1998 in favor of the simpler five-year mean (Marshall et al. MS 1999).

Returns of small and large salmon in the last five years have averaged 547 fish, over twice the conservation requirement. The Bayes-derived probability of this mean exceeding the 230 fish requirement in 1999 is greater than 98% (Marshall et al. MS 1999).

GRAND RIVER

The Grand River (Fig. 1), Richmond County, lies in Salmon Fishing Area 19 (SFA 19). The mainstem flows southerly from Loch Lomond a distance of 15.7 km to tidal waters of the Atlantic at Grand River (Amiro and Longard MS 1990). Gradient of the Grand River and tributaries accessible to salmon are, on average, the lowest of all rivers assessed in this document (Table 14). Unlike most other Cape Breton Island stocks, 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 in recent years despite significant hatchery supplementation with Grand River stock (Table 11) and the elimination of south coast Newfoundland commercial fisheries.

Annual counts of adult salmon have been made at the Grand Falls fishway 1988-1998, a point located 10.2 km above head-of-tide (Amiro and Longard MS 1990; Marshall et al. MS 1998). In 1997 the spawning escapement, was estimated to have been 65% of a 234 fish conservation requirement above Grand River Falls (Marshall et al. op cit). The prognoses for returns to the Grand river in 1998 were that returns to above the falls would approach requirements but, again, perhaps only because of the contribution by hatchery smolts stocked in 1997 and age 0^+ fish stocked in 1995. In 1998 the river was open to hook-and-release angling; no food fish were allocated to First Nations.

Returns of salmon were counted at the Grand Falls fishway between June 19 and July 31, 1998. Juvenile assessments were conducted at four sites, all of which had been done in 1995, 1996 and 1997.

Estimates of Returns

Grand River Falls is a partial barrier to salmon. Forty-five percent of the juvenile salmon producing area is estimated to be above the falls; 55% of the total river production area is below the falls. Fishway bypass rates of 0.4 for small and 0.57 for large salmon were determined during mid-October collections of broodstock above the falls. (Amiro and Longard MS 1990 and 1995).

Counts, mostly between late June and mid-July, numbered 106 small and eight large fish of which 83 (73%) were classified as being of hatchery origin. Counts during the period of operation would typically have comprised 80% of the season total (Marshall et al. MS 1996); assuming a bypass rate at the fishway of 0.4 for small and 0.57 for large, an estimate of counts for the total season would be **244** fish, 221 small and 23 large salmon.

Conservation Requirements

Conservation requirements for the Grand River are based on a substrate area of 4,618 *100 m^2 > 0.12% orthograde and 2.4 eggs per m^2. Requirements number 1.1 million eggs or **545** salmon in total of which **234** are required above the falls.

Escapement

Removals (5% angling mortality and one fishway mortality) are estimated to have been one large and four small fish, resulting in an escapement of **239** fish, basically the requirements above the fishway.

Abundance of Juvenile Salmon

Juvenile salmon abundance was assessed by electrofishing at four sites, two each on the mainstem above and below the falls. Sites were large and assessed by mark-and-recapture estimation with recapture runs conducted one-four days later. Estimates of age 0^+ parr were calculated using the Petersen mark-and-recapture method on three sites and the average capture efficiency of those sites on a fourth site. Age 1^+ and 2^+ fish were estimated using the efficiency of capture for age 0^+ fish.

Densities averaging 25.2 age 0^+ and 6.6 age 1^+ and 2^+ parr per 100 m^2 are comparable to those of 1997, double those of 1996 (Table 13) but low in comparison to most other Cape Breton Island rivers. A doubling of age 0^+ densities between 1995 and 1996 and again 1996 and 1997 is consistent with increased escapements 1994-1996 (Marshall et al. MS 1998).

Forecast

Returns of wild salmon to the fishway, 1994-1998, have averaged 133 mostly small salmon, i.e., 57% of conservation requirements. These data indicate only about 2% probability that the conservation requirement could be met in 1999. Stocking of 23,500 age 0^+ parr in 1996 should provide some additional returns. Current low parr densities are not a source of encouragement for longer range improvement.

SYDNEY, TILLARD, SKYE, CHETICAMP, INHABITANTS, GASPEREAUX AND MABOU RIVERS

Abundance of Juvenile Salmon

Juvenile salmon abundance was assessed by electrofishing on each of the above rivers. Sites on the Sydney River, River Tillard and Gaspereaux River were assessed by mark and recapture estimation with recapture runs conducted one to four days after marking. Estimates of age- 1^+ and -2^+ parr were calculated using the Petersen mark-and-recapture method. Age 0^+ fish were estimated using the efficiency of capture for older fish. Sites on the Skye, Mabou, Cheticamp, and Inhabitants rivers were smaller and barriered; the estimates were made in the same fashion as those of the Margaree, Middle, Baddeck and North rivers.

Densities at sites on the Sydney River were less than 50% of those of 1997 but still approached "normal abundance" (Table 13; Elson 1967). River Tillard densities also decreased in 1998, by almost 50% to below "normal abundance". Continued low densities on the Skye suggest that escapements and or spawning success of escaped aquaculture fish have been modest. Densities in the Mabou sites declined considerably from 1997 densities but still approximate a "normal abundance". Densities at two sites on the Cheticamp River, i.e., 69 age 0^+ and 43 age 1^+ and 2^+ parr per 100 m^2 exceed normal abundance; densities at three sites on River Inhabitants, of 17 age 0^+ and 25 age 1^+, are below "normal abundance". Gaspereaux densities are similar to those of 1996, age 0^+ approximate and age 1^+ are below "normal abundance" (Elson 1967). General

conclusions are (1) that other stocks of SFA 18, Gulf Cape Breton, may all be meeting or exceeding conservation requirements, (2) that the Skye River of Bras d'Or Lakes has not been meeting conservation requirements, and (3) that the status of other stocks of Atlantic coast rivers is uncertain (Marshall et al. MS 1999).

REVIEW OF CONSERVATION REQUIREMENTS FOR HIGHLAND RIVERS

Egg conservation requirements for non-acidified rivers of the Maritimes Region are calculated as the product of the estimated juvenile salmon production area and a required 2.4 eggs per m^2. Gradient-classified production area (> 0.12% grade) estimated from measures made on orthophotographic maps and air photos (Amiro 1993) have been used in the estimation of conservation requirements for the Middle, Baddeck and North rivers but to date had been unavailable for the Margaree River.

Fish requirements to provide prescribed eggs are ideally based on stock and biological characteristics of salmon from the river in question. Characteristics key to the calculation include the proportion of 1SW and MSW fish in the population, proportion females in each component and an estimate of the egg carrying capacities of 1SW and MSW females. All required eggs are to come from MSW salmon, 1SW fish are required to provide a 1:1 male to female ratio among spawners where 1SW fish by virtue of their compostion of the total population, outnumber the MSW requirements. Estimated fish requirements for the Margaree, Middle, Baddeck and North rivers have to date been based on stock and biological characteristics in part determined after returns had run a gauntlet of distant and homewater commercial fisheries and in part using surrogate biological information from other stocks.

In this section, egg and fish conservation requirements for the Margaree, Middle, Baddeck and North rivers are presented which are based on the same method of area calculation, current stock and biological characteristics and a common approach to the estimation of egg carrying capacity of female salmon

Production Area

Estimates of gradient-classified production area for the Middle, Baddeck and North rivers (Table 14) were previously tabled in Marshall et al. MS (1996) and are the basis of current conservation requirements. All gradients were greater than 0.12%, gradients of 20% or more are few and disregarded because they are deemed inaccessible to spawning and juvenile salmon. Estimates of gradient-classified area for the Margaree (Table 14; Fig 9) are presented for the first time and total 3.382 million m^2. Practice has been to discount areas with gradient less than 0.12% because they generally do not produce juvenile salmon, e.g., the entire mainstem Margaree between head-of-tide and Margaree Forks. Thus the productive area used in the calculation of egg requirements for the Margaree would be 2.7952 million m^2. The estimate currently in use is 2.7976 million m^2 based on a compilation of ground surveys (Marshall MS 1982) and tabled more recently in Claytor et al. (MS 1995). Comparison of the Margaree subdrainages is as follows:

Section	Current Area (100 m^2)	Revised area (100 m^2)
Main Margaree	4,925	1,522
Southwest Margaree	5,390	6,829
Northeast Margaree	17,661	19,601
Total	27,976	27,952

Stock and biological characteristics

Biological samples used in the current determination of conservation fish requirements are as follows: Margaree data from Margaree salmon sampled in the 1970s (Marshall 1982) and Middle, Baddeck and North from Amiro and Longard MS 1995 and Marshall et al. MS 1992.

Sampling data used in the new analyses of fish conservation requirements are from Levi's trap, 1992-1996 on the Margaree River (Marshall et al. MS 1997) and from samples seined during "marking" operations, 1996-1998 on the Middle, Baddeck and North river. Key data can be summarized as follows:

	1SW		MSW	
River	% female	FL (cm)	% female	FL (cm)
Margaree	7	56.3	74	78.5
Middle	5	55.5	61	73.0
Baddeck	18	53.7	83	75.0
North	24	53.1	78	70.4

Egg carrying capacity

Estimates of fecundity for current conservation requirements are derived from a standard 1,764 eggs per kg body weight of Miramichi salmon (Elson 1975) for the Margaree and from a standard eggs per fish value attained for North River broodstock (Marshall et al. MS 1992). For this document, a relationship between Fork Length and egg carrying capacity for fish of the St. Mary's River was selected from among those available (Amiro unpubl.) for the: Saint John, Big Salmon, Stewiacke, Medway, LaHave, St. Mary's and Grand Rivers. The equation for the St. Mary's stock is Log Eggs= 5.741 + 0.040 Fork Length (Marshall MS 1986). Constants for all but the Big Salmon River stock ranged from 5.7 to 6.1, coefficients ranged from 0.036 to 0.040. Parameters for the five non-inner Bay of Fundy stocks (n=196) were a constant of 6.091 and a coefficient of 0.036. The difference between using the extremes of the parameters results, in the case of the Margaree, in a less than 1% difference in fish requirements.

Conservation requirements

Egg conservation requirements are unchanged for each of the Middle, Baddeck and North rivers and essentially unchanged for the Margaree River.

Estimates of fish requirements to achieve those egg depositions (and 1:1 M:F ratios) are derived for each of the Margaree, Middle, Baddeck and North River stocks in Tables 15-18, respectively. Summary results are:

River	Current Number		Revised Number		Potential % Change	
	MSW	1SW	MSW	1SW	MSW	1SW
Margaree	1,036	582	1,250	660	21	12
Middle	470	80	590	140	26	75
Baddeck	450	80	390	310	-13	287
North	200	30	220	160	10	433

Proportions MSW:1SW among returns for the years for which biological data were tabled (Margaree 0.72: 0.28, Middle 0.74: 0.26, Baddeck, 0.75: 0.25 and North 0.74: 0.26) indicate that 1SW requirements for the purposes of attaining 1:1 M:F ratios are not practical except in the case of the Middle River. Truncated 1SW requirements are those which would have, on average, accompanied MSW returns to their rivers. Resultant numbers required would then be:

River	Conservation Requirements	
	MSW	1SW
Margaree	1,250	490
Middle	590	140
Baddeck	390	130
North	220	80

Comparison of these similarly derived conservation requirements for the Margaree, Middle, Baddeck and North rivers does not resolve the similarities/differences between estimated escapements, resultant juvenile densities and proximity of densities to the Elson (1967) norm. Adult escapement on the Margaree and resultant juvenile densities are at least consistent with the norm, i.e., escapement of two or three times requirement results in juveniles of two or three times the "norm". However, on the North River, adult escapements have consistently exceeded the prescribed and potential requirements but juvenile levels do not exceed the norm. On the Baddeck River, adult escapements are estimated to be, on average, about 50% of current requirements (60% of potential requirement) but resultant juvenile densities approach/exceed the norm (see Summary Sheet). On the Middle River, estimated adult escapements are on average about 80% of requirements (60% of potential requirements) and juvenile densities equal or exceed the norm (see Summary Sheet). This synthesis assumes however that both juveniles and adult returns are measured without error and that the Elson norm is an appropriate standard for Highland rivers. It also highlights the fact that adult numbers are only a proxy for assessing the attainment of conservation requirements and that, where possible, the assessment should be based on eggs.

ACKNOWLEDGEMENTS

Co-workers Doug Aitken, David Longard, Peter Amiro and Greg Stevens in Halifax; R.C. Thompson, F&HMB in Sydney; Leonard Forsyth, ADAM (Margaree) and First Peoples from Wagmatcook, Chapel Island and Eskasoni First Nations assisted in various facets of electrofishing and October swim-thrus.

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Table 1. Summary of the First Peoples salmon allocations, gear type, and seasons for Cape Breton, 1998.

River/Location	First Peoples	Allocation Small	Allocation Large	Gear Type	Season
Margaree River					
River and Estuary	Eskasoni	6	30	Trapnet, angle, spear, snare	Jun 1 - Aug 31
		20	100	Trapnet, angle, spear, snare	Sep 1 - Oct 31
River and Estuary	Chapel Island	6	30	Trapnet, angle	Jun 1 - Aug 31
		20	100	Trapnet, angle	Sep 1 - Oct 31
NE and main, excluding SW	Membertou	6	30	Trapnet, angle, spear, dipnet, snare	Jun 1 - Aug 31
		20	100	Trapnet, angle, spear, dipnet, snare	Sep 1 - Oct 31
NE and main, excluding SW	Wagmatcook	6	30	Trapnet, angle, night spear, snare	Jun 1 - Aug 31
		20	100	Trapnet, angle, night spear, snare	Sep 1 - Oct 31
River and Estuary	Waycobah	6	30	Trapnet, angle, snare, spear	Jun 1 - Aug 31
		20	100	Trapnet, angle, snare, spear	Sep 1 - Oct 31
	Total	130	650		
North River					
	Eskasoni	10	10	Angle, snare, spear	Jun 1 - Oct 25
	Chapel Island	10	10	Angle, spear, snare	Jun 1 - Oct 25
	Membertou	10	10	Angle, snare, spear, dipnet	Jun 1 - Oct 25
	Wagmatcook	10	10	Angle, snare, spear	Jun 1 - Oct 25
	Waycobah	10	10	Angle, snare, spear	Jun 1 - Oct 25
	Total	50	50		
Gulf NS (including Gulf Cape Breton) (SFA 18)	Native Council NS	1820 by maximum of 182 harvesters			
Cape Breton East (SFA 1	Native Council NS	220 by maximum of 22 harvesters			
Cape Breton fish totals	*Small/Large*	180	700		

Table 2. Recreational catch and effort for Atlantic salmon on rivers of Cape Breton Island, 1998.

River Name	Season dates Begin D M	Season dates End D M	Observed No. of anglers	Numbers caught (including releases) Grilse Obs.	Grilse Est.	Salmon Obs.	Salmon Est.	Unkn. Obs.	Total Obs.	Total Est.	Effort No. of rod days Obs.	Effort No. of rod days Est.	Catch per effort Fish/day	Percent large salmon
Aconi Brook	1/06	31/10 *	0											
Baddeck	1/06	31/10 *	87	46	61	65	86	0	111	147	232	316	0.478	58.6
Barachois	1/06	31/10 *	12	6	8	1	1	0	7	9	27	37	0.259	14.3
Campbell's Brook	1/9	31/10	0											
Catalone	1/06	31/10 *	2	1	1	0	0	0	1	1	2	3	0.500	0.0
Cheticamp	16/05	30/09	8	3	4	14	19	0	17	23	37	50	0.459	82.4
Clyburne	1/06	31/10 *	1	0	0	1	1	0	1	1	6	8	0.167	100.0
Framboise	1/06	31/10 *	2	0	0	0	0	0	0	0	12	16	0.000	0.0
Gaspereaux: C.B.	1/06	31/10 *	2	7	9	1	1	0	8	11	33	45	0.242	12.5
Gerratt	1/06	31/10 *	0											
Grand	1/06	31/10 *	20	43	57	16	21	0	59	78	163	222	0.362	27.1
Grantmire Brook	1/06	31/10 *	2	1	1	1	1	0	2	3	5	7	0.400	50.0
Indian Brook	1/06	31/10 *	9	3	4	1	1	0	4	5	19	26	0.211	25.0
Ingonish	1/06	31/10 *	1	2	3	7	9	0	9	12	8	11	1.125	77.8
Inhabitants	1/06	31/10 *	8	7	9	11	15	0	18	24	27	37	0.667	61.1
Little Lorraine	1/06	31/10 *	0											
Lorraine Brook	1/06	31/10 *	0											
Mabou	1/09	31/10	3	2	3	3	4	0	5	7	14	19	0.357	60.0
MacAskill's Brook	1/06	31/10 *	0											
Margaree	1/06	31/10 *	1073	263	349	1000	1327	0	1263	1676	7543	10286	0.167	79.2
Marie Joseph	1/06	31/10 *	0											
Middle: Victoria Co.	1/06	31/10 *	99	24	32	47	62	0	71	94	230	314	0.309	66.2
Mira	1/06	31/10 *	4	2	3	7	9	0	9	12	42	57	0.214	77.8
North : Victoria Co	1/06	31/10 *	84	85	113	82	109	0	167	222	328	447	0.509	49.1
North Aspy	1/06	31/10 *	8	2	3	6	8	0	8	11	17	23	0.471	75.0
Northwest Brook (R. Ryan)	1/06	31/10 *	0											
River Bennett	1/06	31/10 *	0											
River Deny's	1/06	31/10 *	0											
River Tillard	1/06	31/10 *	5	0	0	0	0	0	0	0	9	12	0.000	0.0
Saint Esprit	1/06	31/10 *	0											
Salmon: C.B.	1/06	31/10 *	12	6	8	7	9	0	13	17	90	123	0.144	53.8
Skye	1/06	31/10 *	1								3	4	0.000	0.0
Sydney	1/06	31/10 *	1	0	0	0	0	0	0	0	2	3	0.000	0.0
Cape Breton Totals			1444	503	668	1270	1683	0	1773	2353	8849	12066	0.195	72.0

* See variation order.

Table 3. Recreational catch and effort for Atlantic salmon on rivers of Cape Breton Island, 1998, 1997 and 1993-1997.

River	1998 Grilse retained	1998 Grilse released	1998 Salmon released	1998 Effort	1997 Grilse retained	1997 Grilse released	1997 Salmon released	1997 Effort	1993 - 1997 means Grilse retained	95% C.I.	Grilse released	95% C.I.	Salmon released	95% C.I.	Effort roddays	95% C.I.
Cape Breton																
Aconi Brook									0.0	N/A	0.0	N/A	0.0	N/A	0.0	N/A
Baddeck	0	61	86	316	0	15	64	157	8.2	17.6	28.8	23.7	94.0	54.4	391.4	291.6
Barachois	1	7	1	37	0	4	20	40	1.6	4.4	5.0	5.0	17.6	8.8	69.2	57.1
Campbell's Brook									0.0	N/A	1.0	N/A	10.0	N/A	30.0	N/A
Catalone	0	1	0	3	0	0	0	7	0.2	0.6	2.0	5.6	1.6	3.8	26.6	39.6
Cheticamp	0	4	19	50	0	19	25	71	0.8	2.2	12.8	6.9	29.2	17.7	110.0	48.3
Clyburne	0	0	1	8	0	1	1	3	0.0	0.0	0.8	1.0	10.2	21.3	17.6	29.5
Framboise	0	0	0	16	0	4	1	30	1.2	3.3	1.6	1.9	0.2	0.6	67.2	96.2
Gaspereaux: Cape Breton Co.	0	9	1	45	0	0	7	30	0.0	0.0	0.0	0.0	4.5	7.6	17.5	12.7
Gerratt									0.0	0.0	0.0	0.0	0.0	0.0	4.3	2.6
Grand	0	57	21	222	3	27	5	136	30.3	81.2	52.5	46.9	18.8	13.1	476.0	727.4
Grantmire Brook	0	1	1	7	0	0	3	10	0.0	N/A	4.0	N/A	6.7	N/A	15.0	N/A
Indian Brook	0	4	1	26	0	0	0	18	0.4	1.1	1.8	2.2	2.0	2.3	23.4	15.5
Ingonish	0	3	9	11	0	4	7	12	3.2	8.9	4.4	2.3	10.4	8.3	62.8	54.7
Inhabitants	0	9	15	37	0	3	5	14	5.4	13.6	10.2	13.5	47.8	41.5	128.2	145.0
Little Lorraine									0.0	N/A	0.0	N/A	0.0	N/A	0.0	N/A
Lorraine Brook									2.0	N/A	0.0	N/A	1.0	N/A	38.0	N/A
Mabou	3	0	4	19	0	0	3	11	2.4	3.4	0.4	0.7	3.2	3.1	16.6	11.4
MacAskill's Brook									0.0	N/A	0.0	N/A	1.0	N/A	9.0	N/A
Margaree	206	143	1327	10286	198	117	2098	8809	304.8	186.1	304.4	428.4	1520.6	569.1	11887.4	3696.1
Marie Joseph									0.0	N/A	0.3	N/A	4.0	N/A	51.3	N/A
Middle: Victoria Co.	5	27	62	314	3	15	79	174	6.0	13.3	28.2	26.5	97.2	66.9	373.8	177.0
Mira	0	3	9	57	0	0	0	3	0.0	0.0	3.6	5.7	1.4	2.7	42.2	46.9
North: Victoria Co.	0	113	109	447	1	68	135	326	12.8	34.2	100.4	83.8	145.4	52.8	615.4	455.2
North Aspy	0	3	8	23	0	1	12	19	0.4	1.1	4.0	6.0	19.2	16.6	43.4	27.3
Northwest Brook (River Ryan)									0.0	N/A	0.0	N/A	0.0	N/A	9.0	N/A
River Bennett									0.0	N/A	0.0	N/A	0.0	N/A	0.0	N/A
River Deny's									0.0	N/A	0.0	N/A	0.0	N/A	1.5	N/A
River Tillard	0	0	0	12					1.0	2.8	3.8	5.8	4.3	9.2	17.8	18.4
Saint Esprit									0.0	N/A	0.0	N/A	0.0	N/A	33.0	N/A
Salmon: Cape Breton Co.	0	8	9	123	0	1	3	64	0.6	1.1	5.0	8.4	10.4	16.4	97.8	78.1
Skye	0	0	0	4	0	0	0	0	2.3	N/A	0.3	N/A	0.0	N/A	10.7	N/A
Sydney	0	0	0	3	0	0	0	3	0.2	0.6	1.0	2.8	0.6	1.1	13.8	22.6
Totals	215	453	1683	12066	205	279	2468	9937	383.8		576.3		2061.2		14699.8	

Table 4. Annual summaries of catch, effort and estimated 1SW fish retained from NS license stub returns for assessed rivers of Cape Breton, 1984-98. Mean = (1993 to 1997). (Unk. Obs. are undefined small/large.)

		No.	Small		Est.	Large		Unk.	Total		Roddays			%
Year	River	Angler	Obs.	Est.	Ret.	Obs.	Est.	Obs.	Obs.	Est.	Obs.	Est.	CPUE	Large
	Baddeck													
1984		60	6	6	4	42	45	0	48	51	254	284	0.189	87.5
1985		34	4	5	4	12	14	0	16	19	94	100	0.170	75.0
1986		68	25	26	20	133	139	0	158	165	364	383	0.434	84.2
1987		90	40	40	26	126	126	0	166	166	411	435	0.404	75.9
1988		86	31	36	19	149	175	0	180	211	366	444	0.492	82.8
1989		98	15	18	8	204	247	0	219	265	392	490	0.559	93.2
1990		103	56	71	40	144	182	0	200	253	445	580	0.449	72.0
1991		110	40	51	28	166	213	0	206	264	483	640	0.427	80.6
1992		129	45	57	50	131	165	0	176	221	538	698	0.327	74.4
1993		146	45	48	33	101	108	0	146	156	689	785	0.212	69.2
1994		74	13	16	1	50	62	0	63	78	238	305	0.265	79.4
1995		61	49	61	7	57	71	0	106	131	263	336	0.403	53.8
1996		70	37	46	0	133	165	0	170	211	293	374	0.580	78.2
1997		42	11	15	0	48	64	0	59	79	115	157	0.513	81.4
1998		87	46	61	0	65	86	0	111	147	232	316	0.478	58.6
	+/- 1997	107%	318%	307%	-	35%	34%	-	88%	86%	102%	101%	-7%	-28%
	+/- Mean	11%	48%	64%	-100%	-16%	-9%	-	2%	12%	-27%	-19%	21%	-19%
	Grand													
1984		268	367	393	338	32	34	11	410	438	2,777	3,110	0.148	8.0
1985		312	520	542	471	127	132	1	648	675	2,896	3,094	0.224	19.6
1986		326	336	360	298	181	194	0	517	554	2,865	3,015	0.180	35.0
1987		262	311	342	308	97	107	0	408	449	1,961	2,077	0.208	23.8
1988		277	276	324	303	86	101	0	362	425	2,731	3,311	0.133	23.8
1989		247	258	312	290	62	75	0	320	387	2,167	2,707	0.148	19.4
1990		240	327	413	335	80	101	0	407	514	2,192	2,858	0.186	19.7
1991		178	100	128	115	14	18	0	114	146	1,499	1,985	0.076	12.3
1992		182	127	160	148	35	44	0	162	204	1,483	1,925	0.109	21.6
1993		184	117	139	118	21	25	0	138	164	1,311	1,494	0.105	15.2
1994		44	58	72	0	16	20	0	74	92	321	411	0.231	21.6
1995		4	4	5	0	10	12	0	14	17	38	49	0.368	71.4
1996		26	72	90	0	20	25	0	92	115	227	290	0.405	21.7
1997		21	22	29	3	4	5	0	26	34	99	136	0.263	15.4
1998		20	43	57	0	16	21	0	59	78	163	222	0.362	27.1
	+/- 1997	-5%	95%	97%	-100%	300%	320%		127%	129%	65%	63%	38%	76%
	+/- Mean	-64%	-21%	-15%	-100%	13%	21%		-14%	-8%	-59%	-53%	32%	-7%
	Margaree													
1984		678	233	242	190	293	305	4	530	551	5,952	6,665	0.089	55.7
1985		793	473	509	399	1,130	1,215	3	1,606	1,727	7,324	7,824	0.219	70.4
1986		1,131	748	782	650	2,522	2,636	2	3,272	3,420	9,724	10,232	0.336	77.1
1987		1,441	925	977	826	1,757	1,857	0	2,682	2,834	12,165	12,887	0.220	65.5
1988		1,455	749	879	752	1,647	1,932	0	2,396	2,810	11,582	14,042	0.207	68.7
1989		1,486	464	561	434	1,298	1,570	0	1,762	2,132	10,594	13,234	0.166	73.7
1990		1,383	514	649	498	1,193	1,507	0	1,707	2,156	10,792	14,073	0.158	69.9
1991		1,236	586	752	559	1,370	1,757	0	1,956	2,509	10,142	13,432	0.193	70.0
1992		1,426	539	678	551	1,541	1,938	0	2,080	2,616	11,483	14,909	0.181	74.1
1993		1,885	696	777	562	987	1,102	0	1,683	1,879	13,920	15,863	0.121	58.6
1994		1,382	346	429	291	1,193	1,479	0	1,539	1,908	10,452	13,376	0.147	77.5
1995		1,268	269	333	199	856	1,060	0	1,125	1,393	9,617	12,293	0.117	76.1
1996		986	738	918	274	1,499	1,864	0	2,237	2,782	7,119	9,096	0.345	61.0
1997		1,158	237	316	198	1,575	2,098	0	1,812	2,413	6,436	8,809	0.282	86.9
1998		1,073	263	349	206	1,000	1,327	0	1,263	1,676	7,543	10,286	0.167	79.2
	+/- 1997	-7%	11%	10%	4%	-37%	-37%	-	-30%	-31%	17%	17%	-41%	-9%
	+/- Mean	-20%	-42%	-37%	-32%	-18%	-13%	-	-25%	-19%	-21%	-13%	-18%	10%

Table 4 (continued). Annual summaries of catch, effort and estimated 1SW fish retained from NS license stub returns for assessed rivers of Cape Breton, 1984-98. Mean = (1993 to 1997). (Unk. Obs. are undefined small/large.)

		No.	Small		Est.	Large		Unk.	Total		Roddays			%
Year	River	Angler	Obs.	Est.	Ret.	Obs.	Est.	Obs.	Obs.	Est.	Obs.	Est.	CPUE	Large
	Middle													
1984		83	29	33	21	66	75	0	95	108	470	526	0.202	69.5
1985		39	18	21	15	24	29	0	42	50	150	160	0.280	57.1
1986		76	44	44	36	107	108	0	151	152	368	387	0.410	70.9
1987		114	55	58	53	111	116	0	166	174	684	725	0.243	66.9
1988		131	42	49	36	121	142	0	163	191	591	717	0.276	74.2
1989		144	43	52	41	231	279	0	274	332	694	867	0.395	84.3
1990		153	85	107	80	156	197	0	241	304	771	1005	0.313	64.7
1991		169	21	27	18	145	186	0	166	213	646	856	0.257	87.3
1992		66	9	11	8	24	30	0	33	41	167	217	0.198	72.7
1993		110	28	30	25	44	48	0	72	78	356	406	0.202	61.1
1994		122	19	24	0	134	166	0	153	190	389	498	0.393	87.6
1995		72	30	37	0	41	51	0	71	88	224	286	0.317	57.7
1996		125	48	60	2	114	142	0	162	202	395	505	0.415	69.5
1997		52	13	17	3	59	79	0	72	96	127	174	0.567	81.9
1998		99	24	32	5	47	62	0	71	94	230	314	0.309	66.2
	+/- 1997	90%	85%	88%	67%	-20%	-22%	-	-1%	-2%	81%	80%	-46%	-19%
	+/- Mean	3%	-13%	-5%	-17%	-40%	-36%	-	-33%	-28%	-23%	-16%	-18%	-8%
	North													
1984		162	60	65	56	139	151	1	200	217	1,091	1,222	0.183	69.8
1985		170	146	162	149	383	426	0	529	588	947	1,012	0.559	72.4
1986		298	235	235	185	1,010	1,010	0	1,245	1,245	1,945	2,047	0.640	81.1
1987		263	219	226	177	529	546	0	748	772	1,574	1,667	0.475	70.7
1988		202	115	135	118	456	535	0	571	670	1,305	1,582	0.438	79.9
1989		162	134	162	122	331	400	0	465	563	1,074	1,342	0.433	71.2
1990		219	212	268	202	483	610	0	695	878	1,416	1,846	0.491	69.5
1991		172	145	186	148	277	355	0	422	541	1,050	1,391	0.402	65.6
1992		205	178	224	184	437	550	0	615	773	1,421	1,845	0.433	71.1
1993		217	72	82	62	142	161	0	214	243	1,094	1,247	0.196	66.4
1994		73	60	74	0	78	97	0	138	171	317	406	0.435	56.5
1995		77	136	168	1	169	209	0	305	378	402	514	0.759	55.4
1996		81	140	174	0	100	124	0	240	298	457	584	0.525	41.7
1997		57	52	69	1	101	135	0	153	204	238	326	0.643	66.0
1998		84	85	113	0	82	109	0	167	222	328	447	0.509	49.1
	+/- 1997	47%	63%	64%	-100%	-19%	-19%	-	9%	9%	38%	37%	-21%	-26%
	+/- Mean	-17%	-8%	0%	-100%	-31%	-25%	-	-20%	-14%	-35%	-27%	-1%	-14%

Table 5. Estimates of returns, escapements, and percent of conservation requirement met for Atlantic salmon from the Margaree River, 1984-1998. Mean = 1993 to 1997.

	Large returns			Large escapement			Conservation req'm met by large			Eggs (10^6)
		Percentiles			Percentiles			Percentiles		collected for
Year	Median	5%	95%	Median	5%	95%	Median	5%	95%	hatchery
1984	412	327	563	381	296	532	37%	29%	51%	0.100
1985	1,462	1,109	2,217	1,378	1,025	2,133	133%	99%	206%	0.150
1986	3,616	2,738	5,680	3,461	2,583	5,525	334%	249%	533%	0.150
1987	4,015	2,976	6,540	3,899	2,860	6,424	376%	276%	620%	0.150
1988	1,688	1,286	2,494	1,545	1,143	2,351	149%	110%	227%	0.300
1989	2,289	1,708	3,693	2,164	1,583	3,568	209%	153%	344%	0.300
1990 (a)	5,156	3,481	7,933	5,022	3,347	7,799	485%	323%	753%	0.380
1991	3,484	1,853	5,785	3,323	1,692	5,624	321%	163%	543%	0.473
1992 (b)	6,375	4,875	9,375	6,222	4,722	9,222	601%	456%	890%	0.300
1993 (b)	3,358	2,408	6,158	3,224	2,274	6,024	311%	219%	581%	0.009
1994 (b)	2,900	2,350	4,500	2,759	2,209	4,359	266%	213%	421%	.
1995 (b)	2,365	-	-	2,308	-	-	223%	-	-	.
1996 (b)	2,792	2,214	4,050	2,579	2,001	3,837	249%	193%	370%	0.327
1997 (b)	4,662	3,268	5,435	4,400	3,000	5,167	425%	290%	499%	0.159
1998	2,949	2,067	3,438	2,780	1,898	3,269	268%	183%	316%	0.187
1998 comparison										
+/- 1997	-37%			-37%			-37%			
+/- Mean	-8%			-9%			-9%			

	Small returns			Small escapement			Conservation req'm met by small		
1984	504	400	688	311	158	446	53%	27%	77%
1985	838	634	1,167	433	125	658	74%	21%	113%
1986	1,096	838	1,420	439	56	638	75%	10%	110%
1987	1,478	1,143	1,865	644	166	888	111%	29%	153%
1988	2,209	1,674	2,911	1,451	795	2,032	249%	137%	349%
1989	768	591	977	328	30	416	56%	5%	71%
1990 [a]	1,977	940	5,077	1,471	291	4,428	253%	50%	761%
1991	1,909	794	3,891	1,340	42	3,139	230%	7%	539%
1992 [b]	1,645	1,258	2,419	1,088	701	1,862	187%	120%	320%
1993 [b]	2,087	1,489	3,851	1,504	906	3,268	258%	156%	562%
1994 [b]	708	573	1,101	394	259	787	68%	45%	135%
1995 [b]	737	-	-	528	-	-	91%	-	-
1996 [b]	1,685	1,277	2,960	1,343	935	2,618	231%	161%	450%
1997 [b]	712	316 [c]	1,517	464	68 [c]	1,269	80%	-12%	218%
1998	757	349 [c]	1,636	534	126 [c]	1,413	92%	-22%	243%
1998 comparison									
+/- 1997	6%			15%			15%		
+/- Mean	-36%			-37%			-37%		

[a]Returns re-estimated using average trapnet efficiency and average summer/fall proportion (Claytor et al. MS 1995).

[b]Modal value from Bayes estimates

[c]Negative estimate replaced with NS Licence Stub estimate of catch for returns; releases minus removals equals escapement.

Table 6. Summary of effort, catch and CPUE from logbook anglers on the Margaree River, 1991 to 1998.

Year	Season	Month	Angler Days	Small Catch	Small CPUE	Large Catch	Large CPUE	Total Catch	Total CPUE
1991									
	Summer	June	60	0	0.000	3	0.050	3	0.050
		July	101	9	0.089	10	0.099	19	0.188
		August	186	16	0.086	32	0.172	48	0.258
	Sub-Total		347	25	0.072	45	0.130	70	0.202
	Fall	September	222	24	0.108	76	0.342	100	0.450
		Oct. 1-15	176	7	0.040	63	0.358	70	0.398
		Oct. 16-31	43	4	0.093	19	0.442	23	0.535
		Oct. 1-31	219	11	0.050	82	0.374	93	0.425
	Sub-Total		441	35	0.079	158	0.358	193	0.438
	Total Season		788	60	0.076	203	0.258	263	0.334
1992									
	Summer	June	117	6	0.051	3	0.026	9	0.077
		July	185	28	0.151	40	0.216	68	0.368
		August	162	10	0.062	20	0.123	30	0.185
	Sub-Total		464	44	0.095	63	0.136	107	0.231
	Fall	September	176	12	0.068	26	0.148	38	0.216
		Oct. 1-15	211	18	0.085	66	0.313	84	0.398
		Oct. 16-31	74	5	0.068	49	0.662	54	0.730
		Oct. 1-31	285	23	0.081	115	0.404	138	0.484
	Sub-Total		461	35	0.076	141	0.306	176	0.382
	Total Season		925	79	0.085	204	0.221	283	0.306
1993									
	Summer	June	134	2	0.015	2	0.015	4	0.030
		July	204	16	0.078	12	0.059	28	0.137
		August	157	29	0.185	16	0.102	45	0.287
	Sub-Total		495	47	0.095	30	0.061	77	0.156
	Fall	September	193	6	0.031	18	0.093	24	0.124
		Oct. 1-15	154	6	0.039	26	0.169	32	0.208
		Oct. 16-31	41	4	0.098	8	0.195	12	0.293
		Oct. 1-31	195	10	0.051	34	0.174	44	0.226
	Sub-Total		388	16	0.041	52	0.134	68	0.175
	Total Season		883	63	0.071	82	0.093	145	0.164
1994									
	Summer	June	80	3	0.038	13	0.163	16	0.200
		July	71	1	0.014	3	0.042	4	0.056
		August	98	9	0.092	5	0.051	14	0.143
	Sub-Total		249	13	0.052	21	0.084	34	0.137
	Fall	September	141	4	0.028	34	0.241	38	0.270
		Oct. 1-15	136	5	0.037	56	0.412	61	0.449
		Oct. 16-31	79	1	0.013	27	0.342	28	0.354
		Oct. 1-31	215	6	0.028	83	0.386	89	0.414
	Sub-Total		356	10	0.028	117	0.329	127	0.357
	Total Season		605	23	0.038	138	0.228	161	0.266

Table 6 (continued). Summary of effort, catch and CPUE from logbook anglers on the Margaree River, 1991 to 1998.

Year	Season	Month	Angler Days	Small		Large		Total	
				Catch	CPUE	Catch	CPUE	Catch	CPUE
1995									
	Summer	June	56	1	0.018	6	0.107	7	0.125
		July	90	2	0.022	12	0.133	14	0.156
		August	71	3	0.042	8	0.113	11	0.155
	Sub-Total		217	6	0.028	26	0.120	32	0.147
	Fall	September	150	4	0.027	23	0.153	27	0.180
		Oct. 1-15	129	8	0.062	26	0.202	34	0.264
		Oct. 16-31	98	1	0.010	19	0.194	20	0.204
		Oct. 1-31	227	9	0.040	45	0.198	54	0.238
	Sub-Total		377	13	0.034	68	0.180	81	0.215
	Total Season		594	19	0.032	94	0.158	113	0.190
1996									
	Summer	June	94	5	0.053	15	0.160	20	0.213
		July	225	62	0.276	41	0.182	103	0.458
		August	214	49	0.229	43	0.201	92	0.430
	Sub-Total		533	116	0.218	99	0.186	215	0.403
	Fall	September	319	62	0.194	82	0.257	144	0.451
		Oct. 1-15	339	34	0.100	107	0.316	141	0.416
		Oct. 16-31	155	8	0.052	34	0.219	42	0.271
		Oct. 1-31	494	42	0.085	141	0.285	183	0.370
	Sub-Total		813	104	0.128	223	0.274	327	0.402
	Total Season		1346	220	0.163	322	0.239	542	0.403
1997									
	Summer	June	130	1	0.008	22	0.169	23	0.177
		July	164	8	0.049	18	0.110	26	0.159
		August	190	9	0.047	18	0.095	27	0.142
	Sub-Total		484	18	0.037	58	0.120	76	0.157
	Fall	September	318	11	0.035	141	0.443	152	0.478
		Oct. 1-15	240	2	0.008	87	0.363	89	0.371
		Oct. 16-31	115	1	0.009	31	0.270	32	0.278
		Oct. 1-31	355	3	0.008	118	0.332	121	0.341
	Sub-Total		673	14	0.021	259	0.385	273	0.406
	Total Season		1157	32	0.028	317	0.274	349	0.302
1998									
	Summer	June	117	0	0.000	5	0.043	5	0.043
		July	198	14	0.071	27	0.136	41	0.207
		August	117	11	0.094	8	0.068	19	0.162
	Sub-Total		432	25	0.058	40	0.093	65	0.150
	Fall	September	247	14	0.057	47	0.190	61	0.247
		Oct. 1-15	200	5	0.025	36	0.180	41	0.205
		Oct. 16-31	121	1	0.008	28	0.231	29	0.240
		Oct. 1-31	321	6	0.019	64	0.199	70	0.218
	Sub-Total		568	20	0.035	111	0.195	131	0.231
	Total Season		1000	45	0.045	151	0.151	196	0.196

Table 7. Results of electrofishing surveys at barrier net sites in the Margaree River Watershed 1995-1998.

					Age 0+					Age 1+, 2+				
Year	Tributary	Site #	Area (m^2)	# of sweeps	Mean length (cm)	Sweep catch	Total estimate	Variance	Density ($100m^{-2}$)	Mean length (cm)	Sweep catch	Total estimate	Variance	Density ($100m^{-2}$)
1998	Big Brook	15	242	3	4.9	171	182	32.4	75	8.5	147	151	9.2	62
	Forest Glen Bk	45	207	3	4.5	479	507	71.1	245	8.0	167	172	12.3	83
	MacFarlanes Bk	96	258	3	4.9	444	463	41.1	179	8.8	147	159	37.7	62
	Trout Bk	98	196	4	5.2	51	51	0.3	26	7.7	91	94	8.2	48
	Old Bridge	51	508	3	4.5	824	842	30.3	166	8.3	344	369	69.8	73
	Mean sites,15,45,96								167					69
1997	Big Brook	15	171	4	4.7	316	317	1.1	185	9.1	93	97	11.0	57
	Forest Glen Bk	45	235	4	4.1	297	309	25.5	132	8.1	196	204	18.4	87
	MacFarlanes Bk	96	268	4	4.8	289	301	25.5	112	8.8	175	180	10.8	67
	Trout Bk	98	206	4	4.3	319	331	24.3	160	8.4	87	89	4.5	43
	Old Bridge	51	421	3	4.3	750	788	88.8	187	9.2	246	271	90.1	64
	Mean sites,15,45,96								143					70
1996	Big Brook	15	215	4	4.6	320	320	0.8	149	8.8	94	96	5.2	45
	Forest Glen Bk	45	249	4	4.2	215	219	7.4	88	7.9	273	277	6.5	111
	MacFarlanes Bk	96	317	4	4.6	328	329	1.8	104	8.8	274	278	6.3	88
	Trout Bk	98	210	3	4.4	59	59	1.4	28	8.3	64	66	6.0	31
	Old Bridge	51	477	3	4.8	575	585	17.5	123	8.9	351	412	321.0	86
	Mean sites,15,45,96								114					81
1995	Big Brook	15	147	4	5.0	268	273	8.9	186	9.8	55	57	4.9	39
	Forest Glen Bk	40	131	4	4.4	178	209	162.3	159	8.8	135	143	23.0	109
	Forest Glen Bk	45	172	4	4.5	414	440	66.9	256	8.3	198	210	30.7	122
	MacFarlanes Bk	96	288	4	5.4	300	336	135.5	117	10.0	189	201	33.7	70
	Trout Bk	98	179	4	5.0	101	107	16.3	60	8.5	81	87	17.9	48
	Old Bridge	51	443	3	5.4	496	550	264.3	127	10.0	214	247	164.0	56
	Mean sites,15,45,96								186					77

Table 8. Estimates of spawners and recruits used in the stock recruitment relationships.

Spawning year	Spawners	Recruits
1947	1,685	4,852
1948	3,358	7,204
1949	1,839	5,716
1950	1,744	4,000
1951	2,093	2,440
1952	969	2,833
1956	486	2,616
1957	822	4,534
1961	344	3,620
1962	1,306	3,850
1963	887	3,538
1964	1,053	2,515
1965	993	3,694
1966	727	1,393
1967	1,009	2,083
1968	828	2,378
1969	488	3,394
1970	901	2,702
1971	351	2,630
1972	373	3,261
1973	393	3,131
1974	436	1,066
1975	293	2,813
1976	366	1,819
1977	538	2,909
1978	699	3,292
1979	363	1,868
1980	681	1,462
1981	618	3,616
1982	760	4,015
1983	657	1,688
1984	381	2,289
1985	1,378	5,156
1986	3,461	3,484
1987	3,899	6,375
1988	1,545	3,358
1989	2,164	2,900
1990	5,022	2,365
1991	3,323	2,792
1992	6,222	4,662
1993	3,224	2,949
1994	2,759	
1995	2,308	
1996	2,579	
1997	4,400	
1998	2,780	

Table 9. Parameter estimates, forecasts and residuals for stock recruitment models.

Parameter	Model			
	Ricker	Beverton-Holt	Mean	Tabular
a	1.74	4.10	.	.
b	3.94	0.29	.	.
Res SS	1.34	0.99	1.27	0.93
X value	2,759	2,759	2,759	2,759
Forecast	4,640	3,720	3,250	4,090

Table 10. Tabular stock recruitment model for Margaree River Atlantic Salmon.

Recruitment	Spawning Stock			
	0 - 600	600 - 1,200	1,200 - 1,800	>1,800
> 7,800				
7,200 - 7,800				1
6,600 - 7,200				
6,000 - 6,600				1
5,400 - 6,000				1
4,800 - 5,400			2	
4,200 - 4,800		1		1
3,600 - 4,200	1	3	2	
3,000 - 3,600	3	2	1	1
2,400 - 3,000	4	3		4
1,200 - 2,400	3	5		1
0 - 1,200	1			
Number of Points	12	14	5	10
Average Spawners	401	829	1,532	3,461
Average Recruits	2,618	2,839	4,243	4,089
Recruits minus Spawners	2,217	2,010	2,712	628
Recruits / Spawners	6.53	3.42	2.77	1.18

Table 11. Numbers of hatchery smolt and parr released to Cape Breton rivers, 1988-1998[1]

Year	Location	Smolt 2+	Smolt 1+	Parr 1+	Parr 0+
Christmas Brook (Eskasoni)					
1992	Cobequid	4,239			
1993	Cobequid	10,017			
1994	Cobequid	7,938			
Grand River					
1988	Cobequid				15,975
1989	Coldbrook		10,913	6,205	
	Cobequid			4,515	19,050
1990	Cobequid	18,628		2,563	23,200
1991	Cobequid	10,772		4,386	14,938
1992	Cobequid	13,885			4,850
1993	Cobequid	10,448		555	6,824
1994	Cobequid	7,449		1,998	
	Mersey				12,140
1995	Cobequid	14,619	11,258		
	Mersey				21,617
1996	Cobequid		16,997		
	Mersey				23,500
1997	Cobequid		15,463		
Indian Brook (Eskasoni)					
1993	Cobequid			2,805	
1994	Cobequid			1,996	
	Mersey				2,808
1995	Cobequid	9,953	5,309		
	Mersey			17,205	
1996	Cobequid		19,866		
1997	Cobequid		5,985		
1998	Mersey				17,542
Margaree River					
1988	Margaree	4,140	22,323	2,202	51,103
	Cobequid	12,504			6,345
1989	Margaree	2,611[2]	10,648	10,177	140,466
	Cobequid	16,124			
1990	Margaree	4,119[2]	14,303	21,370	69,124
	Cobequid	16,514			
1991	Margaree	12,483[2]	17,851	23,817	107,295
	Cobequid	11,392		4,000	8,400
1992	Margaree	23,677[2]	22,893	34,018	92,762
	Cobequid	16,891		3,500	9,800
1993	Margaree	12,667[2]	17,062	24,883	52,756
	Cobequid	14,996		5,712	
1994	Margaree		18,090	6,724	
	Cobequid	11,585			
1995	Margaree	5,400[3]	18,365	34,242	
1997	Margaree	881			135,653
1998	Margaree				99,474
Middle River					
1988	Cobequid	23,927			
1989	Cobequid	23,090			
North River					
1988	Cobequid	3,993			
1989	Cobequid	5,449			
1992	Cobequid				9,520
1993	Cobequid			3,705	4,838
1994	Cobequid	10,067		3,794	
1995	Cobequid	23,145			
Salmon/Gaspereaux Rivers (Mira)					
1989	Cobequid				11,514
1990	Cobequid	8,226		3,658	
1991	Cobequid	16,527		8,439	
1992	Cobequid	11,127		3,711	6,422
1993	Cobequid	9,966		285	
1994	Cobequid	9,018			
1995	Cobequid			4,944	
1996	Cobequid		1,602		
1997	Cobequid	4,624			

[1]Revised from Marshall *et al.* MS 1997; [2]Reared in Lake O'Law cages; [3]An additional 14,072 escaped from cages.

Table 12. Results of electrofishing surveys at barrier net sites in Cape Breton Island, 1995-1998.

River	Site Name	Area m^2	No. of sweeps	Age 0+ Catch	Age 0+ Est. Pop'n	Age 0+ Density $100m^2$	Age 1+, 2+ Catch	Age 1+, 2+ Est. Pop'n	Age 1+, 2+ Density $100\ m^2$
1998									
Middle	Main, Finlayson	556	4	113	119	21.5	253	270	48.5
	Main, Twin Churches*	369	4	134	135	36.7	196	201	54.7
	MacLeods Bk	132	4	21	24	17.8	44	46	35.0
	MacKenzie Bk	101	3	9	10	9.5	48	49	48.9
	Mean, 2 main river sites					29.1			51.6
Baddeck	Upper, Site #2	456	4	196	208	45.7	149	153	33.5
	N Br, Site #3	515	3	227	234	45.5	95	101	19.6
	N Br, Site #4	419	3	388	431	102.8	141	156	37.2
	Peter's Bk, SP#5	217	3	133	139	64.0	55	57	26.3
	Mean, 3 main river sites					64.7			30.1
North	Main, Karr's	444	3	51	55	12.4	61	66	14.9
	Main, MacDonalds	404	3	23	27	6.7	72	78	19.3
	Mean, 2 riverine sites					9.6			17.1
Cheticamp	Robert's Brook	408	3	267	272	66.8	154	159	39.0
	Main (Above Fairbault Bk)	400	4	282	285	71.1	184	188	47.0
Skye	Main	306	3	2	.	0.7	42	51	16.8
	MacDonald Brook	132	3	0	.	.	17	20	14.9
	Mullach Brook	256	3	23	24	9.5	10	10	4.1
Mabou	Mull River	218	3	132	148	67.7	148	153	70.2
	MacLeod Brook	315	3	74	75	23.9	118	125	39.6
Inhabitants	Main	385	3	75	82	21.3	138	140	36.4
	Lamey Brook	527	3	23	25	4.7	158	161	30.6
	Northwest Arm	358	3	85	89	24.8	27	28	7.7
1997									
Middle	Main, Finlayson	533	3	147	152	28.6	330	353	66.3
	Main, Twin Churches*	364	4	153	159	43.6	91	92	25.1
	MacLeods Bk	260	4	165	167	64.1	143	156	60.1
	MacKenzie Bk	122	4	0	0	0.0	148	152	124.2
	Mean, 2 main river sites					36.1			45.7
Baddeck	Upper, Site #2	397	4	190	200	50.3	162	169	42.5
	N Br, Site #3	457	3	774	819	179.2	97	116	25.3
	N Br, Site #4	372	4	401	412	110.7	165	180	48.3
	Peter's Bk, SP#5	161	4	187	190	118.2	56	58	35.8
	Mean, 3 main river sites					113.4			38.7
North	Abv Church Pl (tidal infl.)	414	3	6	6+	1.5+	1	1+	<1
	Main, MacDonalds	430	3	23	24	5.6	134	142	33.1
	MacLeans	352	3	121	314	89.4	119	137	38.9
	Benches	350	3	53	57	16.4	83	87	24.9
	Mean, 3 riverine sites					37.1			32.3

Table 12. Results of electrofishing surveys at barrier net sites in Cape Breton Island, 1995-1998.

River	Site Name	Area m^2	No. of sweeps	Age 0+ Catch	Age 0+ Est. Pop'n	Age 0+ Density $100m^2$	Age 1+, 2+ Catch	Age 1+, 2+ Est. Pop'n	Age 1+, 2+ Density $100\ m^2$
Skye	Main	201	3	39	41	20.5	23	25	12.6
	MacDonald's Brook	133	3	20	21	16.1	2	.	1.5
Mabou	Mull River	167	4	238	252	150.9	140	151	90.5
	MacLeod Brook	301	4	596	624	207.3	109	134	44.5
1996									
Middle	Main, Finlayson	530	4	194	196	36.9	279	287	54.2
	Main, Two Churches	333	3	72	82	24.7	110	120	36.0
	MacLeods Bk	224	4	55	56	24.8	138	147	65.8
	MacKenzie Bk	103	4	175	176	171.0	64	67	64.6
	Mean, 2 main river sites					30.8			45.1
Baddeck	Main, Glenhaven	368	4	226	254	69.1	146	153	41.7
	N. Br, Picnic Pk	491	4	261	281	57.3	87	99	20.1
	N. Br, Bridge	378	4	235	240	63.6	168	174	46.1
	Peter's Bk	168	4	248	253	150.1	39	39	23.2[+]
	Mean, 3 main river sites					63.3			36.0
North	Main, MacDonalds	408	3	40	41	10.1	114	121	29.8
	Main, Church	357	3	116	118	33.0	49	51	14.3
	Mean, 2 main river sites					21.6			22.1
1995									
Middle	Main, Hwy 19	181	4	191	197	108.9	59	62	34.3
	Main, ab Gold Bk	251	3	261	267	106.3	43	46	18.3
	MacKenzie Bk	95	4	159	174	174.1	63	72	75.8
	Mean, 2 main river sites					107.6			26.3

[+]Minimum based on total catch, variance of estimate was negative.
Note: Skye main site 1998 estimate based on total catch/site area.
Note: MacLeod Brook (Middle River) 1998 variances unreliable because N< 50

Table 13. Results of electrofishing surveys for juvenile Atlantic salmon at mark-recapture sites in rivers of Cape Breton Island, 1996-1998.

River	Site name	Site no.	Area m2	Recap time in days	Age 0+ parr Est. pop'n	Age 0+ parr Density 100m²	Age 1+ and 2+ parr Est. pop'n	Age 1+ and 2+ parr Density 100 m²
1998								
Grand River	Mud Hole (Abv Falls)	1	864	1	154	17.8	36	4.2
	Fishway (Abv Falls)	2	876	2	316	36.0	75	8.6
	Crib Pool (Blw Falls)	3	635	2	173	27.2	42	6.6
	F. MacDonald Rd. (Blw Falls)	4	563	2	112	19.9	40	7.1
	Mean,4 main river sites					25.2		6.6
Tillard	Main	1	524	3	91	17.4	135	25.8
Sydney	Medows Brook	1	430	1	89	20.7	138	32.1
Gaspereaux	Victoria Bridge	1	307	1	91	29.6	13	4.2
North River	MacLeans	3	438	1	403	92.0	21	4.8
	Benches	4	530	1	1092	206.0	250	47.2
1997								
Grand River	Mud Hole (Abv Falls)	1	739	2	346	46.8	36	4.9
	Fishway (Abv Falls)	2	795	2	116	14.6	31	3.9
	Crib Pool (Blw Falls)	3	560	2	152	27.1	60	10.7
	F. MacDonald Rd. (Blw Falls)	4	485	2	158	32.6	29	6.0
	Mean,4 main river sites					30.3		6.4
River Tillard	Main	1	503	2	159	31.6	198	39.4
Sydney River	Meadows Brook	1	342	2	160	46.8	278	81.3
1996								
Grand River	Mud Hole (Abv Falls)	1	1130	4	46	4.1	9	0.8
	Fishway (Abv Falls)	2	996	2	130	13.1	15	1.5
	Crib Pool (Blw Falls)	3	953	3	207	21.7	27	2.8
	F. MacDonald Rd. (Blw Falls)	4	633	1	112	17.7	42	6.6
	Mean,4 main river sites					14.2		2.9
Tillard	Main	1	282	2	56	19.9	63	22.3
		2	307	2	24	7.8	51	16.6
						13.9		19.5
Sydney River	Meadows Brook	1	343	2	94	27.4	173	50.4
Gaspereaux	Victoria Bridge	1	265	2	53	20.0	11	4.2

Table 14. Area (m^2x100) by percent orthogradient and distance above mean sea level for five rivers of Cape Breton.

River	Dist. Interval (km)	Orthograde (%)											Totals	% total
		0-0.12	0.121-0.249	0.25-0.49	0.5-0.99	1-1.49	1.5-1.99	2-2.49	2.5-2.9	3-3.49	3.5-5.0	>5.0		
Margaree	00-10.0	955	0	0	114	170	0	0	0	0	0	0	1239	3.7
	10.1-20.0	2863	2274	994	40	600	458	97	59	6	3	8	7402	21.9
	20.1-30.0	0	2574	2929	981	509	664	162	76	54	43	8	8000	23.7
	30.1-40.0	1191	573	2806	1494	381	388	86	129	77	92	29	7246	21.4
	40.1-50.0	203	54	638	1801	991	122	94	31	25	74	58	4091	12.1
	50.1-60.0	659	0	191	1728	837	440	166	145	46	79	33	4324	12.8
	60.1-70.0	0	0	0	233	650	237	142	58	52	33	9	1414	4.2
	70.1-80.0	0	0	35	21	24	0	15	0	0	7	4	107	0.3
	Totals	5871	5475	7593	6412	4162	2309	762	498	260	331	149	33823	100
	% Total Area	17.4	16.2	22.4	19	12.3	6.8	2.3	1.5	0.8	1	0.4		
Middle	00-10.0		2,538	685	300	72	80	24		15			3,713	43
	10.1-20.0			849	1,260	20	32		10	12			2,184	25.3
	20.1-30.0				1,723	287	83	46					2,139	24.7
	30.1-40.0				246	160	137	16	51				611	7.1
	Totals		2,538	1,534	3,530	539	331	85	62	27			8,646	100
	% Total Area		29.4	17.7	40.8	6.2	3.8	1	0.7	0.3				
Baddeck	00-10.0			842	77	23		4	5				952	11.4
	10.1-20.0		494	1,479	2,612	175	43	44			10		4,857	58.1
	20.1-30.0				698	675	573	326	149	68	65		2,554	30.5
	Totals		494	2,321	3,387	873	616	374	155	68	75		8,363	100
	% Total Area		5.9	27.8	40.5	10.4	7.4	4.5	1.9	0.8	0.9			
North	00-10.0			391	1331	704	83	176	6	11	38	25	2,765	72
	10.1-20.0				26	115	106	244	115	209	123	18	956	25
	20.1-30.0				56	40	11						107	3
	Totals			391	1413	859	201	419	121	220	161	43	3,828	100
	% Total Area			10.2	36.9	22.4	5.2	11	3.2	5.7	4.2	1.1		
Sydney	00-10.0	1,135	722	580	356	79	18						2,890	60.8
	10.1-20.0		362	142	498	358	101	38	28	25	36	22	1,610	33.9
	20.1-30.0			150	20	36	12	13	13			5	249	5.2
	Totals	1,135	1,084	872	874	474	131	51	41	25	36	28	4,751	100
	% Total Area	23.9	22.8	18.4	18.4	10	2.8	1.1	0.9	0.5	0.8	0.6		
Grand	00-10.0	48	2,175	548	144	53	64	13	8		5	1	3,058	55.7
	10.1-20.0	595	38	725	108	28	49	27	5	6	8	6	1,596	29.1
	20.1-30.0	230	78	57	191	97	32	26	11	5	14	3	745	13.6
	30.1-40.0		62			8	9	6	2		5		92	1.7
	Totals	873	2,353	1,329	443	187	154	72	27	11	32	10	5,491	100
	% Total Area	15.9	42.8	24.2	8.1	3.4	2.8	1.3	0.5	0.2	0.6	0.2		

Table 15. Estimated spawning requirements for the Margaree River.

Ortho-photo Estimate of Habitat Area			3,382,400		
Area with stream gradient < 0.12%			587,200		
Area with stream gradient >= 0.12%			2,795,200		
Ortho-photo Estimate of Juvenile Production Area (stream gradient >= 0.12%)					
Margaree including tributaries.			**2,795,200**		
Conservation Requirements:					
Rearing Units		=	27,952	(100 m²)	
Optimal Egg Deposition		=	240	per unit	(Elson 1975)
Total Egg Requirements		=	**6,700,000**		
Biological Characteristics (Levi's trapnet:1992-1996; wild fish; Marshall et al. MS 1997):					
Length-Fecundity Relationship St. Mary's River					
CHNG'****	= (LogeEggs=5.741+0.040(fork length))			(Marshall MS 1986)	
1SW	% Female	=	7%		
	Mean Length (cm)	=	56.3		
	Fecundity	=	2,960		
MSW	% Female	=	74%		
	Mean Length (cm)	=	78.5		
	Fecundity	=	7,194		
Eggs per spawner	1SW	=	fecundity* %female		
		=	2,960 * 7%		
		=	204		
	MSW	=	fecundity* %female		
		=	7,194* 74%		
		=	5,356		
Required number of MSW salmon		=	egg requirements / eggs per MSW salmon		
		=	6,700,000 / 5,356		
		=	1,251		
	Females	=	931		
	Males	=	320		
Deficit Males (1SW)		=	611		
Required number of 1SW salmon		=	deficit males / %male		
		=	611 / 93%		
		=	656		

				Plus	Minus
Adult requirements:	**MSW**	=	***1,250***	214	
	1SW	=	***660***	78	

Table 16. Estimated spawning requirements for the Middle River.

Ortho-photo Estimate of Habitat Area					(Amiro 1993)
Area with stream gradient < 0.12%			0		
Area with stream gradient >= 0.12%			864,600		
Ortho-photo Estimate of Juvenile Production Area (stream gradient >= 0.12%)					
Middle River including tributaries.			**864,600**		
Conservation Requirements:					
Rearing Units		=	8,646	(100 m²)	
Optimal Egg Deposition		=	240	per unit	(Elson 1975)
Total Egg Requirements		=	**2,100,000**		
Biological Characteristics (Seining; 1996-1998 - Wild fish this report):					
Length-Fecundity Relationship					
= (LogeEggs=5.741+0.04(fork length))					(Marshall MS 1986)
1SW	% Female	=	5%		
	Mean Length (cm)	=	55.5		
	Fecundity	=	2,867		
MSW	% Female	=	61%		
	Mean Length (cm)	=	73		
	Fecundity	=	5,813		
Eggs per spawner	1SW	=	fecundity* %female		
		=	2,867* 5%		
		=	137		
	MSW	=	fecundity* %female		
		=	6,015* 73%		
		=	3,547		
Required number of MSW salmon		=	egg requirements / eggs per MSW salmon		
		=	2,100,000 /3,574		
		=	592		
	Females	=	361		
	Males	=	231		
Deficit Males (1SW)		=	130		
Required number of 1SW salmon		=	deficit males / %male		
		=	130 / 95%		
		=	137		

Adult requirements:				Plus	Minus
	MSW	=	***590***	**120**	
	1SW	=	***140***	**60**	

Table 17. Estimated spawning requirements for the Baddeck River.

Ortho-photo Estimate of Habitat Area					(Amiro 1993)
Area with stream gradient < 0.12%			0		
Area with stream gradient >= 0.12%			836,300		
Ortho-photo Estimate of Juvenile Production Area (stream gradient >= 0.12%)					
Baddeck River including tributaries.			**836,300**		
Conservation Requirements:					
Rearing Units		=	8,363	(100 m²)	
Optimal Egg Deposition		=	240	per unit	(Elson 1975)
Total Egg Requirements		=	**2,000,000**		
Biological Characteristics (Seining; 1996-1998 - Wild fish this report):					
Length-Fecundity Relationship					
= (LogeEggs=5.741+0.040(fork length))					(Marshall MS 1986)
1SW	% Female	=	18%		
	Mean Length (cm)	=	53.7		
	Fecundity	=	2,668		
MSW	% Female	=	83%		
	Mean Length (cm)	=	75		
	Fecundity	=	6,254		
Eggs per spawner	1SW	=	fecundity* %female		
		=	2,668* 18%		
		=	471		
	MSW	=	fecundity* %female		
		=	6,254* 83%		
		=	5,172		
Required number of MSW salmon		=	egg requirements / eggs per MSW salmon		
		=	2,000,000 / 5,172		
		=	387		
	Females	=	320		
	Males	=	67		
Deficit Males (1SW)		=	253		
Required number of 1SW salmon		=	deficit males / %male		
		=	253/ 82%		
		=	307		

	Plus	Minus
		(60)
	230	

Adult requirements:	**MSW**	=	***390***
	1SW	=	***310***

Table 18. Estimated spawning requirements for the North River.

Ortho-photo Estimate of Habitat Area			0		(Amiro 1993)
Area with stream gradient < 0.12%			0		
Area with stream gradient >= 0.12%			382,700		
Ortho-photo Estimate of Juvenile Production Area (stream gradient >= 0.12%)					
North River including tributaries.			**382,700**		
Conservation Requirements:					
Rearing Units		=	3,827	(100 m²)	
Optimal Egg Deposition		=	240	per unit	(Elson 1975)
Total Egg Requirements		=	**900,000**		
Biological Characteristics (Seining; 1996-1998 - Wild fish this report):					
Length-Fecundity Relationship					
= (LogeEggs=5.741+0.040(fork length))					(Marshall MS 1986)
1SW	% Female	=	24%		
	Mean Length (cm)	=	53.14	(males)	
	Fecundity	=	2,609		
MSW	% Female	=	78%		
	Mean Length (cm)	=	70.44		
	Fecundity	=	5,211		
Eggs per spawner	1SW	=	fecundity* %female		
		=	2,609* 24%		
		=	614		
	MSW	=	fecundity* %female		
		=	5,211* 70.4%		
		=	4,041		
Required number of MSW salmon		=	egg requirements / eggs per MSW salmon		
		=	900,000 /4,041		
		=	223		
	Females	=	173		
	Males	=	50		
Deficit Males (1SW)		=	123		
Required number of 1SW salmon		=	deficit males / %male		
		=	123 / 76%		
		=	161		

Adult requirements:	**MSW**	=	***220***
	1SW	=	***160***

Plus	Minus
20	
130	

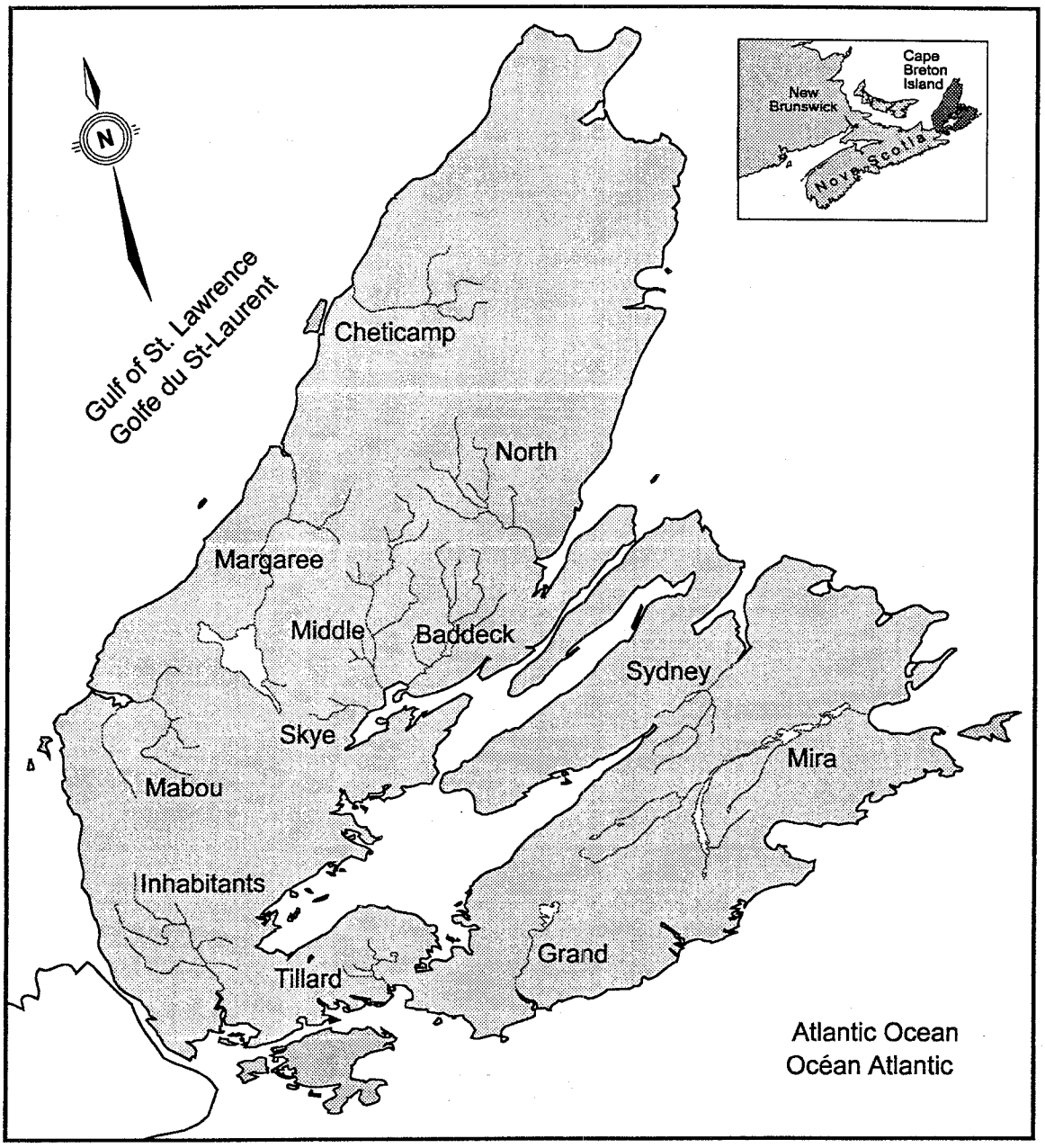

Fig. 1. Cape Breton Island rivers which were assessed for Atlantic salmon, 1998.

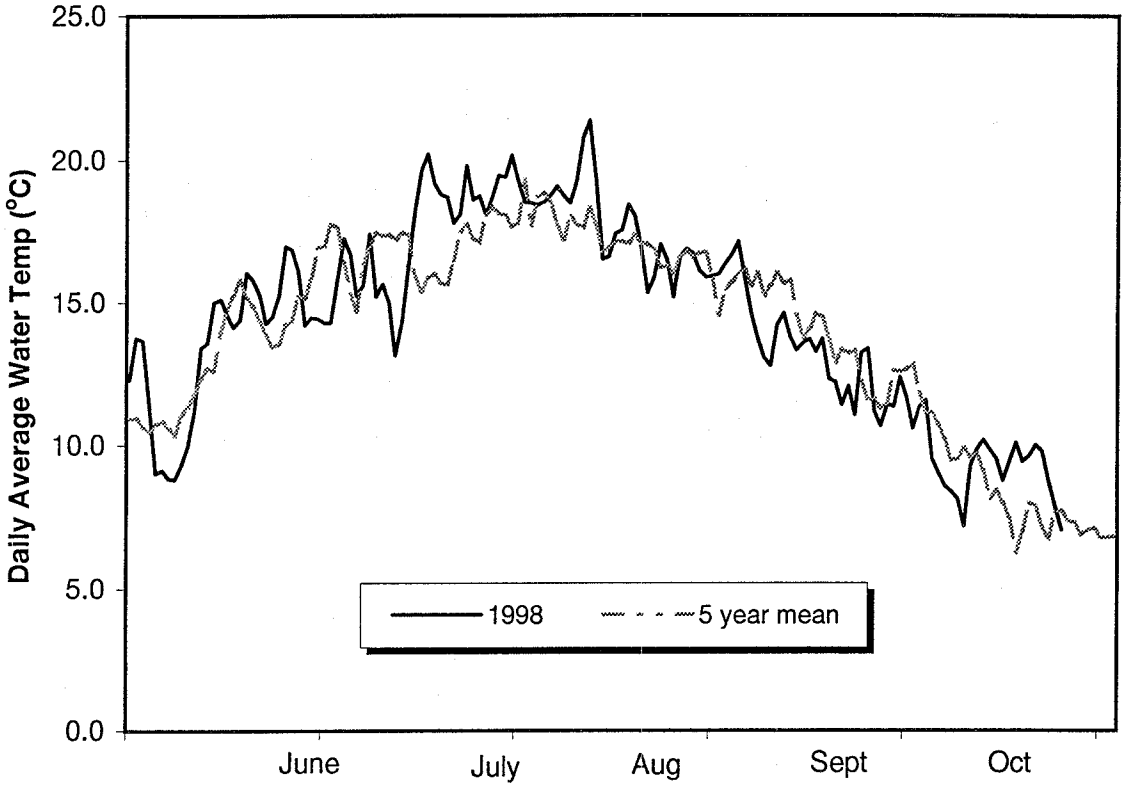

Fig. 2. Mean daily water temperatures Northeast Margaree River (Doyle's Bridge) 1998 and 1993-1997.

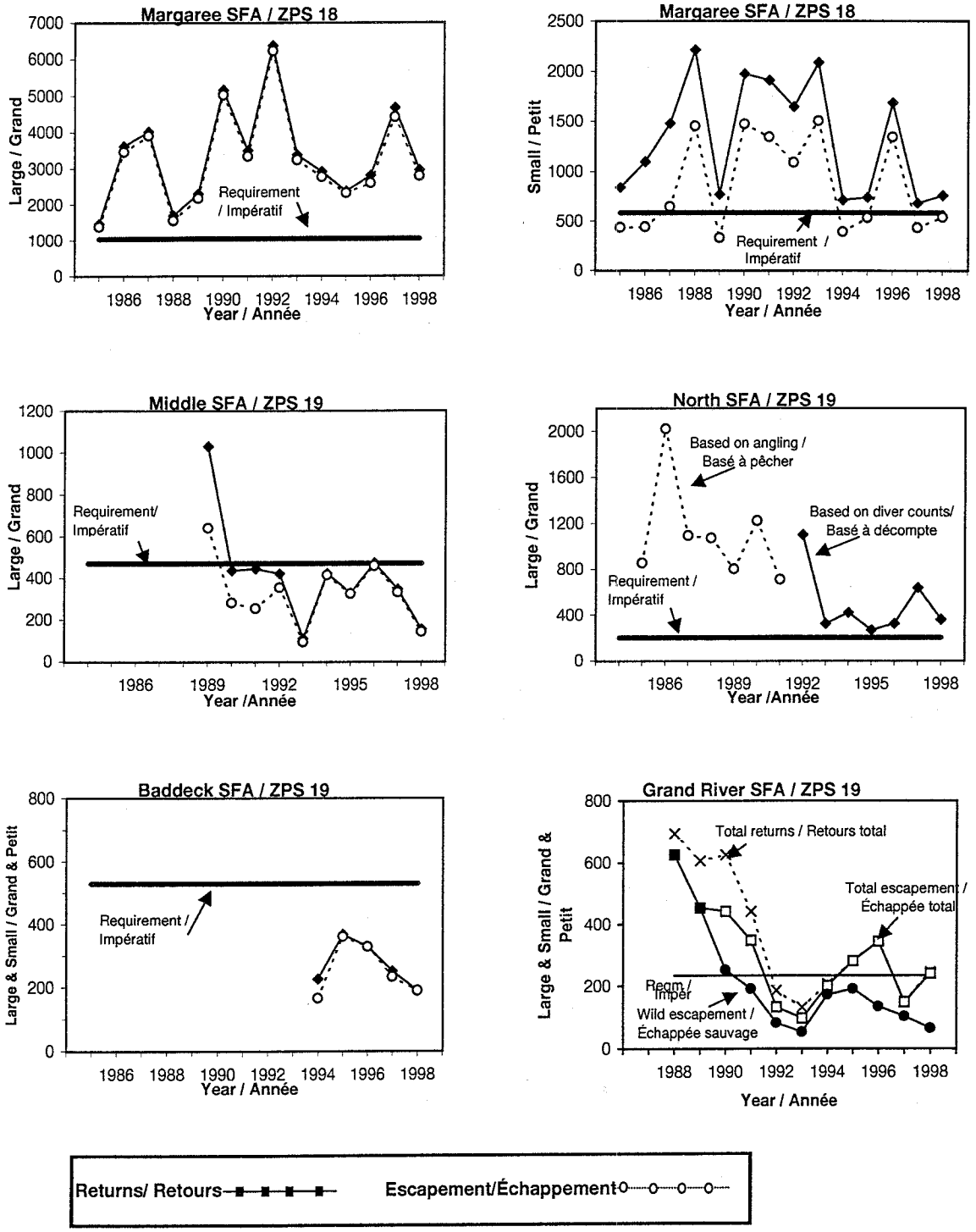

Fig. 3. Estimates of small and large salmon returns and spawners to selected Cape Breton Island rivers.

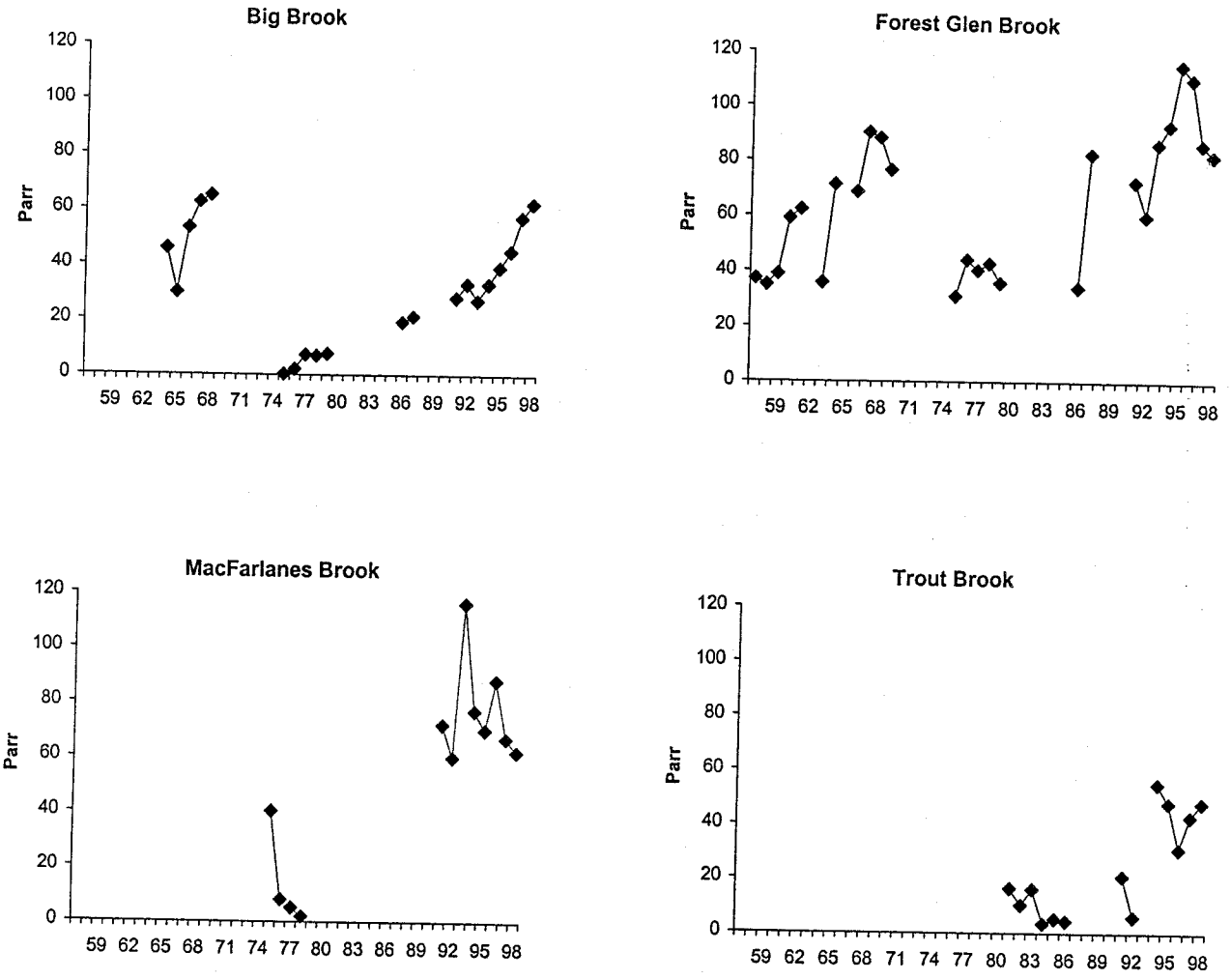

Fig. 4. Parr densities per 100 m^2 at four index sites on the Margaree River, 1957-1998.

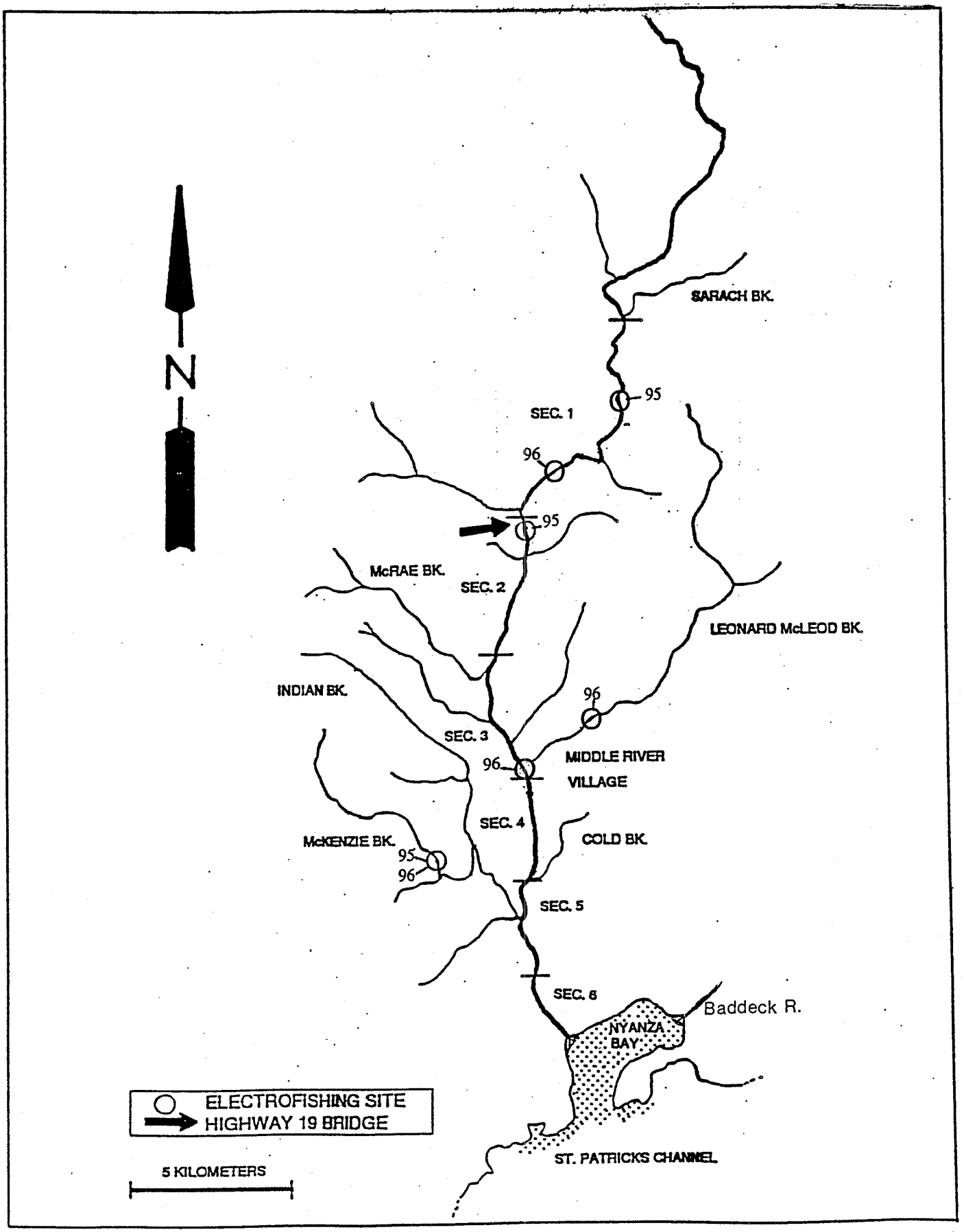

Fig. 5. Middle River, Victoria County, showing swim-thru sections and electrofishing sites in 1995 (95), 1996(96), 1997(96) and 1998(96).

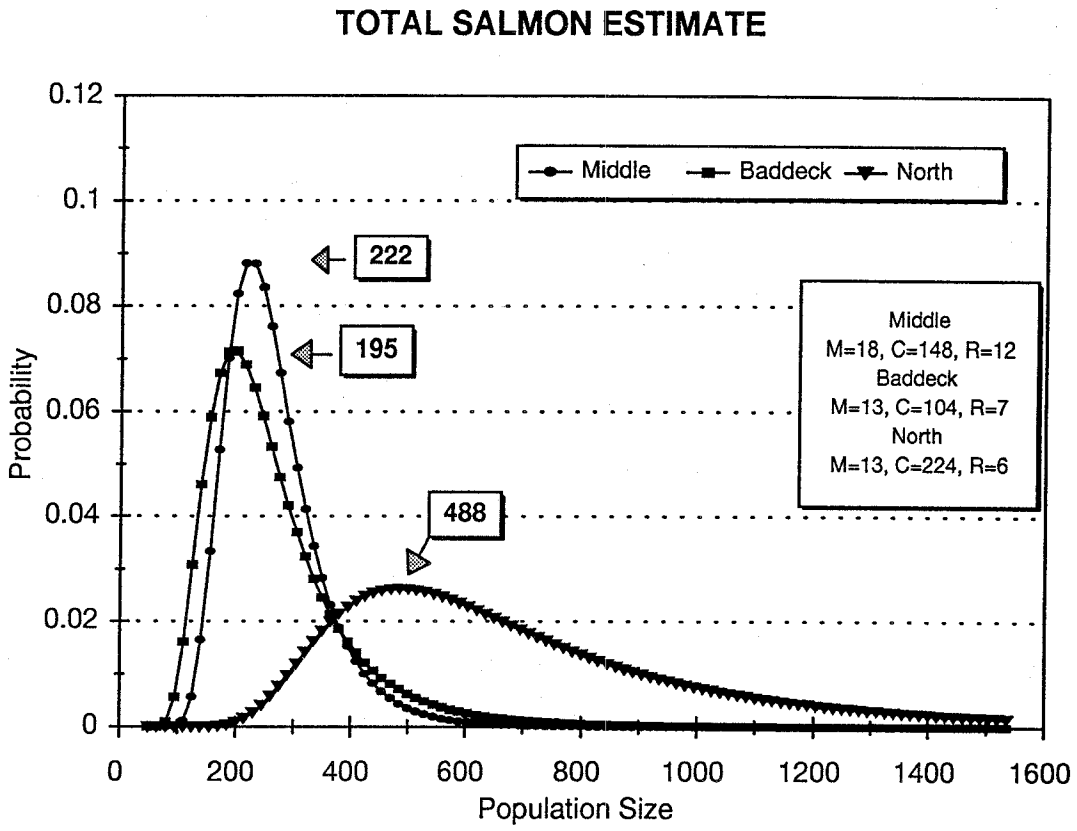

Fig. 6. Estimated abundance of small and large salmon in the Middle, Baddeck and North rivers in October, 1998 based on mark-and-recapture techniques.

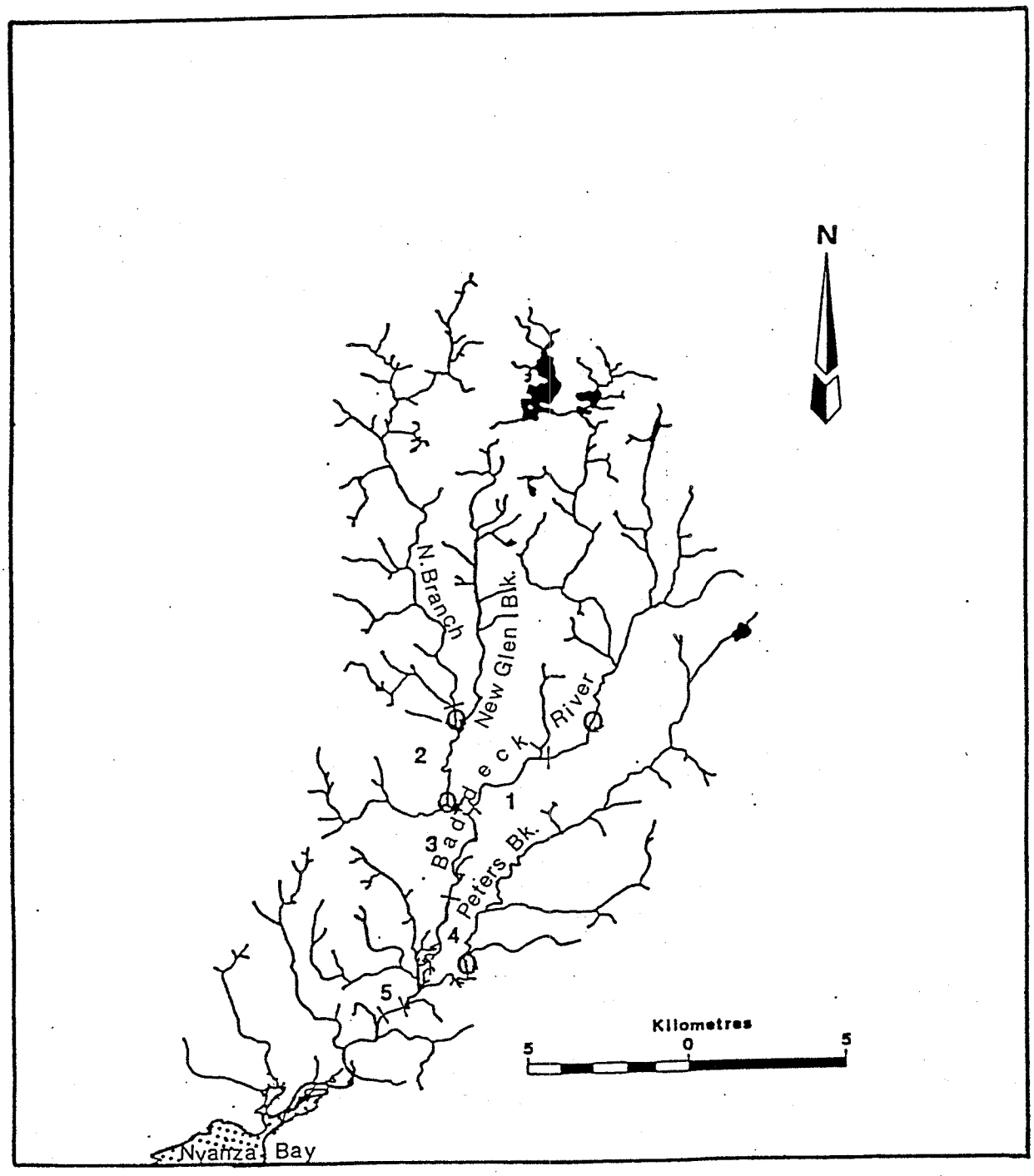

Fig. 7. Baddeck River, Victoria County, showing swim-thru sections and electrofishing sites (O) in 1996, 1997 and 1998.

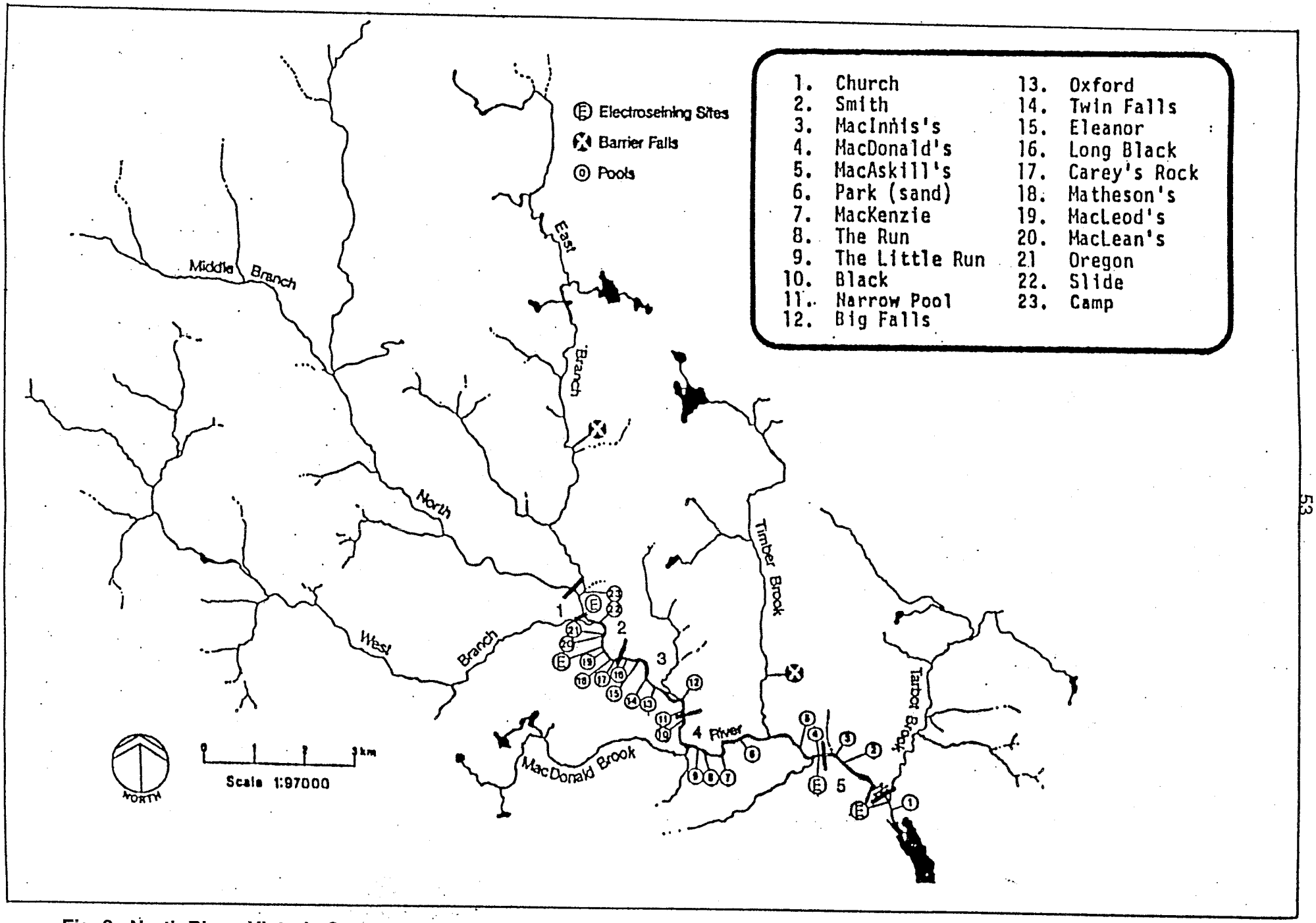

Fig. 8. North River, Victoria County, showing names and locations of angling pools, swim-thru sections (uncircled numbers and slash to mark section boundary) and electrofishing sites in 1997 and 1998.

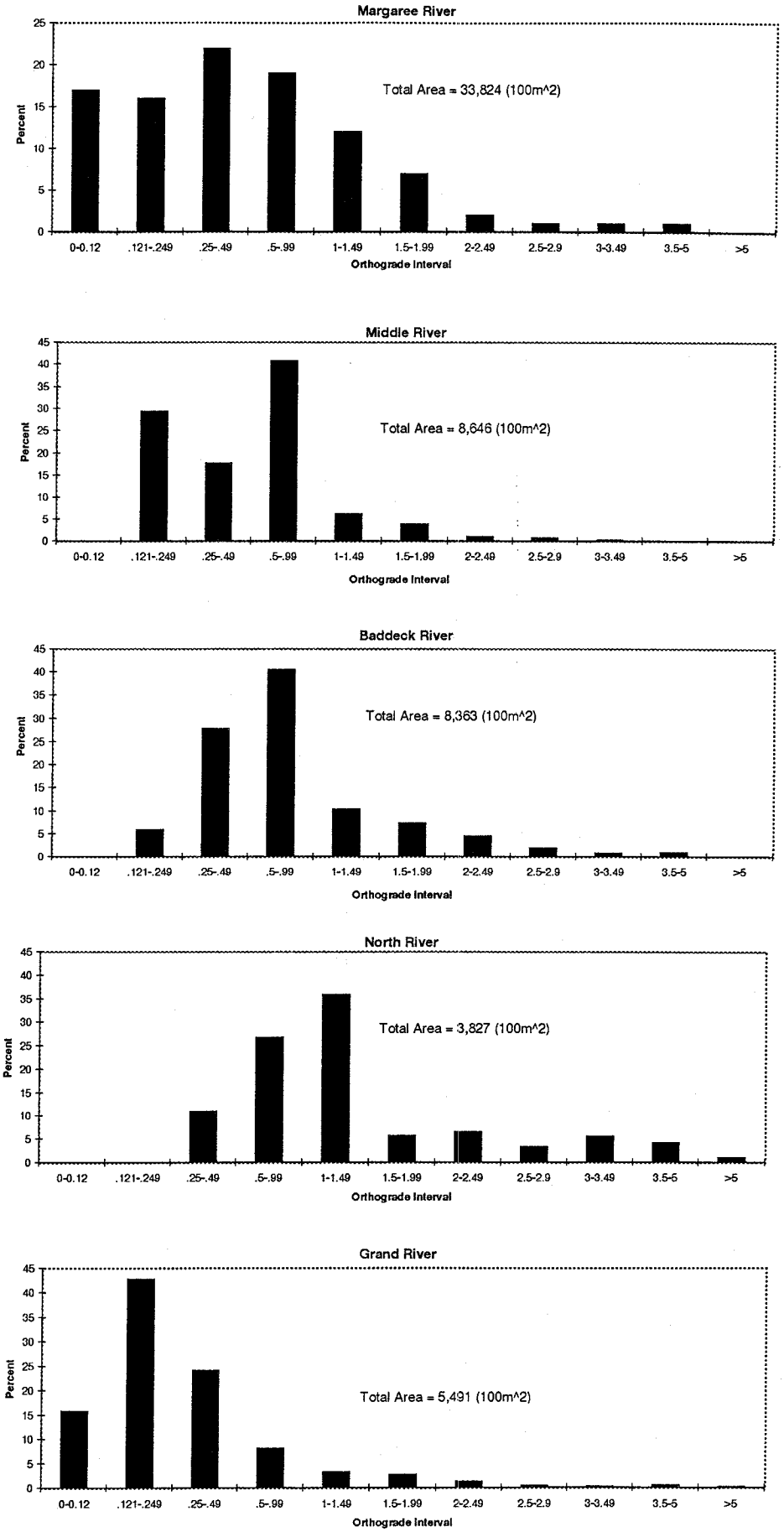

Figure 9. Percent orthograde for five rivers of Cape Breton Island.

Appendix I. Middle River mark-and-recapture data background to Bayes estimates of populations of 1SW and MSW salmon, October 1994-1998. Numbered sections shown in Fig. 8.

Year	Dates M/R	Location	Tags applied (M) MSW	ISW	Total	Tags recovered (R) MSW	1SW	Total
1994	Oct-16	Hgwy 19 (Sec 1/2)	8	-	8	7	-	7
	Oct-17	MacLeod Bk (Sec 3)	1	-	1	1	-	1
		Cold Bk (Sec 4)	8	-	8	5	-	5
		Total			17			13
						Recovery rate =		*0.765*
						Swim-thru count **C**=324; **M**=17; **R**=13		
						Grilse = 0.108 of total.		
1995	Oct-17	Hgwy 19 (Sec 1/2)			3	1		1
	Oct-18	Behind Midway Mtr (Sec 3)			1		1	2
		MacLeod Bk (Sec 3)			4	{		
		Cold Bk (Sec 4)			2	2+1		3
		Cold Bk (Sec 5)			2			
		Total			12			6
						Recovery rate=		*0.500*
		Swim conditions: water low relative to 1996				Swim-thru count **C**=183; **M**=12; **R**=6		
						Grilse = 0.1257 of total.		
1996	Oct-18,19	Hgwy 19 (Sec 1/2)	4	-	4	2	5	2
	Oct-22	MacLeod Bk (Sec 3)	3	4	7	1		1
		Two Churches (Sec 4)	4	1	5	6	1	7
		Total			16	9		10
						Recovery rate=	*0.82*	*0.625*
		Swim conditions: water relatively high; good visibility; Thompson gauge est 1.90 feet				Swim-thru count **C**=359; **M**=16; **R**=10		
						Grilse = 0.209 of total.		
1997	Oct-18,19	Hgwy 19 (Sec 1/2)	2	2+6	10	{4	{3	{7
	Oct-20,22	Cabin (Sec 2)	2	1	3	17		11
		Oland's (Sec 3)	4		4	3	1	4
		Pipe (Sec 5/6)	28	4	32	12	2	14
		Total			49	19		25
						Recovery rate (all) =	*0.528*	*0.510*
						Recovery rate (3 sites)=0.647		
		Swim conditions: water low; ideal visibility; Thompson gauge= 1.22 feet				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=0.163 of total.		
1998	Oct-17,18	Hgwy 19 (Sec 1/2)	6	1	7			
	Oct-19,20	Cabin (Sec 2)		1	1	4	3	7
		Arbuthnots (Sec 2)	3	2	5			
		MacLeods (Sec 3)			0	1	0	1
		Two Churches (Sec 4)	3	2	5	4	0	4
		Total			18			12
						Recovery rate = 0.667		
		Swim conditions: water moderate; good visibility; Thompson gauge=1.40 feet				Swim-thru count **C**=148; **M**=18; **R**=12		
						Grilse (52/148) =0.358 of total		

Appendix II. Baddeck River mark-and-recapture data background to Bayes estimates of populations of 1SW and MSW salmon, October 1994-1998. Section numbers shown Fig. 10.

Year	Dates M/ R	Location	Tags applied (M) MSW	ISW	Total	Tags recovered (R) MSW	1SW	Total
1994	Oct-19	North Br. brdg, Forks (Sec 2,3)	6		6	6		6
	Oct-20	Nicholson (Sec4)	5	1	6	3	-	3
		Total			12			9
						Recovery rate=		*0.750*
			Swim-thru count **C**=110; **M**=12; **R**=9					
			Grilse (17/110) = 0.154 of total.					
1995	Oct-21	North Br brdg, Fks, Golf (Sec 2,3,1)	10	4	14	5	2	7
	Oct-22	Nicholson (Sec 4)	10	4	14	3	2	5
		Total			28			12
						Recovery rate=		*0.429*
		Swim conditions: visibility diminishes with increasing cloud and rain thru afternoon	Swim-thru count **C**=154; **M**=28; **R**=12					
			Grilse (42/154) = 0.273 of total.					
1996	Oct-20	Glenhaven, Golf C (Sec 1)	4	1	5	1	-	1
	Oct-21	North Br brdg (Sec 2)	3		3	5	-	5
		McPhee's (Sec 3)	4		4	2	-	2
		Nicholson (Sec 4)	2	1	3	1	-	1
		Red bdg (Sec 5)	1	1	2	2	-	2
		Total			17	11		11
						Recovery rate=		*0.647*
		Swim conditions: water of good visibility; flows moderate/ high from melt of Oct 16 snow	Swim-thru count **C**=214; **M**=17; **R**=11					
			Grilse (43/214) = 0.2001 of total.					
1997	Oct-19	McPhee's (Sec 2)	5	1	6	2	1	3
	Oct-22	North Br brdg, Riprap Sec (3,4)	9	3	12	11	5	16
		Red brdg (Sec 5)	11	3	14			
		Total			32			19
						Recovery rate =		*0.594*
		Swim conditions: perfect day; low water; Red Bridge gauge = 1.28 ft	Swim-thru count **C**=138; **M**= 32;**R**= 19					
			Grilse (35/138) = 0.254 of total.					
1998	Oct-18	McPhee's (Sec 2)	6	2	8	1	2	3
	Oct-21	Gravel Pit Rip Rap(Sec 4)	3	2	5	3	1	4
		Total			13			7
						Recovery rate =		*0.539*
		Swim conditions: partly cloudy; water moderate; Red Bridge gauge = 1.76 feet	Swim-thru count **C**=104; **M**=13; **R**=7					
			Grilse (30/104) = 0.289 of total					

Appendix III. North River mark-and-recapture data background to Bayes estimates of populations of of 1SW and MSW salmon, October 1994-1998. Pools and Sections shown Fig. 11.

Year	Dates M/ R	Location	Tags applied (M) MSW	ISW	Total	Tags recovered (R) MSW	1SW	Total
1994	Oct-17	MacLeans (Sec 2)	20	2	22	8	0	8
	Oct 18-19	Total		*Recovery rates =*		*0.40*		*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-19	MacLeans (Sec 2)	16	4	20	9	1	10
	Oct-20	MacDonalds (Sec 4)	1	7	8	1	2	3
		Total			28			13
				Recovery rates =		*0.58*		*0.464*
		Swim conditions: discharge and water clarity excellent; gorge not done	Swim-thru counts **C**=181; **M**=28; **R**=13 Grilse (57/181) = 0.315 of total.					
1996	Oct-22	MacDonalds (Sec 4)	3	11	14	3	5	8
	Oct-23	Total			14			8
				Recovery rates =		*1.00*		*0.571*
		Swim conditions: higher than 97 & possibly '95; overcast; 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	MacLeans (Sec 2)	14	3	17	3	1	4
	Oct-23	MacDonalds (Sec 4)	2	-	2	2	0	2
		Church (Sec 5)	5	1	6	2	0	2
		Total			25			8
				Recovery rates =		*0.33*		*0.320*
		Swim conditions: low discharge few clouds & excellent visibility; count incl Oxford & Twin Falls	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	MacLeans (Sec 2)	11	2	13	6	0	6
	Oct-22	Total			13			6
				Recovery rates =		*0.546*		*0.462*
		Swim conditions: water dropping but higher than 1997; partly cloudy; light shower	Swim-thru counts **C**=224; **M**=13; **R**=6 Grilse (59/224) = 0.263 of total					