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Status of Atlantic salmon stocks in selected rivers of Cape Breton Island, 1997

by

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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 21 rivers reportedly fished for salmon in 1997. Juvenile salmon abundance was assessed on the Sydney, Tillard, Skye and Mabou rivers.

Returning salmon were either counted at fishways or estimated by mark-and-recapture techniques. Estimated returns of 4,938 large and 756 small salmon to the Margaree, and 636 large and 122 small salmon to the North contributed to the attainment, in total, of 320% and 330% of respective conservation requirements. Returns of 346 large and 68 small fish to the Middle River, 189 large and 62 small fish to Baddeck River, and a total of 152 fish to the Grand River contributed to the attainment of 72, 44 and 65% of their respective conservation requirements. Evidence of lateness of salmon returning to some rivers raised uncertainty about completeness of estimates to the Middle, Baddeck and perhaps, North rivers.

Prognoses for 1998, based on forecast models, juvenile salmon densities, recent estimates of an index of overwinter habitat in the North Atlantic and numbers of hatchery smolts stocked in 1997 are uncertain. However, large salmon of the Margaree and North rivers have achieved conservation requirements for over a decade and should continue to do so in 1998, the abundance of small salmon relative to conservation is less certain. Returns to the Grand River should approach conservation requirements, those of the Middle, and Baddeck rivers are unlikely to achieve conservation requirements in 1998.

RÉSUMÉ

Des évaluations de l'état des stocks de saumon 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 font l'objet d'au moins 90 % de l'effort total de la pêche récréative exercé dans les 21 rivières de l'île où une pêche récréative du saumon a été pratiquée en 1997. L'abondance des saumons juvéniles a été évaluée dans les rivières Sydney, Tillard, Skye et Mabou.

Les saumons en remontée étaient dénombrés aux passes à poisson ou estimés par marquage-recapture. Les remontées estimées de 4 938 grands saumons et 756 petits saumons dans la Margaree et de 636 grands et 122 petits saumons dans la North ont permis d'atteindre, respectivement, 320 % et 330 % des besoins de conservation. Des remontées de 346 grands et 68 petits saumons dans la rivière Middle, de 189 grands et 62 petits saumons dans la Baddeck et de 152 saumons dans la Grand ont permis d'atteindre les objectifs de conservation respectifs de ces rivières à raison de, respectivement, 72 %, 44 % et 65 %. Le fait que la remontée ait été tardive dans certaines rivières porte à douter du caractère complet des estimations dans les rivières Middle, Baddeck et, peut-être, North.

Les prévisions pour 1998, fondées sur les résultats des modèles de prévision, les densités de saumons juvéniles, des estimations récentes d'un indice de l'habitat d'hiver dans l'Atlantique nord et le nombre de saumoneaux d'élevage libérés en 1997, demeurent peu fiables. Les remontées de grands saumons des rivières Margaree et North ont permis d'atteindre les besoins de la conservation pendant plus d'une décennie et ces besoins devraient être atteints en 1998, mais cela est moins certain pour les petits saumons. Les remontées de la rivière Grand devraient s'approcher des besoins de conservation, mais cela est peu probable pour les rivières Middle et Baddeck.

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

Year	1992	1993	1994	1995	1996	1997	MIN[1]	MAX[1]	MEAN[1]
Angling catch[2]									
Large	1,938	1,102	1,479	1,060	1,864	2,222	1,060	1,938	1,489
Small	678	777	429	333	918	330	333	918	627
First Peoples' harvest									
Large	-	58	50	4	89	124	-	-	-
Small	-	8	14	2	7	20	-	-	-
Total estimated returns									
Large	6,375	3,358	2,900	2,365	2,792	4,938	2,365	6,375	3,558
small	1,645	2,087	708	737	1,685	756	708	2,087	1,372
Spawning escapement									
Large	6,222	3,224	2,759	2,308	2,579	4,676	2,308	6,222	3,418
Small	1,088	1,504	390	529	1,343	508	390	1,504	971
% of large required	601	311	266	223	249	451	223	601	330
Juveniles 100m^{-2}									
No. of sites	3	3	3	3	3	3	3	3	3
Fry	154	122	117	186	114	143	117	186	139
Parr	50	79	69	77	81	70	50	81	71

[1] Min, Max and Mean are for 1992-1996.
[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 103 fish taken by First Peoples, and an estimated 207 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 1997. Densities of juvenile salmon were estimated at three tributary and one mainstem sites.

State of the Stock: Estimated large salmon returns of 4,938 fish exceeded those of 1996 by 77%; small salmon (756) were down 55% from returns in 1996 but similar to 1994-1995 levels. Large salmon and their egg depositions were 451% of the conservation requirement. Escapement of small salmon was only 87% of requirement, the spawning requirement for small salmon has not been met in 6 of the last 13 years. Juvenile densities of 143 age-0^{+} parr and 70 age-1^{+} and -2^{+} parr 100 m^{-2} (3 ongoing tributary sites) are consistent with recent high levels of egg deposition.

Forecast for 1998: Forecasts of returns for 1998 range from 3,265 to 4,643 large salmon, i.e., 3.2 to 4.5 times the conservation requirements. Recent changes in the marine environment that may have affected small and large salmon returns in 1997 and may affect returns again in 1998; however, high parr densities in 1994-1995 and historic spawning escapements indicate conservation requirements for large salmon should be exceeded in 1998. Returns of small salmon will be without a hatchery component (about 25% of the summer fish). Mean returns of hatchery and wild small salmon over the previous five years averaged 971 fish; removals have averaged less than 500 fish. The forecast of small salmon in 1998 is uncertain.

Management considerations: Returns of large salmon should exceed conservation requirements, small salmon may not achieve conservation requirements if marine survival continues to be low. Reduced marine survival in most of Atlantic Canada's salmon stocks has been confirmed and does not support an increase in exploitation.

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

Year	1992	1993	1994	1995	1996	1997	MIN[1]	MAX[1]	MEAN[1]
First Peoples' harvest (small + large)									
In-river	38	0	15	0	0	0	0	38	11
Estuarial[2]	38	20	59	8	20	18	0	38	17
Angling catch									
Small (retained)	11(8)	30(25)	24	37	60(2)	16(3)	11	61	32
Large	30	48	166	51	142	85	30	166	87
Swim-thru counts									
Small	56	2	35	23	75	42	2	75	38
Large	212	32	324	160	284	216	32	324	202
Total est. returns									
Small + Large	532	144	529	379	599	414	144	599	437
Proportion of holding area covered in swim-thru counts	0.96	0.55	0.83	0.83	0.83	1.0	0.55	0.96	0.80
Estimated escapement									
Large	355	93	415	324	458	331	93	458	329
Total	449	99	460	371	579	396	99	579	392
% of Large required	76	20	88	69	97	70	20	97	70
Juveniles 100m^{-2}									
No. sites				2	2	2			
Fry				26.3	30.8	36.1			
Parr				107.6	45.1	45.7			

[1] Min, Max and Mean are for 1992-1996.
[2] Wagmatcook FN harvest revisions and of Middle River origin. See also Baddeck R.
[3] Swim-through counts divided by proportion area covered, 1990-1993; mark-and-recapture modal values (no tag loss) 1994-1997, taken as 100% of area.
[4] Values, 1992-1993, raised by mean swim-thru count efficiency of 0.622, 1994-1996 (Marshall et al. MS 1997).

Harvests: Harvests of Middle River salmon were restricted to an assumed 18 salmon taken by Wagmatcook First Nation. The recreational fishery was legally confined to hook-and-release.

Data and Methodology: Counts of tagged and untagged adult salmon were conducted on Oct 20 and 22, 1997, by teams of divers floating virtually all of the river's salmon holding areas. (Tags had been applied to 17 useable fish on Oct 19 and 20.) 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 on 2 tributary and 2 mainstem sites.

State of the Stock: Returns were estimated at 414 fish. The escapement was an estimated 331 large salmon, 70% of requirement. Age-1+ and -2+ parr densities at 2 mainstem sites averaged 46 fish 100m^{-2}; age-0+ densities averaged 36 fish 100m^{-2}. Both values exceed an Elson "normal" abundance index and are similar to densities on the Middle in various years since 1957.

Forecast for 1998: Data are inadequate for predictive models with which to forecast returns in 1998. Adult returns have not met conservation requirements 1992-1997; the decline in returns in 1997 provide little optimism that conservation requirements will be met.

Management considerations: Returns are uncertain and should not be expected to be above the recent average returns; i.e., less than conservation requirements. However, juvenile densities are "normal" and should carry the stocks through short-term depression in adult recruitment. It would be imprudent to liberalize existing fishery management plans.

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

Year	1992	1993	1994	1995	1996	1997	MIN[1]	MAX[1]	MEAN[1]
First Peoples' harvest (small + large)									
In-river	0	0	0	0	0	0	0	0	0
Estuarial[2]	37	20	59	7	0	18	0	37	13
Angling catch									
Small (retained)	57(50)	48(33)	16(1)	61(7)	46	16	16	61	46
Large	165	108	62	71	165	64	71	165	114
Swim-thru counts									
Small	-	-	17	34	43	35	17	43	31
Large	-	-	93	110	170	103	93	170	124
Aquaculture				10	1(H)	0			
Total estimated returns[3]									
Small + Large	-	-	226	368	329	251	226	368	308
Estimated escapement									
Large			140	269	263	174	140	269	224
Total	-	-	166	361	329	233	166	361	285
% of Large required	-	-	31	60	58	39	31	60	50
Juveniles 100m^{-2}									
No. of sites					3	3			
Fry					63.3	113.4			
Parr					36.0	38.7			

[1] Min, Max and Mean are for years through 1996.
[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 in 1997 remained hook-and-release only.

Data and Methodology: Counts of tagged and untagged adult salmon were conducted on Oct 22, 1997. Tags were applied to 25 large and 7 small salmon at three locations on Oct 19. Petersen mark-and-recapture principles and a Bayesian estimation procedure were used to estimate the probable populations; the count data was used to apportion the estimate into small and large components. Juvenile salmon densities were estimated at 3 mainstem sites.

State of the Stock: Returns were estimated at 251 fish. Catches of Baddeck River origin fish by Wagmatcook First Nation in Nyanza Bay of 15 large and 3 small fish were assumed; escapement was an estimated 174 large and 59 small salmon. Large salmon were down 34% from those of 1996, small salmon numbered about the same as in 1996. Angling catch (no retention) averaged 38% of 1996 catches. Age-1$^+$ and -2$^+$ parr densities at 3 main river sites averaged 39 fish 100m^{-2}, age-0$^+$ densities averaged 113 fish 100m^{-2}. Age-1$^+$ and -2$^+$ densities approximate a 'normal' abundance index, age-0$^+$ densities exceed those of the mainstem Middle and some Margaree river sites. Densities of both 1996 and 1997 exceeded those of 1977-1978.

Forecast for 1998: The mean adult return 1994-1997 is 279 (range 251-368) fish, 53% of conservation requirements; however, juvenile densities in 1996 and 1997 have exceeded or approximated a normal abundance. A 24% reduction in Baddeck River returns in 1997 from those of 1996 and declines in returns to most Atlantic coast rivers indicate a uncertain future dependent on unidentified events at sea. Returns are unlikely to exceed those of 1997 and will be less than conservation requirements.

Management considerations: Conservation requirements have not been achieved on the Baddeck River in recent years and are unlikely to be met in 1998.

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

Year	1992	1993	1994	1995	1996	1997	MIN[1]	MAX[1]	MEAN[1]
First Peoples' harvest (small + large)									
In-river	0	0	0	0	0	0			
Angling catch									
Smal(retained)	224(184)	82(62)	74	168(1)	174	69(1)	74	224	144
Large	550	161	97	209	124	139	97	550	228
Swim-through counts									
Small			68	47	138	54	47	138	84
Large			167	120	184	281	120	235	180
Aquaculture				14					
Total estimated returns[2]									
Small + Large	1,548	486	590	388	566	758	388	1,548	716
Est. spawning escapement									
Small	264	102	171	120	243	122	102	264	180
Large	1,100	322	419	268	323	636	268	1,100	486
% of Large required	550	161	210	134	162	318	134	550	243
Juveniles 100m^{-2}									
No. sites					2	3			
Fry					21.6	37.1			
Parr					22.1	32.3			

[1] Min, Max and Mean are the five (or fewer) years through 1996.
[2] 1994-1997, modal values of Baysed 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: An allocation of 50 small and 50 large salmon was made to First Nations; the recreational fishery remained hook-and-release only.

Data and Methodology: Counts of tagged and untagged adult salmon were conducted on Oct 23, 1997. Tags were applied to 21 large and 4 small salmon at three locations on Oct 21. Mark-and-recapture principles and a Bayesian estimation procedure were used to describe an estimate of the most probable population; the count data was used to apportion the estimate into small and large components. Juvenile salmon densities were estimated at 4 mainstem sites, two each above and below the gorge (one proved to be tidal).

State of the Stock: Returns were estimated at 758 fish. No removals were known, thus escapement was an estimated 636 large and 122 small salmon. Large salmon were up 97% from those of 1996 and the highest since 1992. Large salmon requirements are estimated to have been exceeded in each of the last 14 years. Small salmon estimated returns 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 3 mainstem sites averaged 32 fish 100 m^{-2}; age-0^{+} densities averaged 37 fish 100 m^{-2}. Both values approximate an Elson "normal" abundance.

Forecast for 1998: Returns to the North River, 1993-1997 have averaged about 400 large fish or twice and conservation requirement. Reductions in marine survival of 2SW returns destined for the North River in 1998 are unlikely to impact on the attainment of conservation requirements. Returns of small salmon have averaged in excess of 100 fish and suggest the conservation requirements of 30 fish are highly achievable.

Management considerations: Conservation requirements have been achieved on the North river for over a decade and should continue to do so in 1998.

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

Year	1992	1993	1994	1995	1996	1997	MIN[1]	MAX[1]	MEAN[1]
First Peoples' harvest									
In-river	0	0	0	-	0	0	-	-	-
Estuarial	0	0	0	-	0	0	-	-	-
Angling catch for total river									
Small(retained)	160(148)	139(118)	72	5[2]	90	32(3)	5	160	93
Large	44	25	20	12	25	6	12	44	25
% Caught and retained above the fishway	31	31	0	-	0	0	-	–	-
Broodstock[3]	10	0	7	0	0	0	-	-	-
Count at fishway									
Small	114	91	64	157	200	28[4]	64	200	125
Large	18	5	5	8	5	5	5	18	8
% Hatchery	38	45	14	32	61	30	14	61	38
Fish which by-pass the fishway									
Small	40	32	130	105	132	-	32	132	88
Large	14	4	9	11	7	-	4	14	9
Population estimate above the fishway									
Small + Large	186	132	208	281	345	152[5]	132	345	230
Estimated escapement above the fishway									
Small + Large	133	97	201	281	345	152	97	345	211
% of fish required above fishway	57	41	86	120	147	65	41	147	90
Juveniles 100m^{-2}									
No. Sites				4	4	4			
Fry				7.5	14.2	30.3			
Parr				7.7	2.9	6.4			

[1] Min, Max and Mean are for 1992-1996. [2] Closed to all fishing.
[3] Only broodstock collected at or above fishway. [4] Incomplete
[5] Estimate [[(33+40)/0.8]/0.6] revised upwards from 125 value in DFO Sci. Stock Status Rep. D3-09 (1998).

Harvests: River open only to hook-and-release fishing.

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 very low in 1997 and trap counts were less complete than usual. Total returns were estimated as Potential count/[1- by-pass rate (0.4)] where the Potential count was augmented by 40 fish (estimated below the fishway when the trap was removed on Sep 3) raised by 0.2 (missing fall component). Juvenile salmon densities were estimated at four sites, two sites each above and below the Falls.

State of the stock: Conservation requirements were unlikely to have been met in 1997; returns were the third lowest of 10 years of data. Hatchery fish comprised 30% of returns. Juvenile densities were double those of 1996 but low in comparison to most other Cape Breton rivers. A doubling of age-0^{+} densities between 1995-1996 and 1996-1997 is consistent with increased escapements 1994-1996.

Forecast for 1998: There is no precedent for forecasting returns to Grand River. Estimated returns above the fishway 1994-1997 have averaged 246 fish, i.e., 105% of conservation requirement. On average 34% of returns have been of hatchery origin. Recent low marine survival of most Atlantic coast Nova Scotia stocks, average returns, 1994-1997, and expected contribution by hatchery smolts released in 1997 suggest that returns in 1998 may, at best, approach conservation requirements. Current low densities of juveniles are building but are likely below habitat capacity.

Management considerations: The wild salmon component is below requirement and 1998 is the last scheduled year for significant returns from hatchery supplementation. Increasing (but still low) juvenile densities associated with improved escapements in 1994-1996 suggest the benefits of maximizing egg depositions during times of relatively low adult returns.

INTRODUCTION

This document is background to the management of Atlantic salmon (*Salmo salar*) stocks of Cape Breton Island, Nova Scotia (Fig. 1). The main elements of this document are the assessment of the numbers of salmon that returned in 1997 to the Margaree, Middle, Baddeck, North and Grand rivers, their numbers of spawners relative to conservation requirements and, where possible, a prognosis of returns in 1998. 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 rivers assessments were the same as in 1996; the Margaree was assessed differently using estimated angler catch from Nova Scotia Salmon Licence stubs in 1997 and the relationship between estimates of angler catch 1992-1996 and total population estimates, 1992-1996. Fewer data were available for assessment of returns and escapement to the Grand River than in 1996. In 1997, assessments of juvenile salmon were conducted on the Margaree, Middle, Baddeck, North, Sydney, Grand, Tillard, Skye and Mabou rivers. Re-evaluation of conservation requirements on the Middle River remains to be completed.

In 1996, conservation requirements for the Margaree, Middle, North and Grand rivers were met or exceeded. Requirements were not met on the Baddeck River. The prognoses for 1997, were optimistic i.e., that returns would at least be similar if not increased from those of 1996. Meetings with fishery managers and First Peoples resulted in: i) allocations of salmon from the Margaree River, North River and Bras d'Or to First Peoples; ii) a retention recreational fishery for small salmon or grilse (<63cm) captured Jun 1-Oct 31 on the Margaree (Sep 1-Oct 31 on the Mull and Judique rivers); and iii) hook-and-release only recreational fishery for salmon on all remaining rivers of the Island including rivers of Cape Breton Highlands National Park (CBHNP) which are regulated by Parks Canada. Food fisheries by First Peoples in bays and channels of Bras d'Or were directed at aquaculture and sea-ranched 1SW salmon.

Description of the Fisheries

Aboriginal Fisheries

The fishing of salmon with trapnets and in some instances gill nets, was licensed in the Margaree River estuary and Bras d'Or Lake, channels and bays, specifically, in the vicinity of Christmas Brook, Eskasoni, St. Peter's Inlet, Whycocomagh Bay and Nyanza Bay (Table 1). Harvests at Eskasoni were targeted on returns from sea ranching experiments, those at Whycocomagh targeted on aquaculture escapees. Angling, snaring, spearing and seining 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 1,130 small and 700 large and 100 black 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 allocated to 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 1997. 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 0 fish 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 CBHNP. 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, only 139 "salmon" have been accorded as harvested by First Peoples. Most interest has been shown by Wagmatcook and Membertou First Nations fishing the Nyanza Bay and Margaree and possibly Sydney rivers. No salmon have been reported from Bras d'Or fisheries.

Poaching

Estimated losses to poaching in Cape Breton 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 Intervale rivers have been suggested to be about 100 salmon.

Recreational Catches

In 1997, anglers spent an estimated 10,150 rod days on 21 of the Islands' rivers (Table 2). Estimated catches (including releases) were 504 small and 2,609 large salmon. Only 214 small salmon were reported being retained. Compared to 1996, the estimated effort was down 14%; estimated catches of small salmon were down 70% and estimated catches of large salmon were about the same as in 1996 (Table 3). Compared to the 1992-96 mean values, effort was down 41%, small catch was down 56% and the large salmon catch was up 16%. 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, is now the lowest of record for Cape Breton 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 reporting 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 principle 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 (Figs. 2 and 3) and, in all probability, water temperatures that do not exceed the low 20's C (Fig. 4).

Annual assessments of the 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 and MS 1997). 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 1997 suggested that returns of large salmon could number 1,650 to 4,150 large fish, i.e., egg depositions were certain to surpass the 1,036 large fish requirement for conservation.

Returns

Estimation procedures

Unlike previous years, 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 1997, returns were estimated from historical estimates of returns based on adult investigations at Levi's trap and preliminary recreational catch data from NS Salmon Licence stubs (with additional insight from logbooks completed by volunteer anglers).

Returns of small salmon in 1997 were estimated from the equation Rtns = 40.123 + 2.169 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 1997 were estimated from the equation: Rtns = Angl Ctch 1997/ $\text{Ctch Rate}_{\text{Modal Value 1991-96}}$ 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 = 40.123 + 2.169 Angl Ctch for a NS Licence Stub estimate of 330 small salmon retained (207) and released (123) provides an estimated preliminary return of **756** (0 - 1,670) small salmon. This value is down 55% from the 1,685 value for 1996 and approximates the three lowest returns of small salmon ascribed to the Margaree in the last decade (Table 5; Fig. 5). The low estimate is consistent with catch per effort (CPUE) data from 95 volunteer anglers who submitted logbooks of their fishing activity on the Margaree in 1997 and those who submitted data, 1991-1996 (Table 6).

The preliminary estimate of large salmon returns is **4,938** (3,461-5,756) where "Ctch Rate" is 0.45 (0.642-0.386) and the estimate of large salmon catch (NS Licence Stub) is 2,222 fish. The 1997 value is up 77% from the estimate of 2,792 large fish in 1996 and the third highest value of the last decade (Table 5; Fig. 5). The high estimate of large salmon catch is also consistent with the relatively high CPUE value derived from logbooks (Table 6).

River discharge was generally low, and cool through the summer (Figs. 2, 3, 4) and fall months, i.e., conducive to good angling and possibly the higher catch rate (and by extrapolation, catches and population estimate) relative to the model years, 1991-1996. However on the basis of the ratio of small and large salmon CPUE data for volunteer anglers (0.027: 0.281) i.e. (1:10), and a reasonable

estimate of small returns (756) it can equally be argued that the relative abundance of large fish (4,938) could have been even greater.

Conservation Requirements

The conservation requirement for the entire Margaree River system is based on an egg deposition of 2.4 eggs/m^2, historical biological characteristics, and a rearing area of 27,976 units of habitat, 100m^2. The product of egg deposition rate and rearing units equated to an 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 small salmon to provide a 1:1 male:female ratio among large salmon. Eggs per female were based on a value of 1,764 eggs kg^{-1} 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 of the requirement for 2.4 eggs m^{-2}.

Known/estimated losses to spawning on the Margaree in 1997 total 262 large and 248 small salmon. Losses included harvests by First Peoples and recreational fishers and a broodstock collection by the Aquatic Development Association for the Margaree (ADAM). Losses to hook-and-release mortality were assumed to be 0.05 of 2,222 large and 123 small salmon, i.e., 111 large and 6 small fish.

Escapement of large salmon was 451% of the 1,036 fish conservation requirement; small salmon escapement was only 87% of the 582 fish requirement (Table 5). Escapements of large salmon, 1985 to 1994, have ranged from 133% to 601% of requirement with the 1997 value being the third highest of the period. Escapements of small salmon over the same period have ranged from 56% to 258% (Table 5) with the 1997 value being the fifth lowest of the period. Large salmon escapements have been met in each of the last 13 years; small salmon spawning escapements have been met in seven of the last 13 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 three 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 112-187 fish 100m^{-2} were up, on average, from those of 1996 but less than those of 1995 (Table 7). Parr densities (age-1^+ and -2^+) of 43-87 fish 100m^{-2} were, on average, similar to those of 1996. Recent abundances of fry and parr are two to three times the densities in the mid-1970s (Chaput and Claytor MS 1989 and Fig. 6). Densities (wild fish only) of 187 fry 100m^{-2} and 64 parr 100m^{-2} at the 'Old Bridge' site are comparable to values in 1995-1996 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 MS 1989). 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 100m^{-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 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 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 solver function (Claytor et al MS 1995).

Forecasts of returns in 1998 from an estimated 3,224 MSW spawners range from 3,265 (Mean) to 4,643 (Ricker) large salmon (Tables 9 and 10) i.e., returns should exceed the 1,036 large salmon conservation requirement by perhaps threefold. 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. Dramatic declines in many 1SW stocks in 1997 are believed to be a portent of low returns of 2SW fish in 1998.

Returns of 4,938 MSW fish in 1997 exceeded forecasts which ranged from 1,656 (Ricker) to 4,160 (Tabular). Spawners which contributed to returns in 1997 had numbered 6,222 fish but forecasts were restrained by a paucity of data at the upper end of the distribution. Returns in 1997 suggest that the right-hand tail of a Beverton-Holt model is more appropriate than that of a Ricker model. In contrast to the low MSW (and 1SW) returns to many Maritime rivers, high MSW returns to the Margaree remained consistent with increasing indices of thermal habitat (Fig. 7), a variable that has been used to forecast the abundance of North American salmon in the Northwest Atlantic prior to fisheries.

Returns of small salmon have been variable in the last 5 years. High juvenile densities contributed to the 1996 smolt class and do not explain the low returns of 1SW fish in 1997. Freshwater production remains largely unchanged and thus events at sea will determine returns in 1998. 1SW returns in 1998 will again be unassisted by hatchery products (Table 11). Returns over the last 5 years, 1993-1997, have ranged from 708 to 2,087 fish, the mean number is 1,195 fish.

Current densities of juvenile salmon and those densities associated with the exceeding of conservation requirements by large salmon (since 1985) suggest that conservation requirements for large salmon will continue to be met /exceeded through the end of the decade inspite of the reduced marine survival that is impacting many salmon stocks and which may or may not be affecting MSW returns to the Margaree.

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 tabled in Marshall et al. MS 1996. 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 and MS 1997; Amiro and Longard MS 1995). Spawning escapement in 1996 was estimated to have been 97% of large salmon conservation requirement. The prognoses for 1997 was that returns were to be met or perhaps slightly exceeded. 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 1997) and in 1997.

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. 8). 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 1997.

Estimation of Returns

A mark-and-recapture experiment provided data for estimation of the population on Oct 19 and 20, 1997 (App. 1). Marks, orange streamer tags, were applied to salmon captured by drift-netting (mono and multi-filament 3.5 in. stretched mesh) or seining in the three upper sections of the river (Fig. 8; tags applied in a lower section were discounted because of unusually low recovery rates, App. I). The numbers of marked and unmarked fish, by small and large size category, were tallied by three teams of divers floating the "floatable" portion of the mainstem and the main up-river holding pools at and below the Gold brooks. The total number of small and large fish in the river was estimated using mark-and-recapture techniques and Bayesian estimator; no tags were considered to have been lost. The count data was used to apportion the estimate into small and large components.

Estimates of Returns

Despite good weather, low flows and good visibility, 1.5 days of seining yielded only 9 small and 8 large salmon for use as 'marks'. The swim-thru, on Oct 20, (top pools on Oct 22) under bright sky and good water of modest flow produced a total count of 258 fish (42 small and 216 large) of which 4 small and 7 large fish were tagged. Input to the analyses consisted of **M**=17; **C**=258 and **R**=11 (App. I).

The most probable estimate of total salmon in the Middle River, Oct 20/22, was **396** fish (Fig. 9; 90% CL 276-791). Proportioning of the estimate on the basis of the small and large salmon count suggests a population comprised of 331 large and 65 small salmon (no adjustment upwards for hook-and-release mortality prior to the census). There were no fish of aquaculture origins noticed during the swim-thru. Guesstimated removals by Wagmatcook First Nation, of 15 large and three small salmon in the approaches to Middle River suggest a total return of **346 large** and **68 small** salmon.

A total return of 414 fish is 69% of 1996 returns and the third lowest since 1989 (Fig. 5). Estimated catches (Table 4: no retention) by anglers fishing to the Oct 25 closing date (the season was varied to close in advance of the regulated date) were 85 large and 19 small fish i.e., respective catch rates of 0.25 and 0.29. Catches of both small and large salmon were down considerably from those of 1996 and the previous 5-year mean (Table 4).

Conservation Requirements

Conservation requirements for the Middle River are based on a substrate area of 8,646 $100m^2$ and 2.4 eggs 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

Assuming that the modal estimate of in-river population is the escapement, **333** large salmon represents **70%** of requirement. An escapement of **65** small salmon was **81%** of conservation requirements. There was only a 27% chance that the 550 total fish conservation requirement was met. As in 1995, fall discharges were low and a potential deterrent to river entry. However the observation by anglers of significant numbers of "new" fish in the lower reaches in the week or so prior to census suggested that most fish had moved into the river. Water temperatures were cold and scouring of redds was prominent in several locations.

Abundance of Juvenile Salmon

Electrofishing of juvenile salmon was conducted at four sites in 1997. 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^+ (36.1 $100m^{-2}$) and age-1^+ and -2^+ parr (45.7 $100m^{-2}$) that were comparable to values in 1996 (Table 12). All values approached or exceeded the Elson (1967) "normal" index of abundance.

Forecast

The mean total return, 1993-1997, is 401 (range; 144-599) fish, 73% of conservation requirements. "Normal" and above-normal juvenile densities in the last few years and the improvement in marine thermal habitat indices (Fig. 7) suggested, prior to 1997, long-term potential

for improvement. The 30% reduction in Middle River returns in 1997 from those of 1996, the notable decline in 1997 and long-term trend in declines in both 1SW and MSW returns to most rivers of Atlantic coast Nova Scotia and Bay of Fundy (Anon MS 1998; North River this document excepted) and 1SW stocks on the Margaree indicate a less certain future dependent on as yet unidentified events reducing survival at sea. Under this uncertainty the preferred assumption is that returns to the Middle River in 1998 are unlikely to exceed those returns of 1997 (414 fish or 75% of conservation requirement) i.e., they will be less than conservation requirements.

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 (Marshall et al. MS 1996). 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% and 58% of the conservation requirements had been met in 1994, 1995 and 1996, respectively. The prognoses for 1997 was that returns might be similar to those levels of 1995-1996.

Densities of juvenile salmon were examined in 1977 and 1978, and, with less precision in 1994. Estimates of age-0^+, -1^+, -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 (Marshall et al. MS 1997) and again in 1997.

Estimation of Returns

A mark-and-recapture experiment provided data for estimation of the population on Oct 22, 1997. Marks, orange streamer 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 19 (Fig. 10). Marked and unmarked fish, small and large were enumerated by three teams of divers floating the same sections as in 1996 (Marshall et al. MS 1997). 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 three locations on Oct 19 and well distributed through the drainage. Thirty-two tags, the most in four years of tagging, were applied to 25 large salmon and seven small salmon for use in the population estimate (App. II). The swim-thru, on Oct 22, under low water conditions and excellent visibility provided a total count of 138 fish (35 small and 103 large) of which 13 large and 6 small were tagged. As in 1996, no sighted fish had external characteristics

suggestive of aquaculture origins. Data submitted to mark-and-recapture analysis were: **M=32**; **C=138** and **R=19**.

The most probable number of total salmon in the Baddeck River, Oct 22, was **233** fish (Fig. 9; 90% CL 176-367). The addition of 15 large and three small fish accorded to Baddeck River origins from guesstimated catches by Wagmatcook First Nation in Nyanza Bay suggests a return of **189** large and **62** small salmon (total of 251) exclusive of possible losses to hook-and-release mortality in the recreational fishery. Large salmon were down 28% from 1996, small salmon numbered the same as in 1996. The estimated catch (no retention) by anglers through Oct 24 (closure in advance of the regulated date), (Tables 2, 3 and 4) was 16 small and 64 large salmon, 35% and 39% of the small and large salmon catch in 1996.

Conservation Requirements

Conservation requirements for the Baddeck River are based on a substrate area of 8,363 100 m^2 and 2.4 eggs 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

An escapement of **233** salmon is **44%** of the 530 fish conservation requirement. There was less than a 1% chance that requirements was met. Large salmon were 39% of requirement, down 33% from that of 1996. Fall river discharges had been lower than those of 1996 but were not considered limiting to river entry of salmon that might earlier have 'staged' in Nyanza Bay.

Abundance of Juvenile Salmon

Electrofishing at 3 main river sites in 1997 (more comparable to tributary sites on the Middle and Margaree rivers) yielded average age-0^+ and age-1^+,-2^+ densities of 113 and 39 fish $100m^{-2}$ respectively (Table 12). Age-1^+ and -2^+ densities approximate a "normal" abundance index; age-0^+ densities exceed those of the mainstem Middle River and some Margaree sites. Densities of both 1996 and 1997 exceeded those of 1977-1978.

Forecast

The mean adult return 1994-1997, is 279 (range; 251-368) fish, 53% of conservation requirements. "Normal" and above-normal juvenile densities in 1996 and 1997 and the improvement in marine thermal habitat indices (Fig. 7) suggested, prior to 1997, long-term potential for improvement. A 24% reduction in Baddeck River returns in 1997 from those of 1996, the notable decline in 1997 and long-term trend in declines in both 1SW and MSW returns to most rivers of Atlantic coast Nova Scotia and Bay of Fundy (Anon MS 1998; North River this document excepted) and 1SW stocks on the Margaree indicate a less certain future dependent on as yet unidentified events reducing survival at sea. Under this uncertainty the least risk is taken by assuming that returns to the Baddeck River in 1998 are unlikely to exceed those returns of 1997 (250 fish or 47% of requirement), i.e., returns will be less than conservation requirements.

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, and Margaree rivers (Fig. 1) and on the east, 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 most potential for production of juvenile salmon, per unit area, of the three rivers herein evaluated by orthogradient measure (Marshall et al. MS 1996). The stock is known as early-run and principally composed of large (2SW) salmon; a late-run component has been suggested but 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 suggested escapements of 255%, 169% and 246% of the 230 fish conservation requirements (Marshall et al. MS 1997). Based on 1996 stock status, hatchery stocking and a stock-recruit relationship, similar or greater returns were forecast for 1997. 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 1997.

Estimation of Returns

A mark-and-recapture experiment was conducted on Oct 23. Streamer tags were applied to fish captured at three locations on Oct 21 (App. III; Fig. 11). Twenty-five tags, the best distributed in four years of tagging, were applied to 21 large salmon and four small salmon for use in the population estimate. The swim-thru, on Oct 23, under relatively low water conditions and excellent visibility provided a total count of 335 fish (54 small and 281 large; including about 40 fish in two pools in the gorge) of which seven large and one small were tagged. The count in 1996 was 322 fish. A low tag recovery rate in the headwater reaches (several possibilities considered) was adjusted upwards using the mean recovery rate for that reach, 1994-1995, i.e., three untagged fish became "tagged" App. III). Several large salmon were identified as being of hatchery origin (Adipose clip); no sighted fish had external characteristics suggestive of aquaculture origins. Data submitted to mark-and-recapture analysis were: **M=25**; **C=335** and **R=11**.

The total number of fish in the river on Oct 23 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 was 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 **758** fish (Fig. 9; 90% CL 526-1,516). No removals were known and thus total returns were estimated to be comprised of **636** large and **122** small salmon (total of 758) exclusive of possible losses to hook-and-release mortality in the recreational fishery. Large salmon were up 97% from those of 1996 and constitute the largest estimate since 1992 (Fig. 5). Small salmon were down 100% from the hatchery and wild return in 1996; comparison of wild returns alone would suggest that small salmon returns in 1997 were up as much 25% over those of 1996.

The estimated catch (no retention) by anglers through Oct 31 (Tables 2, 3 and 4) was 68 small and 139 large salmon -40% and 112% of the respective small and large salmon catch in 1996. Respective catch rates are 0.57 and 0.22. Fewer than 100 fish were reported within the river June - September; most fish were thought to have entered in October. As in 1996, several dozens of fish were counted within tidal influence during the October swim-thru census.

Conservation Requirements

Conservation requirements for the North River are based on a substrate area of 3,559 100 m^2 and 2.4 eggs m^{-2}. Egg requirements of 0.85 million are to be provided, on average by **200** large and **30** small salmon (Amiro and Marshall MS 1990; Marshall et al. MS 1992).

Escapement

An escapement of the **758** salmon estimated to be in the river on Oct 23 is **330%** of the 230 fish requirement. This value is up considerably over that of 1996 (Fig. 5). Large salmon, augmented by some unquantified but relatively few hatchery fish, were **318%** 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 37 age-0^+ $100m^{-2}$ and 32 age-1^+ and 2^+ parr $100m^{-2}$ (Table 12) i.e., approximately "normal" abundance (Elson 1967).

Forecast

Using Bayesian techniques, Amiro and Harvie (MS 1996) investigated probabilities for potential returns of North River stock in 1994 and 1995 from a Ricker stock-and-recruit function. Spawners (Fig. 5) and recruits were developed for spawner years 1974-1989 from recreational harvests in North River, an angling exploitation rate of 0.5, and 0.83 of total commercial harvests reported for St. Ann's Bay and Harbour. To compensate for significant first order auto-correlation and forecasts that would have exceeded returns in 1993 and 1994, the 1992 point was excluded and the 1994 value was used as prior weighting. The function $Recruit_{adj} = Spawner * e^{(2.61009 - 0.00331 * Spawner)}$, forecast returns in 1995 of 331-727 salmon (90% CL) from an estimated 800 large salmon spawners in 1989. The Oct estimate of return in 1995 was about 260 wild fish, fewer than the forecast. The same model solved for an estimated 1,220 spawners in 1990 suggested returns of 253-553 fish (90% CL) in 1996; returns were estimated at only about 240 wild large salmon. The same model (Amiro and Harvie MS 1996) solved for an estimated 710 spawners in 1991 forecast a return of 340-746 (90% CL) large fish in 1997, we report a population of 636 fish (some few of hatchery origin).

The above model was not solved for large salmon returns in 1998. However solution for the estimated 1,100 spawners in 1992 would yield a forecast in the range of 200-600 (90% CL) fish, i.e., 100-300% of conservation requirements. Returns of large salmon in the last five years have averaged slightly fewer than 400 large fish, i.e., about twice conservation requirements. There is a risk, however, in not acknowledging that the North River large salmon returns in 1998 (1996 smolt class) may as well have succumbed to higher than usual marine mortality evidenced in low 1SW returns to rivers of Atlantic coast Nova Scotia and Bay of Fundy (Anon. 1998) and possibly, Margaree in 1997. Returns of 1SW fish have averaged in excess of 100 fish over the last several years and should in 1998 meet the requirement of 30 fish.

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 least of all rivers assessed in this document (Marshall et al. MS 1996). Unlike most other Cape Breton stocks, salmon of the Grand river are principally small (1SW) and of June/July run timing. The few large salmon are essentially 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 had been made at the Grand Falls fishway 1988-1997, a point located 10.2 km above head-of-tide (Amiro and Longard MS 1990; Marshall et al. MS 1998). In 1996 the spawning escapement was estimated to have been 147% of a 234 fish conservation requirement above Grand River Falls (Marshall et al. op cit). However, only 79 (the fewest counted in the last decade) of 200 fish were of wild origin. The prognoses for returns to the Grand River in 1997 was that returns to above the Falls would exceed the requirements but again, perhaps only because of the contribution by hatchery stocked smolts. In 1997 the river was open to hook-and-release angling; there was no allocation of food fish to First Nations.

With assistance from Chapel Island First Nation, returns were counted at the Grand Falls fishway between mid-June and late-August, 1997. Juvenile assessments were conducted at four sites, all of which had been done in 1995 and 1996.

Returns

Grand River Falls is a partial barrier to salmon located 10.2 km above head-of-tide. 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 bi-pass 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 MS 1995).

The trap was operated June 23 to Aug 28, and removed on Sept 3. Counts, mostly between June 23 and July 23 numbered only 28 small fish and five large fish of which ten (total) were classified as hatchery. Counts during the period of operation would typically have comprised 80% of the season total (Marshall et al. 1996). However, river discharge during operation in 1997 was very low. Three fish were recovered from the trap and another 40 were estimated to be in the pool below the fishway on the day that the trap was removed from the fishway. Thus, counts are incomplete, but minimally might have been at least 73 summer and 91 (73/0.8) summer+fall returns. Low river discharges probably effectively restricted "bi-pass" but 0.4 bi-pass rate would suggest a possible return, relative to estimates of other years, of **152** fish (Revised from 125 in DFO Science Stock Status Report D3-09 [1998].)

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 m^{-2}. Requirements number 1.1 million eggs or **545** salmon in total of which **234** are required above the Falls.

Escapement

A return and escapement of 152 fish is 65% of the requirements above the fishway and the third lowest in ten years of data.

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 between one and four days later. Estimates of age 1^+,2^+ parr were calculated using the Petersen mark-and-recapture method. Age 0^+ fish were estimated using the efficiency of capture for older fish.

Densities averaging 30 age-0^+ $100m^{-2}$ and six age-1^+ and -2^+ parr $100m^{-2}$ are double those of 1996 (Table 13) but low in comparison to most other Cape Breton rivers. A doubling of age-0^+ parr densities between 1995 and 1996 and again 1996 and 1997 is consistent with increased escapements 1994-1996 (Marshall et al. MS 1997).

Forecast

Returns to the fishway, 1994-1997 have averaged 246 fish, i.e., 105% of conservation requirements. On average, however, 34% of returns have been of hatchery-origin smolts. Returns of hatchery 1SW fish in 1998 will conclude recent stocking. Recent low marine survival of most Atlantic coast Nova Scotia stocks, average returns, 1994-1997, and expected contribution by hatchery smolts released in 1997 suggest that returns in 1998 may approach conservation requirements.

SYDNEY, TILLARD, SKYE 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 and River Tillard were assessed by mark and recapture estimation with recapture runs conducted between one and four days after marking. Estimates of age- 1^+ ,-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 and Mabou rivers were smaller and barriered; the estimates being made in the same fashion as those of the Margaree, Middle, Baddeck and North rivers.

Densities at sites on the Sydney River and River Tillard increased over those of 1996 and equal or exceed "normal abundance" (Table 13; Elson 1967). Densities on the Skye and Mull rivers have not been determined since the late 1970s. Low densities on the Skye suggest that escapements and or spawning success of escaped aquaculture fish have been modest. High densities in the Mabou sites i.e., >150 age-0^+ $100m^{-2}$ and > 40 age-1^+ and -2^+ parr $100m^{-2}$ are consistent with late-run rivers of Gulf Nova Scotia.

ECOLOGICAL CONSIDERATIONS

In-river

The Margaree is the only one of the five rivers assessed for which there is river discharge data. Margaree discharge patterns and levels are likely to be reasonably representative of other Highland-origin rivers but are not necessarily representative of Lowland rivers (Cape Breton and Richmond counties). Mean monthly discharges for Margaree in July, 1997, were below the 70-year mean (Fig. 3). Raised fall discharges began in mid-September (Fig. 2) and despite low monthly mean discharges appeared, at least on the Margaree, to be adequate to bring salmon into the river. Water temperatures, as indicated by those recorded at Doyle's Bridge on the Margaree (Fig. 4), were in fact cool relative to those of recent years.

Marine

An upward trend in thermal habitat index, 1994-1996 (Fig. 5) and increased returns in 1997 should have equalled or exceeded those of 1996. However, returns to many of Atlantic Canada's rivers were down from those returns of 1996 (Anon MS 1998). Factors examined for the possible decline in survival focused on marine events and included temperature profiles and thermal habit indices, removals in legal and illegal fisheries, predation by cod, seals, seabirds, diseases or parasites, changes in biological characteristics of salmon and changes in marine fish species communities (Anon MS 1998). No global factor was identified as causative agent for the wide geographic declines in survival. Declines were identified in the 1SW returns to the Margaree and possibly Grand rivers and MSW returns to the Middle and Baddeck rivers. The impact of marine events on returns in 1998 is unknown.

MANAGEMENT CONSIDERATIONS

Conservation requirements in 1997 were met or exceeded on the Margaree and North rivers. Requirements were not met on the Middle, Baddeck and Grand rivers.

Returns to the Margaree and North rivers have over the long term, and should again in 1998, meet large salmon spawning requirements; there is less certainty as to the level of small salmon returns.

In view of uncertainty in patterns of marine survival, returns of large salmon, the principal component in the Middle and Baddeck rivers should not be expected to be above the recent average returns, i.e., less than conservation requirements. For the Grand River, wild stocks have been declining and below conservation requirement for the last several years. Small salmon of hatchery origin which contributed to recent past attainments of requirements could make a significant contribution to continuing an increase in juvenile densities.

Little can be said for other non-CBHNP rivers of the Island which support about four percent of the recorded recreational effort. Juvenile abundance data is limited although suggestive of adult returns of a magnitude of the assessed rivers. Whether they are above or below conservation requirements remains unknown.

In total, reductions in components of salmon returns to Cape Breton and other Atlantic Canada rivers in 1997 appear to have been the result of poorly understood and recent changes affecting salmon survival at sea. Reduced 1SW returns in 1997 will, in many stocks, be a precursor to reduced 2SW returns in 1998. Because the events which reduced sea survival in 1997 may still be operating on the 1997 smolt class, i.e., 1SW returns in 1998, it would be imprudent to liberalize existing fishery management plans for Cape Breton Island.

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Table 1. Summary of the First Peoples salmon allocations, gear type, and seasons for Cape Breton, 1997.

River/Location	First Peoples	Allocation Small	Allocation Large	Gear Type	Season
Margaree River					
River and Estuary	Eskasoni	6	30	Trapnet, angle, spear	Jun 1 - Aug 31
		20	100	Trapnet, angle, spear	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	Jun 1 - Aug 31
		20	70	Trapnet, angle, spear, dipnet	Sep 1 - Nov 22
			30	Gillnet	Sep 24 - Nov 22
NE and main, excluding SW	Wagmatcook	6	30	Trapnet, angle, night spear, pool seine	Jun 1 - Aug 31
		20	100	Trapnet, angle, night spear, pool seine	Sep 1 - Oct 31
River and Estuary	Waycobah	6	30	Trapnet, angle	Jun 1 - Aug 31
		20	100	Trapnet, angle	Sep 1 - Nov 15
	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 23
	Wagmatcook	10	10	Angle, snare, spear	Jun 1 - Oct 25
	Waycobah	10	10	Angle, snare, spear	Jun 1 - Aug 23
	Total	***50***	***50***		
Christmas Bk/Bras d'Or Lakes					
	Eskasoni	250		Trapnet, lure, angle, snare, spear	Jun 1 - Oct 31
Bras d'Or Lakes & Tribs					
	Membertou	200		Angle, snare, spear	Apr 1 - Mar 31/98
St. Peters Inlet/Bras d'Or Lakes					
	Chapel Island	150		Trapnet, angle, snare, spear	Jun 1 - Oct 25
Middle River, Nyanza Bay and Bras d'Or Lakes	Wagmatcook	100		Trapnet, gillnet, spear, snare	Jul 1 - Nov 14 ??
Indian Point in Whycocomagh Bay and Bras d'Or Lakes	Waycobah	250		Trapnet, angle, snare, spear	Jun 1 - Oct 23
	Total	***950***	***700***		
Middle River	Wagmatcook	100 Black Salmon		Angle, trapnet	Apr 23 - May 31
	Total Black	***100***			
Gulf NS (including Gulf Cape Breton) (SFA 18)	Native Council NS	1820 by maximum of 182 harvesters			
Cape Breton East (SFA 19)	Native Council NS	220 by maximum of 22 harvesters			
Cape Breton fish totals	***Small/Large***	***1130***	***700***		
	Black Salmon:	***100***			

Table 2. Recreational catch and effort for Atlantic salmon on rivers of Cape Breton Island, 1997 (Preliminary).

River	Season dates Begin D M	Season dates End D M	Obseved 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	24/10 *	39	11	16	44	64	0	55	80	107	159	0.514	80.0
Barachois	1/06	31/10 *	10	3	4	15	22	0	18	26	29	43	0.621	83.3
Campbell's Brook	1/09	31/10	0											
Catalone	1/06	31/10 *	4	0	0	0	0	0	0	0	5	7	0.000	0.0
Cheticamp	16/05	30/09	18	14	20	19	27	0	33	48	47	70	0.702	57.6
Clyburne	1/06	31/10 *	1	1	1	1	1	0	2	3	2	3	1.000	50.0
Framboise	1/06	31/10 *	4	3	4	1	1	0	4	6	22	33	0.182	25.0
Gaspereaux: C. Breton Co.	1/06	31/10 *	6	0	0	5	7	0	5	7	22	33	0.227	100.0
Gerratt	1/06	31/10 *	0											
Grand	1/06	31/10 *	20	22	32	4	6	0	26	38	98	146	0.265	15.4
Grantmire Brook	1/06	31/10 *	2	0	0	2	3	0	2	3	7	10	0.286	100.0
Indian Brook	1/06	31/10 *	5	0	0	0	0	0	0	0	13	19	0.000	0.0
Ingonish	1/06	31/10 *	2	3	4	5	7	0	8	12	9	13	0.889	62.5
Inhabitants	1/06	31/10 *	6	2	3	4	6	0	6	9	10	15	0.600	66.7
Little Lorraine	1/06	31/10 *	0											
Lorraine Brook	1/06	31/10 *	0											
Mabou	1/09	31/10	3	0	0	2	3	0	2	3	8	12	0.250	100.0
MacAskill's Brook	1/06	31/10 *	0											
Margaree	1/06	31/10 *	1068	228	330	1536	2222	0	1764	2551	6026	8958	0.293	87.1
Marie Joseph	1/06	31/10 *	0											
Middle: Victoria Co.	1/06	24/10 *	52	13	19	59	85	0	72	104	127	189	0.567	81.9
Mira	1/06	31/10 *	2	0	0	0	0	0	0	0	2	3	0.000	0.0
North : Victoria Co.	1/06	31/10 *	55	48	69	96	139	0	144	208	231	343	0.623	66.7
North Aspy	1/06	31/10 *	6	1	1	9	13	0	10	14	14	21	0.714	90.0
Northwest Brook (River 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 *	0											
Saint Esprit	1/06	31/10 *	0											
Salmon: Cape Breton	1/06	31/10 *	12	1	1	2	3	0	3	4	47	70	0.064	66.7
Skye	1/06	31/10 *	0											
Sydney	1/06	31/10 *	2	0	0	0	0	0	0	0	2	3	0.000	0.0
Cape Breton Totals			1317	350	504	1804	2609	0	2154	3116	6828	10150	0.315	83.8

See variation order.

Table 3. Recreational catch and effort for Atlantic salmon on rivers of Cape Breton Island, 1997(preliminary), 1996 and 1992-96.

	1997 Preliminary				1996				1992 - 96 means							
	Grilse		Salmon		Grilse		Salmon		Grilse				Salmon		Effort	
River	retained	released	released	Effort	retained	released	released	Effort	retained	95% C.I.	released	95% C.I.	released	95% C.I.	roddays	95% C.I.
Cape Breton																
Aconi Brook	0	0	0	0	0	0	0	0	4.0	N/A	4.0	N/A	9.0	N/A	27.0	N/A
Baddeck	0	16	64	159	0	46	165	374	18.2	27.6	27.0	26.1	114.2	61.4	499.6	278.4
Barachois	0	4	22	43	0	11	17	63	2.2	4.3	4.2	5.8	14.8	10.6	75.0	53.6
Campbell's Brook	0	0	0	0	0	0	0	0	0.5	N/A	0.5	N/A	7.5	N/A	28.5	N/A
Catalone	0	0	0	7	0	10	7	47	1.8	4.3	2.2	5.4	2.2	3.7	65.4	101.2
Cheticamp	0	20	27	70	0	14	48	126	3.8	8.1	9.8	6.8	38.0	27.7	130.0	49.1
Clyburne	0	1	1	3	0	2	40	57	0.0	0.0	0.8	1.3	12.5	26.3	21.3	35.7
Framboise	0	4	1	33	0	1	0	37	4.4	8.7	1.4	1.4	1.0	2.8	132.6	181.2
Gaspereaux: Cape Breton Co.	0	0	7	33	0	0	11	15	0.0	0.0	0.0	0.0	2.8	7.6	13.0	5.4
Gerratt	0	0	0	0	0	0	0	3	0.0	0.0	0.0	0.0	0.0	0.0	4.4	2.1
Grand	3	29	6	146	0	90	25	290	66.5	107.9	48.5	53.4	28.5	14.7	833.8	1023.2
Grantmire Brook	0	0	3	10	0	7	10	20	0.0	N/A	4.0	N/A	7.0	N/A	17.5	N/A
Indian Brook	0	0	0	19	0	4	4	27	0.4	1.1	1.8	2.2	2.0	2.3	23.6	15.4
Ingonish	0	4	7	13	0	5	6	82	3.2	8.9	3.8	3.0	9.2	9.8	69.4	45.1
Inhabitants	0	3	6	15	2	22	72	118	11.2	18.0	9.6	14.2	75.0	54.2	212.2	196.0
Little Lorraine	0	0	0	0	0	0	0	0	0.0	N/A	0.0	N/A	0.0	N/A	0.0	N/A
Lorraine Brook	0	0	0	0	0	0	0	0	6.5	N/A	1.5	N/A	5.0	N/A	50.0	N/A
Mabou	0	0	3	12	7	1	7	20	3.0	2.9	1.4	2.6	6.2	8.8	19.6	11.6
MacAskill's Brook	0	0	0	0	0	0	0	0	0.0	N/A	0.0	N/A	1.0	N/A	9.0	N/A
Margaree	207	123	2222	8958	274	918	1864	9096	375.4	209.7	306.4	426.8	1488.6	510.4	13107.4	3264.9
Marie Joseph	0	0	0	0	0	0	0	4	2.3	6.2	1.0	2.0	4.3	7.9	72.0	75.8
Middle: Victoria Co.	3	16	85	189	2	60	142	505	7.0	13.1	26.0	29.2	87.4	76.9	382.4	159.0
Mira	0	0	0	3	0	0	0	4	0.6	1.7	4.4	5.2	1.6	2.6	66.2	54.9
North: Victoria Co.	1	68	139	343	0	174	124	584	49.4	99.1	94.8	89.2	228.4	229.2	919.2	761.4
North Aspy	0	1	13	21	0	5	39	61	1.4	2.7	3.8	6.2	21.8	16.0	61.2	38.9
Northwest Brook (River Ryan)	0	0	0	0	0	0	0	0	0.0	N/A	0.0	N/A	0.0	N/A	9.0	N/A
River Bennett	0	0	0	0	0	0	0	0	1.0	N/A	0.0	N/A	1.0	N/A	6.0	N/A
River Deny's	0	0	0	0	0	0	0	1	0.3	N/A	0.0	N/A	1.0	N/A	4.3	N/A
River Tillard	0	0	0	0	0	10	14	23	1.8	3.1	3.2	4.8	4.4	7.2	24.4	23.3
Saint Esprit	0	0	0	0	0	0	0	0	0.3	N/A	0.0	N/A	0.0	N/A	29.7	N/A
Salmon: Cape Breton Co.	0	1	3	70	0	15	32	161	1.8	3.1	5.0	8.4	11.4	15.7	141.4	122.7
Skye	0	0	0	0	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	5	1	45	0.8	1.6	1.2	2.7	2.4	4.7	20.2	23.7
Totals	214	290	2609	10150	285	1400	2628	11763	570.2		566.6		2188.1		17085.9	

Table 4. Annual summaries of catch, effort and estimated 1SW fish retained from NS license stub returns for assessed rivers of Cape Breton, 1984-97. Mean = (1992 to 1996). The 1997 data are preliminary. (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		39	11	16	0	44	64	0	55	80	107	159	0.514	80.0
	+/- 1996	-44%	-70%	-65%	-	-67%	-61%	-	-68%	-62%	-63%	-57%	-11%	2%
	+/- Mean	-59%	-71%	-65%	-100%	-53%	-44%	-	-58%	-50%	-74%	-68%	44%	13%
	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		20	22	32	3	4	6	0	26	38	98	146	0.265	15.4
	+/- 1996	-23%	-69%	-64%		-80%	-76%	-	-72%	-67%	-57%	-50%	-35%	-29%
	+/- Mean	-77%	-71%	-66%	-94%	-80%	-76%	-	-73%	-68%	-86%	-82%	9%	-49%
	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		1,068	228	330	207	1,536	2,222	0	1,764	2,551	6,026	8,958	0.293	87.1
	+/- 1996	8%	-69%	-64%	-24%	2%	19%	-	-21%	-8%	-15%	-2%	-15%	43%
	+/- Mean	-23%	-56%	-47%	-45%	26%	49%	-	2%	21%	-43%	-32%	61%	25%

Table 4. (Continued)

Year	River	No. Angler	Small Obs.	Small Est.	Est. Ret.	Large Obs.	Large Est.	Unk. Obs.	Total Obs.	Total Est.	Roddays Obs.	Roddays 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	19	3	59	85	0	72	104	127	189	0.567	81.9
	+/- 1996	-58%	-73%	-68%	50%	-48%	-40%	-	-22%	-6%	-100%	-84%	37%	18%
	+/- Mean	-47%	-51%	-41%	-57%	-17%	-3%	-	29%	58%	-100%	-79%	86%	17%
	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		55	48	69	1	96	139	0	144	208	231	343	0.623	66.7
	+/- 1996	-32%	-66%	-60%		-4%	12%	-	-40%	-30%	-49%	-41%	19%	60%
	+/- Mean	-58%	-59%	-52%	-98%	-48%	-39%	-	-52%	-44%	-69%	-63%	33%	15%

Table 5. Estimates of returns, escapements, and percent of conservation requirement met for Atlantic salmon from the Margaree River, 1984 to 1997. Mean = (1992 to 1996).

Year	Large Returns			Large Escapement			Conservation Req'm Met by Large			Eggs (10^6) collected for Hatchery
		Percentiles			Percentiles			Percentiles		
	Median	5%	95%	Median	5%	95%	Median	5%	95%	
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)	**4,938**	3,461	5,756	**4,676**	3,199	5,494	451%	309%	530%	0.159
+/- 1996	77%			81%			81%			
+/- Mean	39%			37%			37%			

	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	**756**	(330)	1,670	**508**	(88)	1,422	87%	0%	244%
+/- 1996	-55%			-62%			-62%		
+/- Mean	-45%			-48%			-48%		

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

(b) - Modal value from Bayes estimates.

Table 6. Summary of effort, catch and CPUE from logbook anglers on Margaree River, 1991 to 1997.

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	40	4	0.100	5	0.125	9	0.225
		Oct. 1-31	194	10	0.052	31	0.160	41	0.211
	Sub-Total		387	16	0.041	49	0.127	65	0.168
	Total Season		882	63	**0.071**	79	**0.090**	142	**0.161**

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**
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	149	8	0.054	18	0.121	26	0.174
	August	172	7	0.041	17	0.099	24	0.140
Sub-Total		451	16	0.035	57	0.126	73	0.162
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		1124	30	**0.027**	316	**0.281**	346	**0.308**

Table 7. Results of electrofishing surveys at barrier net sites in the Margaree River, July 1994-1995 and August 1996-1997.

Year	Tributary	Site #	Area (m^2)	# of sweeps	Age 0+ Mean length (cm)	Age 0+ Sweep catch	Age 0+ Total estimate	Age 0+ Variance	Age 0+ Density ($100m^{-2}$)	Age 1+, 2+ Mean length (cm)	Age 1+, 2+ Sweep catch	Age 1+, 2+ Total estimate	Age 1+, 2+ Variance	Age 1+, 2+ Density ($100m^{-2}$)
1997	Big Brook	15	171	4	4.7	316	317	1.1	185	9.1	93	97	11	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
1994	Big Brook	15	148	4	4.9	155	189	219.6	128	9.4	45	49	18.5	33
	Forest Glen Bk	40	116	3	4.0	111	116	14.6	100	7.9	88	107	142.5	92
	Forest Glen Bk	45	193	4	4.2	161	210	468.5	109	7.5	167	185	68.1	96
	MacFarlanes Bk	96	160	4	5.0	172	183	31.5	115	9.1	115	123	22.0	77
	Trout Bk	98	174	4	4.4	50	61	98.6	35	7.2	87	95	27.6	55
	Mean sites,15,45,96								117					69

Table 8. Estimates of spawner 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	4,938
1993	3,224	
1994	2,759	
1995	2,308	
1996	2,579	
1997	4,676	

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

	Model			
Parameter	*Ricker*	*Beverton-Holt*	*Mean*	*Tabular*
a	1.73	4.23	.	.
b	4.09	0.31	.	.
Res SS	1.32	0.99	1.08	0.93
X value	3,224	3,224	3,224	3,224
Forecast	4,643	3,858	3,265	4,246

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

	Spawning Stock			
Recruitment	*0 - 600*	*600 - 1200*	*1200 - 1800*	*>1800*
> 7800				
7200 - 7800				1
6600 - 7200				
6000 - 6600				2
5400 - 6000			1	1
4200 - 4800		1	1	
3600 - 4200	1	3	2	
3000 - 3600	3	2	1	1
2400 - 3000	4	3		3
1200 - 2400	3	5		1
0 - 1200	1			
Number of Points	12	14	5	9
Average Spawners	401	829	1532	3487
Average Recruits	2618	2839	4243	4246
Recruits minus Spawners	2217	2010	2712	759
Recruits / Spawners	6.53	3.42	2.77	1.22

Table 11. Numbers of hatchery smolt and parr released to Cape Breton rivers, 1988-1997.[1]

		Smolt		Parr	
Year	Location	2+	1+	1+	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		
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	5,433[3]	18,365	34,242	
1997	Margaree	881			135,653
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 the Middle, Baddeck and North rivers, 1995-1997.

River	Site Name	Area m2	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
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	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
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.

*Not same site as 1996, site upriver above bridge.

Table 13. Results of mark-recapture and barrier net electrofishing for juvenile salmon in rivers of Richmond, Inverness and Cape Breton counties, 1995-1997.

River	Site Name	Site No.	Marking MM	Marking DD	Recap time (days)	Site Area (m^2)	Marking Run Age 0+ count	Marking Run Age 1+2+ marked	Mort	Recapture Run Age 0+ count	Recapture Run Age 1+,2+ Unmark	Recapture Run Age 1+,2+ Marked	Mark run efficiency	Site Estimate Age 0+	Site Estimate Age 1+,2+	Density/100 m^2 Age 0+	Density/100 m^2 Age 1+,2+
1997																	
GRAND RIVER																	
	Mud Hole (Abv Falls)	1	8	14	2	739	96	10	0	95	12	4	0.28	346	36	46.8	4.9
	Fishway (Abv Falls)	2	8	13	2	795	30	7	1	53	15	4	0.26	116	31	14.6	3.9
	Crib Pool (Btw Falls)	3	8	14	2	560	38	15	0	45	14	4	0.25	152	60	27.1	10.7
	F. MacDonald Rd.(Blw Falls)	4	8	15	2	485	98	18	0	90	3	4	0.62	158	29	32.6	6
											Avg sites 1-4		0.35	193	39	30.3	6.4
SYDNEY RIVER																	
	Sydney River Site #1	1	9	17	2	342	49	81	4	21	24	9	0.31	160	278	46.8	81.3
RIVER TILLARD																	
	River Tillard Site #1	1	9	16	2	503	73	89	2	44	46	37	0.46	159	198	31.6	39.4
SKYE RIVER (Barrier net sites)																	
	Skye River		7	9		201								41	25	20.5	12.6
	MacDonalds Bk		7	10		133								21	2	16.1	1.5
MABOU RIVER (Barrier net sites)																	
	MacLeod Bk Site #2		7	26		301								624	134	207	44.5
	Mull River Site #1		7	21		167								251	151	151	90.5
1996																	
GRAND RIVER																	
	Fr. MacDonald Rd (bl Falls)	4	8	15	1	633	32	12	0	38	7	2	0.29	112	42	17.7	6.6
	Crib Pool (bl Falls)	3	8	12	3	953	46	6	0	31	3	0	0.22	207	27	21.7	2.8
	Fishway (abv Falls)	2	8	7	2	996	26	3	0	43	6	1	0.20	130	15	13.1	1.5
	Mud Hole (abv Falls)	1	8	16	4	1,130	36	7	0	38	1	3	0.78	46	9	4.1	0.8
											Avg sites 1-4		0.37	123.8	23.3	14.2	2.9
GASPEREAUX RIVER																	
	Victoria Brdg	1	8	28	2	265	53	11	0	44	0	3	1.00	53	11	20.0	4.2
SYDNEY RIVER																	
	Site #1	1	8	28	2	343	24	44	0	33	20	6	0.25	94	173	27.4	50.4
RIVER TILLARD																	
	Site #1	1	8	21	2	282	43	48	0	41	9	28	0.76	56	63	19.9	22.3
	Site #2	2	8	21	2	307	8	17	0	7	17	8	0.33	24	51	7.8	16.6
											Avg sites 1-2		0.55	40.0	57.0	13.9	19.5
1995																	
GRAND RIVER																	
	Fr. MacDonald Rd (bl Falls)	4	9	12	3	533	7	8	0	28	5	2	0.35	20	23	3.8	4.3
	Crib Pool (bl Falls)	3	9	11	2	827	44	14	0	15	9	4	0.34	129	41	15.6	5.0
	Fishway (abv Falls)	2	8	29	2	996	7	28	0	4	18	6	0.27	26	103	2.6	10.3
	Mud Hole (abv Falls)	1	9	12	3	926	25	8	1	21	6	3	0.41	61	22	6.6	2.4
	Black River		9	13	3	586	10	25	1	11	16	7	0.34	30	77	5.1	13.1
											Avg sites 1-4		0.34	61.5	60.8	7.5	7.7

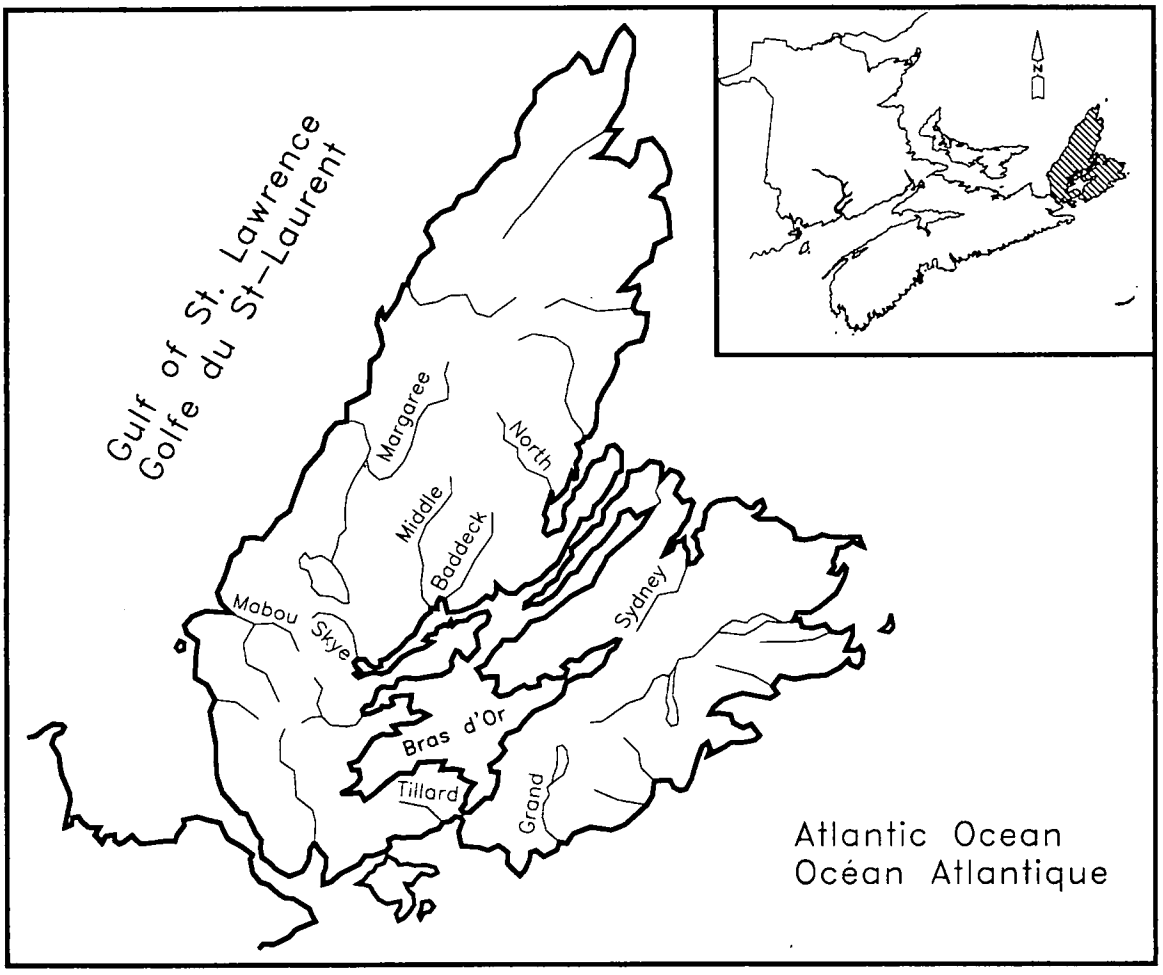

Fig.1. Cape Breton Island showing rivers (labelled) in which Atlantic salmon were assessed in 1997.

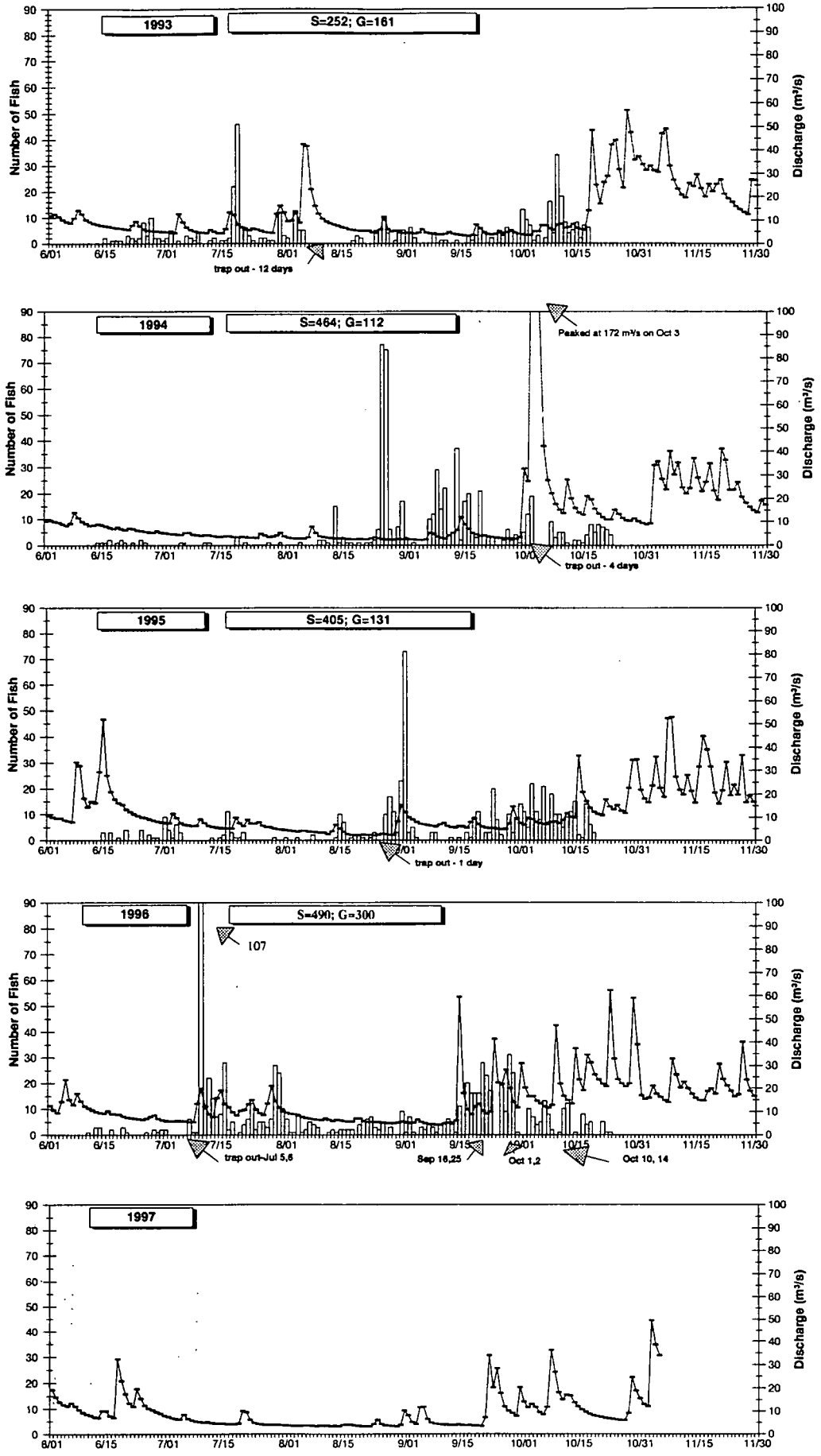

Fig. 2. Mean 24-hour discharge (m³/s) at Northeast Margaree (1993-1997) and counts of salmon at Levi's trapnet (1993-96), Margaree River.

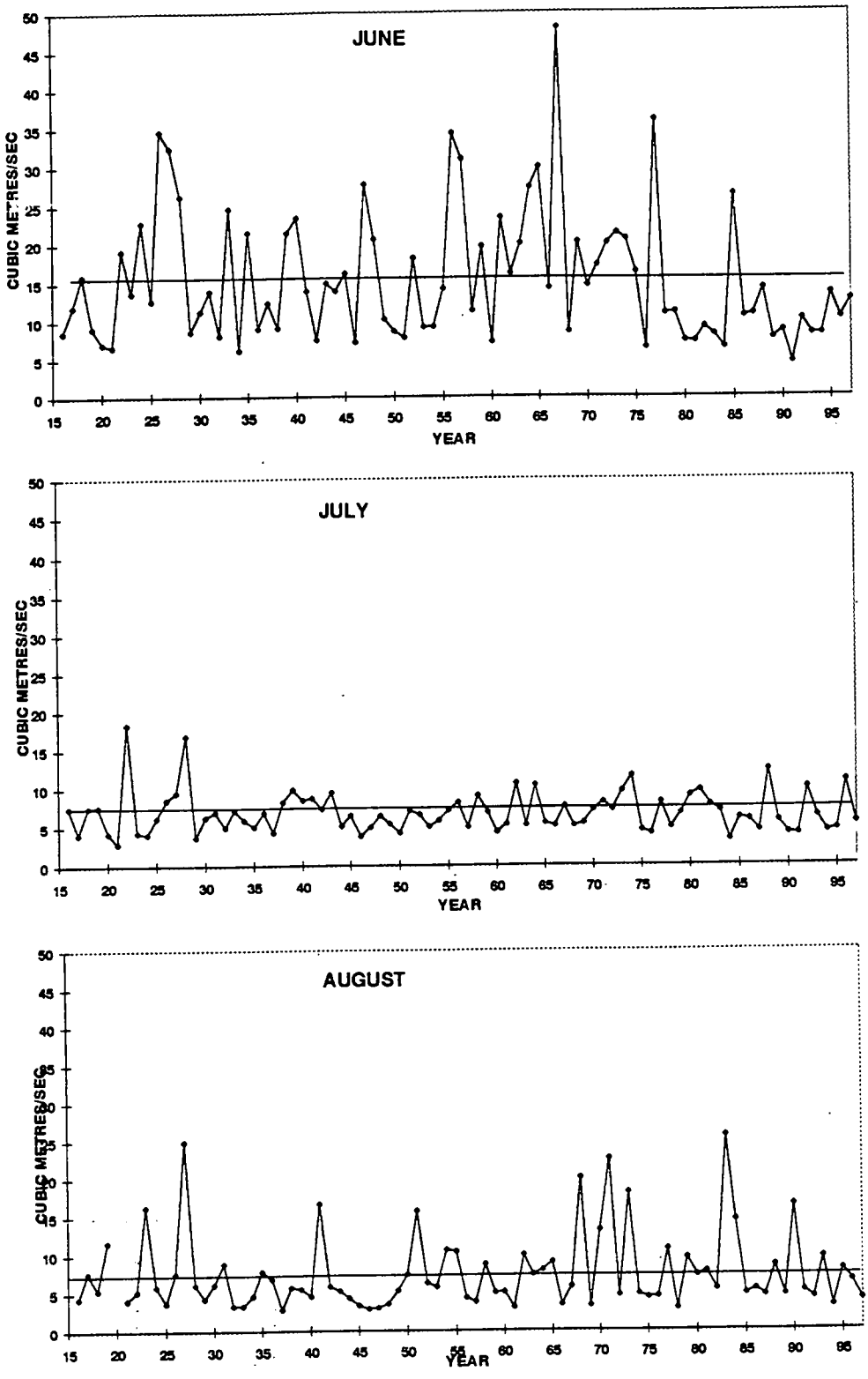

Fig. 3. Annual mean monthly discharges on Northeast Margaree. Horizontal line is long term mean.

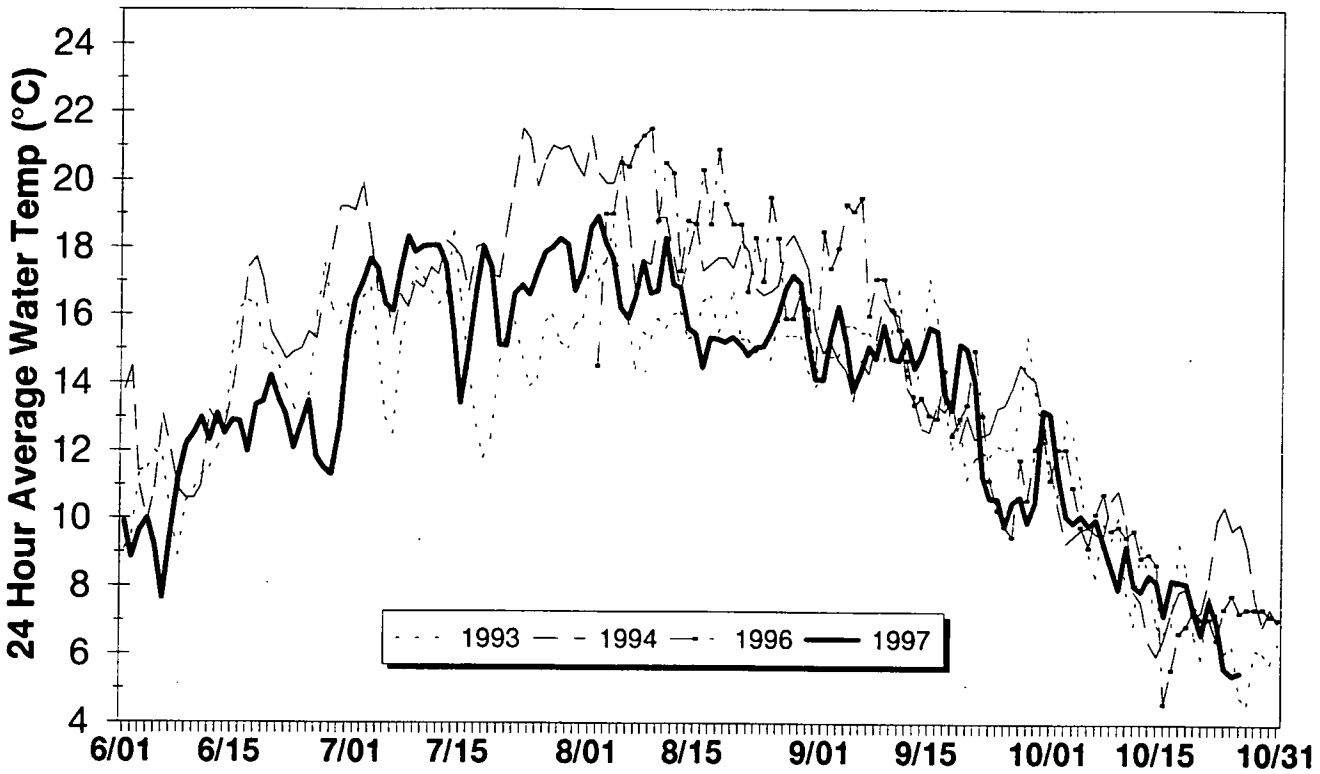

Fig. 4. Mean daily water temperatures Northeast Margaree (Doyle's Bridge), 1993-1994, 1996-1997.

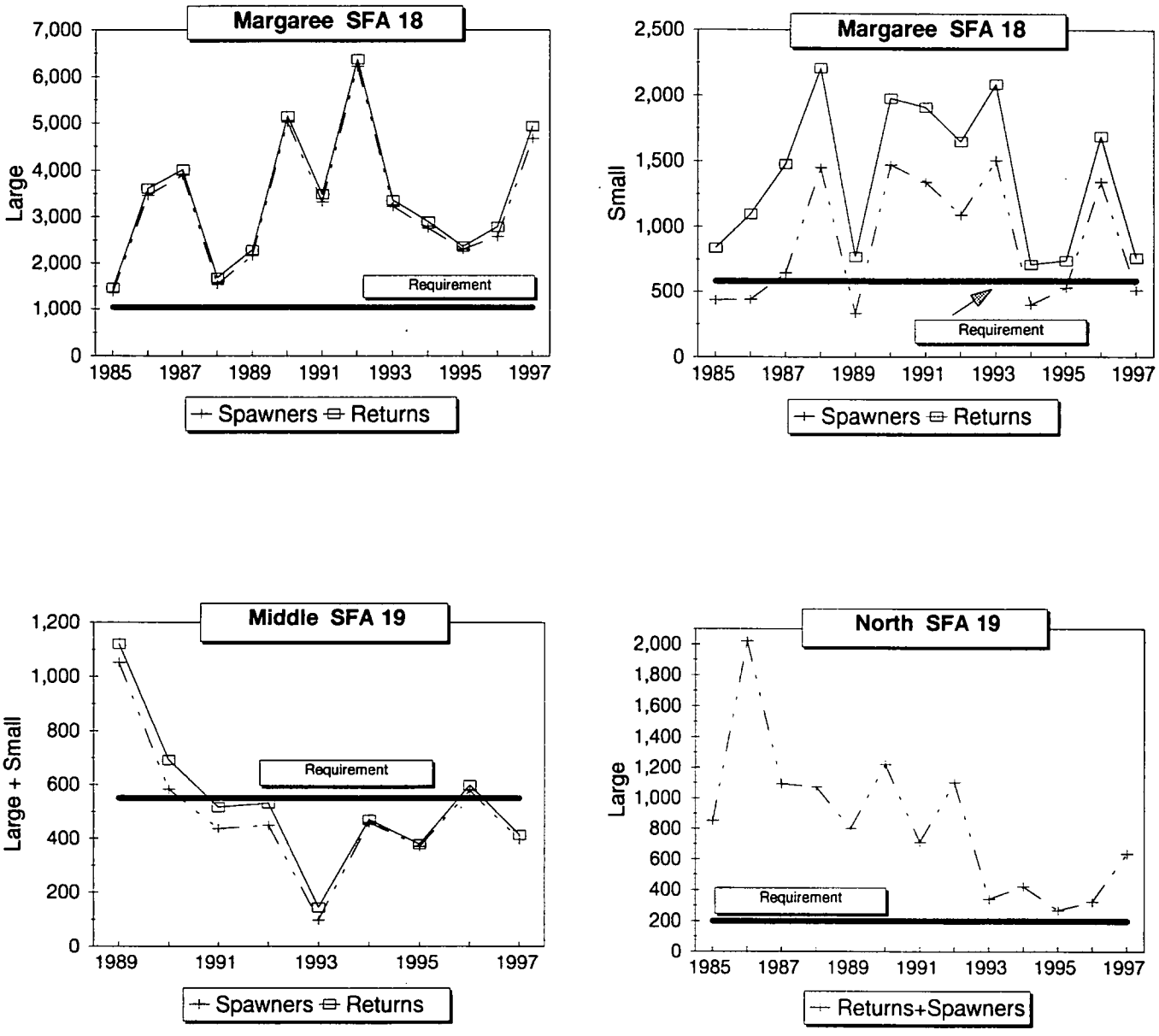

Fig. 5. Estimates of small and large (Margaree & Middle) and large (North) salmon returns and spawners to selected Cape Breton rivers.

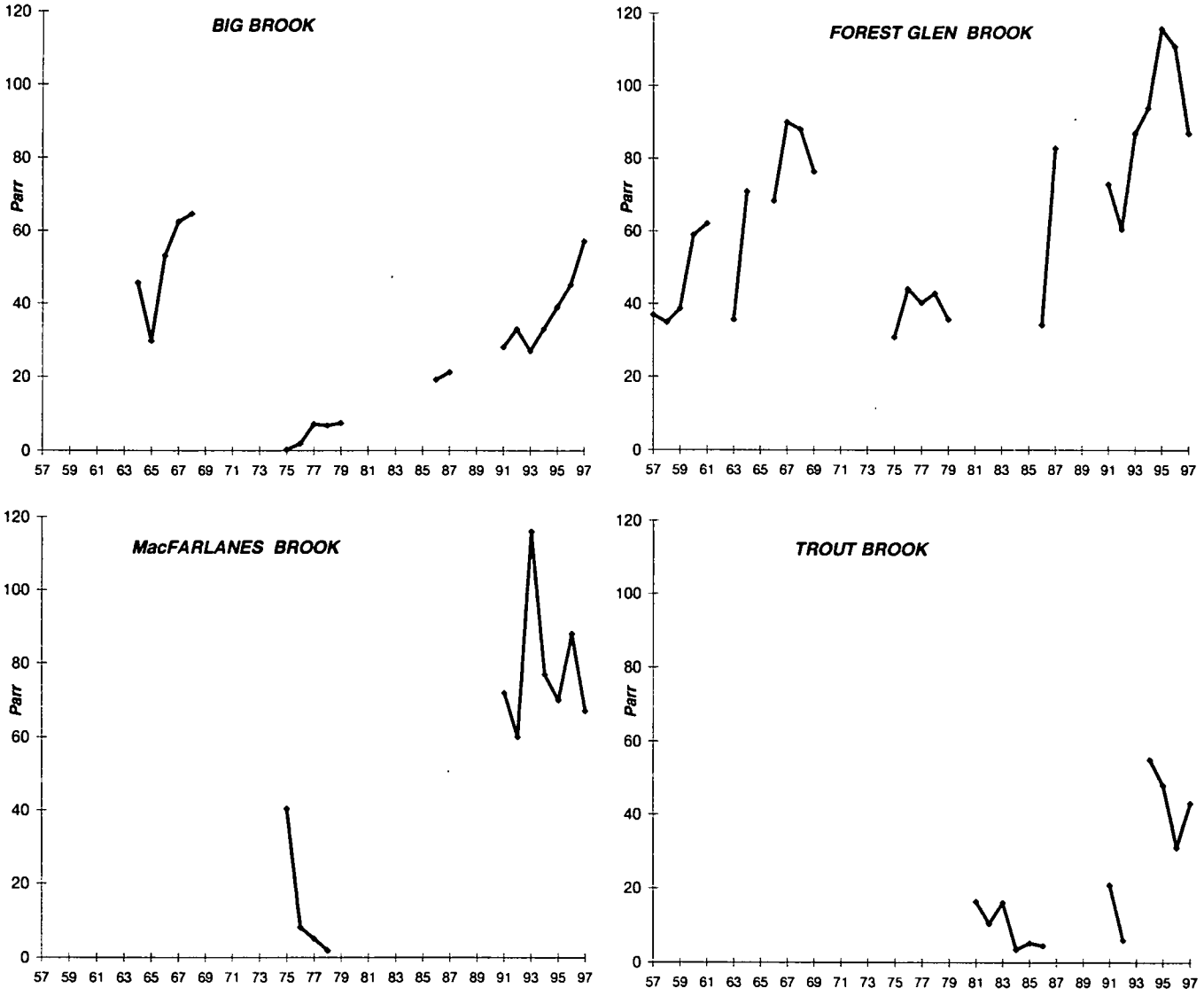

Fig. 6. Parr densities (100m^{-2}) at four index sites on the Margaree River from 1957 to 1997.

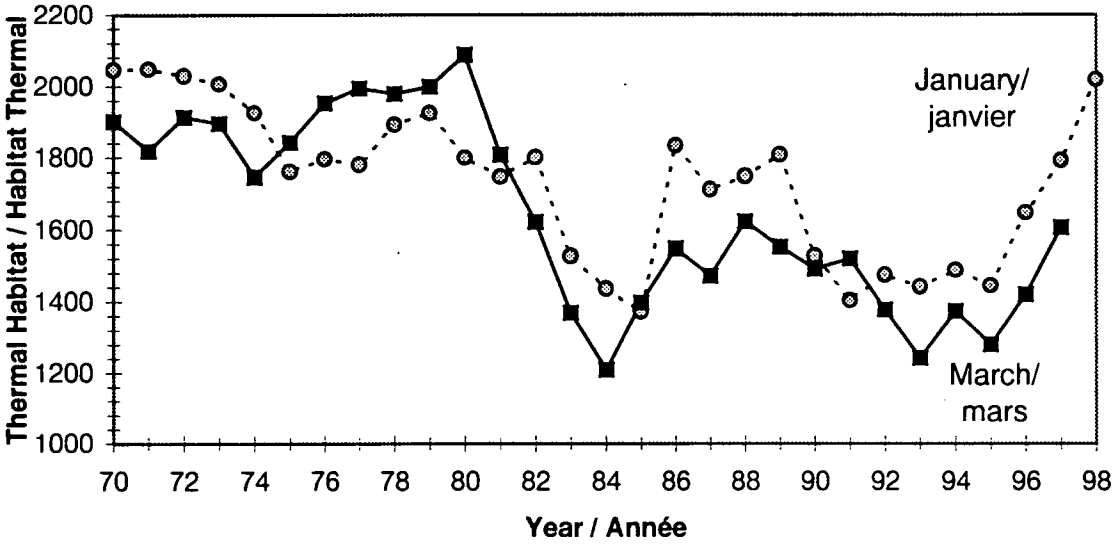

Fig. 7. January and March indices of thermal habitat in the N.W. Atlantic, 1970- 1998 (Reddin pers. comm.).

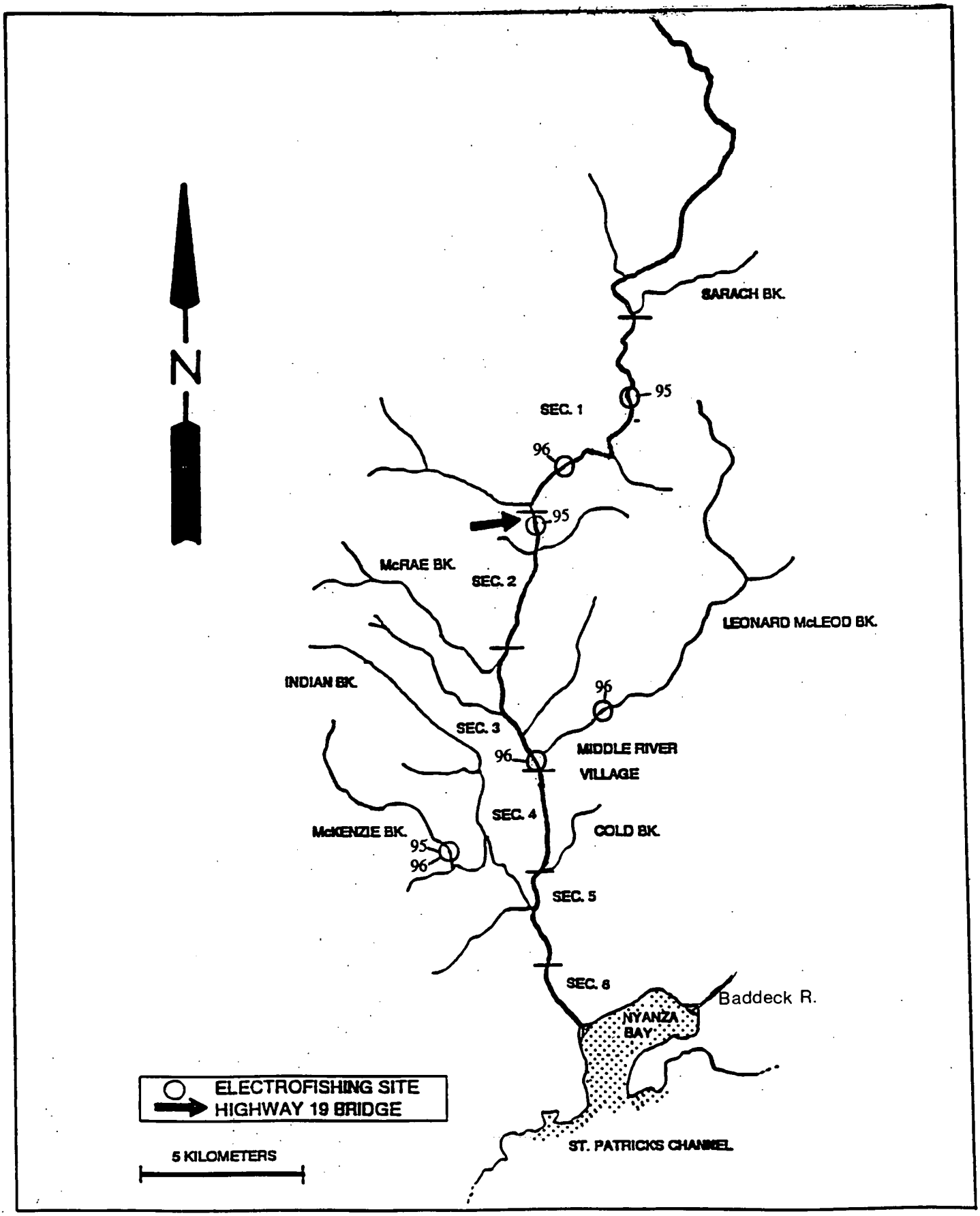

Fig. 8. Middle River, Victoria County, showing swim-thru sections and electrofishing sites in 1995 (95), 1996 (96) and 1997(96).

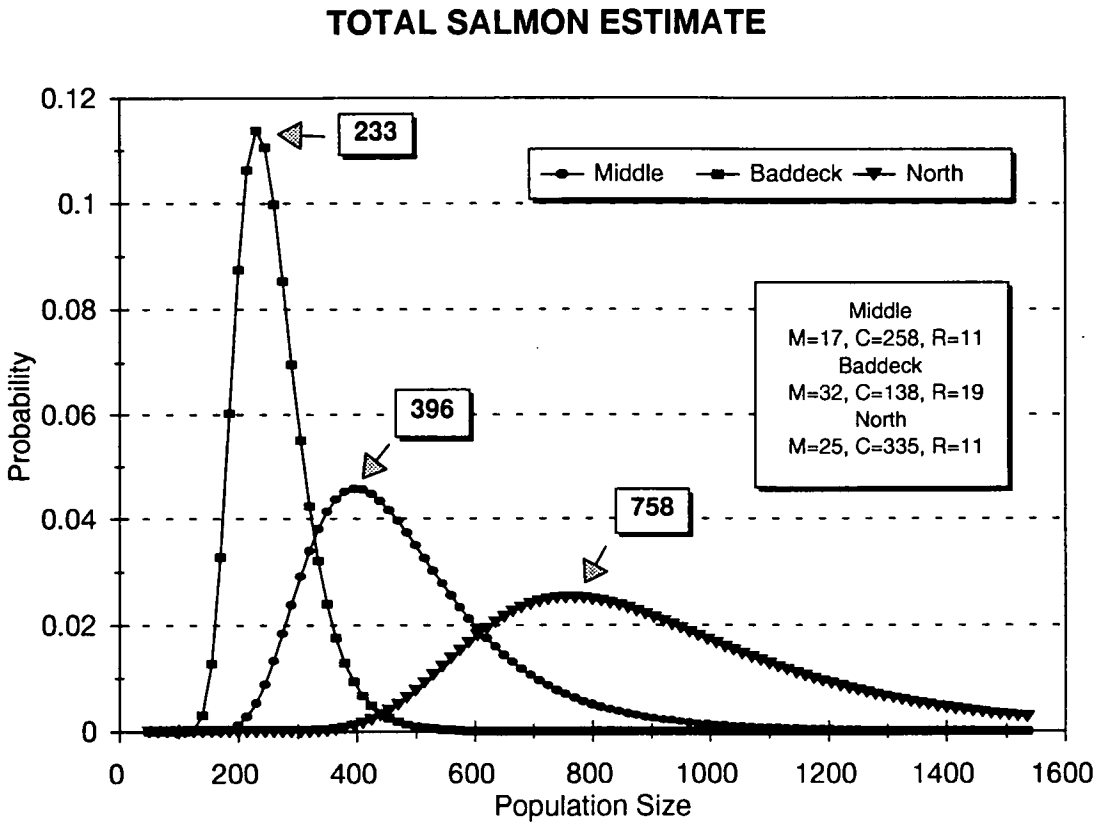

Fig. 9. Modal estimates of returning small + large salmon to the Middle, Baddeck and North rivers in 1997 based on mark and-recapture techniques.

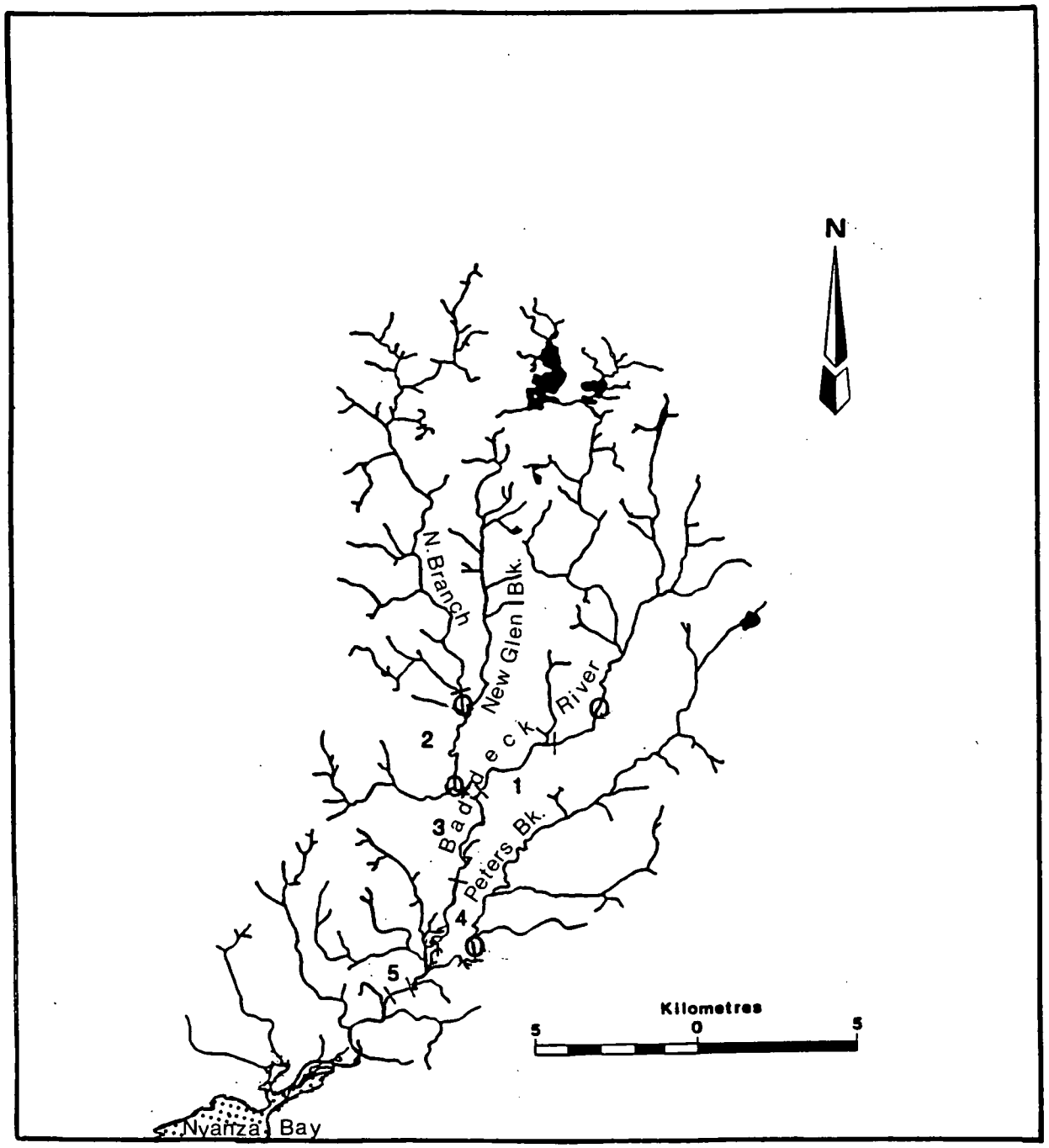

Fig.10. Baddeck River, Victoria County, showing swim-thru sections and electrofishing sites (O) in 1996 and 1997.

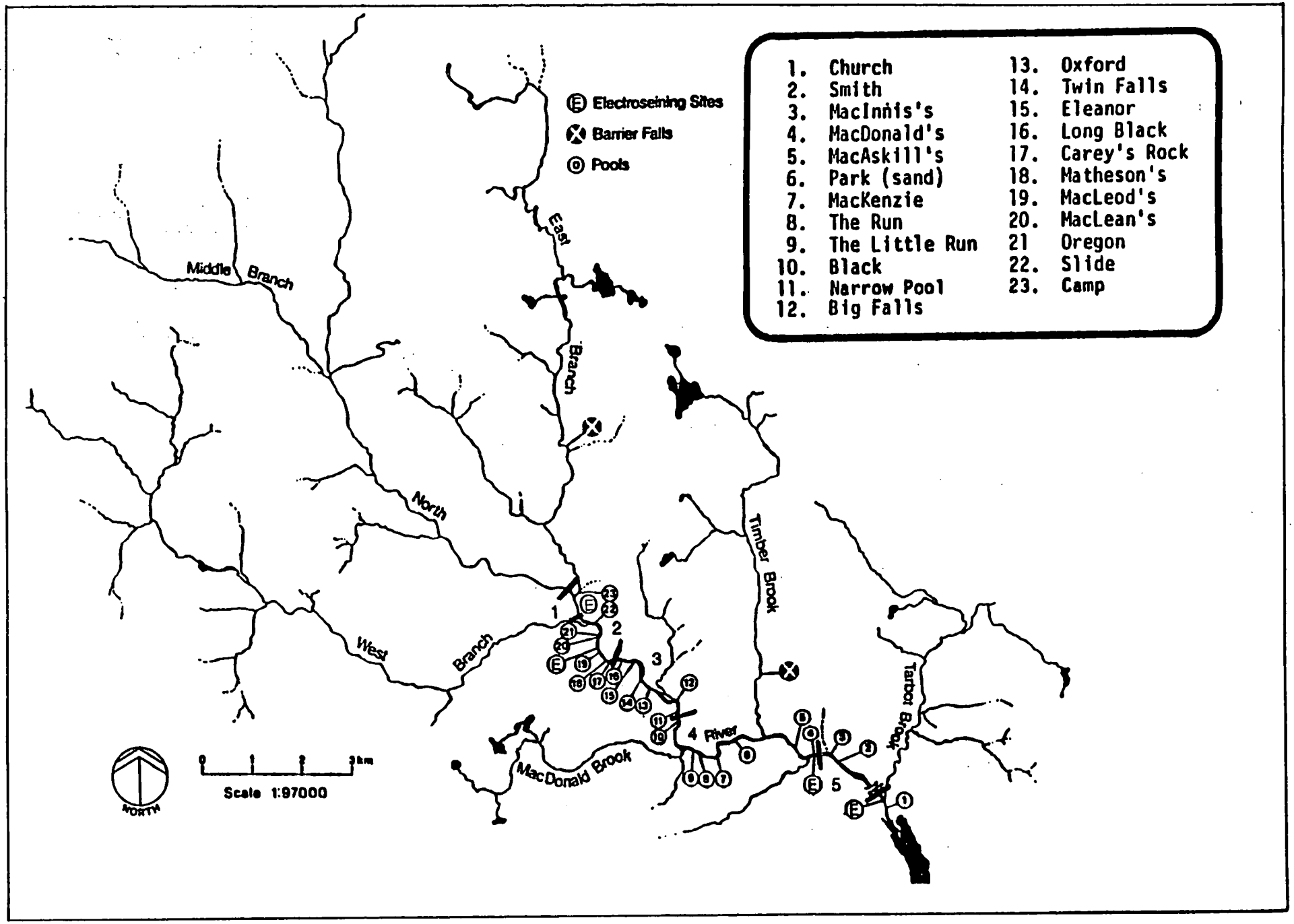

Fig. 11. North River, Victoria County, showing names and locations of angling pools, swim-thru sections (uncircled numbers and slash to mark section boundary) and elctrofishing sites in 1997.

Appendix I. Middle River mark-and-recapture data background to Bayes estimates of populations of 1SW and MSW salmon, October 1994-1997. 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			
	Oct-20,22	Cabin (Sec 2)	2	1	3	17	{4	{3 {7	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.					

Appendix II. Baddeck River mark-and-recapture data background to Bayes estimates of populations of 1SW and MSW salmon, October 1994-1997. Section numbers shown Fig. 10.

Year	Dates M/ R	Location	Tags Applied (M) MSW	1SW	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
						Recapture 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
						Recapture 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
						Recapture 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
						Recapture 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.					

Appendix III. North River mark-and-recapture data background to Bayes estimates of populations of 1SW and MSW salmon, October 1994-1997. Pools and Sections shown Fig. 11.

Year	Dates M/ R	Location	Tags Applied (M) MSW	1SW	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 coditions: 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.