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An update on the status of Atlantic salmon on Prince Edward Island in 1999

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ABSTRACT

Atlantic salmon runs on Prince Edward Island are maintained largely by stocking semi-naturally reared fish in several of the larger rivers, notably the Morell. Total harvest mortality of small salmon was estimated as 325 in 1997, 289 in 1998, and 192 in 1999. In the same years, respectively, 77, 114, and 150 large salmon were hooked and released. Salmon counted at the Leards Pond fishway on the Morell's West Branch totaled 230 in 1997 and 86 in 1999. A mark-recapture experiment suggested that most salmon entering the pond in 1997 were enumerated at the counting station. In 1999, large salmon were seined upstream from Leards, although no large salmon had been released into the pond. This suggests that there were problems with trap efficiency in 1999. Juvenile densities measured by electrofishing averaged 18.9 100 m^{-2} in 1998 and 21.0 100 m^{-2} in 1999, the highest densities since 1994. Estimated egg deposition as a percent of conservation for the Morell's West Branch above Leards fell from 243% in 1996 to 9% in 1999. The 1999 value may be understated if trap efficiency was low in 1999. Given the fluctuations in indicators of the Morell salmon run in the last several years, there is no basis for predicting salmon runs in 2000. High sediment loading from poor land-use practices is harmful to Atlantic salmon on PEI. No change to current management is recommended for artificially reared fish, but it is recommended that the retention of wild salmon be prohibited.

RESUMÉ

Les populations des saumons de l'Atlantique de l'Île du Prince Édouard sont soutenues par le stockage des poissons élevés de façon semi-naturelle dans les plus grandes rivières, notamment la Morell. La mortalité totale due à la récolte était estimée à 325 en 1997, 289 en 1998, et 192 en 1999. Durant ces mêmes années, respectivement, 77, 114, et 150 grands saumons étaient capturés et relâchés. Les saumons comptés dans la passe migratoire de Leards sur l'affluent ouest de la Morell totalisaient 230 en 1997 et 86 en 1999. Une expérience marquage-récapture suggère que la plupart des poissons qui entraient dans l'étang Leards en 1997 était énuméré à la station de comptage. En 1999, des grands saumons étaient capturés avec une seine-bourse en amont de Leards, malgré le fait qu'aucun grand saumon n'était relâché dans l'étang. Ceci suggère que la trappe avait des problèmes d'efficacité en 1999. La densité moyenne des juvéniles mesurée par la pêche électrique était 18.9 100 m^{-2} en1998 et 21.0 100 m^{-2} en 1999, les valeurs les plus hautes depuis 1994. La déposition des ouefs comme pourcentage des besoins de la conservation dans l'affluent ouest de la Morell en amont de Leards a chuté de 243% en 1996 à 9% en 1999. La valeur pour 1999 est possiblement sous-estimée si l'efficacité de la trappe était basse en 1999. Vues les fluctuations dans les indicateurs des populations du saumons depuis quelques années, il y a pas de base pour prédire les arrivés du saumon en 2000. Un fort fardeau de sédiments dû aux mauvaises pratiques d'utilisation du terrain est nuisible pour le saumon de l'Atlantique de l'Île du Prince Édouard. Aucun changement dans le régime de gestion n'est recommandé pour les poissons élevé de façon artificielle, mais on recommande que la rétention des saumons sauvages soit interdite.

INTRODUCTION

Prince Edward Island has a low diversity of freshwater fishes, and native game fishes are limited to brook trout and Atlantic salmon. Brook trout are present, often in substantial numbers, in nearly all PEI streams. Atlantic salmon were formerly widespread and abundant, but self-sustaining runs persist in only a small number of streams. Atlantic salmon are also stocked in several of the larger rivers, using a technique known as semi-natural rearing (Bielak et al. 1991).

The Morell River is PEI's best salmon stream from the points of view of wild juvenile production, runs of stocked and wild fish, and angler harvest (Cairns 1996, 1997). This paper provides an update on the status of Prince Edward Island Atlantic salmon, with emphasis on those of the Morell. Salmon status on PEI has been previously reviewed by Ducharme (1977), Bielak et al. (1991), Davidson and Bielak (1992), Davidson and Angus (1994), Cairns et al. (1995, 1996), and Cairns (1997).

DESCRIPTION OF FISHERIES

In most PEI rivers the angling season for Atlantic salmon is 15 June to 15 September, but in the Morell the season starts on 1 June continues to various dates in the fall, depending on the site (Figs. 1 and 2) (see Cairns 1997). The daily bag limit is one salmon and the seasonal limit is seven. Retention of large salmon is prohibited. Salmon licence sales were 450 1999 (Table 1). The Department of Fisheries and Oceans and the PEI Native Council have an agreement providing for an allocation of 400 small Atlantic salmon from the Morell River.

CONSERVATION REQUIREMENT

Conservation requirements for Atlantic salmon, based on 2.4 eggs m^{-2} of non-impounded, non-tidal river area, are 569,222 eggs for the Morell, including 179,345 eggs for the West Branch upstream from Leards Pond (see Davidson and Bielak 1992 and Cairns et al. 1995 for habitat area, fecundities, and sex ratios).

FISHERIES DATA

Stocking

Most salmon stocked on PEI are raised during their first year of life at the Cardigan Hatchery, and then transferred at age 1+ into open ponds where they are fed artificial foods. A smaller number of salmon are released directly after hatchery rearing. Numbers stocked are given in Tables 2 and 3. Exact numbers of fish entering the wild are not known because most fish that have been reared semi-naturally in ponds are allowed to leave without being counted.

Angler surveys

Angler harvest of Atlantic salmon on PEI has been estimated by a stub return survey since 1995 (Tables 4 and 5). Total retained catch of small salmon was 320 in 1997, 282 in 1998, and 186 in 1999 (Table 5). Anglers hooked and released an estimated 77, 114, and 150 large salmon in 1997-1999, respectively.

Native harvest

The PEI Native Council harvested 1, 28, and 0 small salmon from the Morell River in 1997-1999, respectively. Members and associates of the Abegweit Band initiated a commercial fishery for salmon in the Morell and West Rivers in fall 1999. Numbers harvested are unknown, but are thought to be very small.

RESEARCH DATA

Morell adult counts

Adult salmon ascending into Leards Pond on the Morell River have been trapped and counted in 1981-1997 and in 1999. In 1997, unlike other years, salmon were permitted to ascend the bypass as well as the fishway. A fence and trap were installed at the top of the bypass to capture fish that came that way. Salmon counted at Leards numbered 230 and 86 in 1997 and 1999, respectively (Table 6, Fig. 3). Leards counts for 1999 include 27 salmon which were seined on 9 September from the pool immediately below the fishway. Most (94%) salmon taken in 1997 and 1999 were small, and only 15-17% were of wild origin. Due to removals by Cardigan Hatchery for broodstock purposes, only 30 salmon (all small) were released into Leards Pond in 1999.

Following suggestions that the Leards trap was not capturing all ascending salmon, a mark-recapture scheme was set up in 1996 to measure its capture efficiency (Cairns 1997). It was estimated that the trap captured 40% of salmon entering Leards Pond. In 1997 a further test was conducted. One hundred and eighty nine salmon were put in Leards Pond on 7 June-30 July; 117 of these were marked with Alcian blue dye administered by a Madajet needleless injector (Table 7). On 23 July and 1 August, the pool below Mooneys Pond was seined and 52 salmon were captured. Fifty-five percent of these fish bore dye marks. The Baysian median estimate of fish entering Leards Pond was 224 fish, assuming no mortality between capture and release. Under this assumption, trap efficiency was 84.4%.

However, it is likely that at least some mortality occurred between capture and recapture. Salmon captured in the fishway in late June and early July 1997 had surface lesions that varied from minor to severe. In some the patches of skin were removed and muscle tissue was exposed. These lesions were apparently due to fish attempting to ascend the bypass, which consists of a sloping concrete apron whose surface has been roughened by erosion. Water flow over the bypass was at the time only a few centimetres deep, leaving insufficient water for adult salmon to swim in a normal upright position. Laboratory examination showed no signs of infection or other disease processes other than those which would be expected to invade surface wounds (D. Groman, Atlantic Veterinary College, pers. comm.). The lesions were consistent with physical trauma caused by the beating of tails and bodies against the rough surface of the bypass. If this trauma led to death of some fish released into the pond, then the calculated trap efficiency (84.4%) would be an underestimate (Table 7). It is not known if the apparent increase in trap efficiency from 1996 to 1997 is due to the difference in the capture system, because trap efficiency has not been measured in other years.

In 1998 and 1999, Morell salmon were counted by seine, canoe, snorkel, and wading surveys (Tables 8 and 9). The total number of fish counted during these surveys in 1998 was 242 (214 small and 28 large). The bulk of these counts in 1998 came from seinings in the pool below Mooneys Pond. In-river counts yielded only 31 fish on 29 June and nine fish on 14 September. On 16 July 1999, a survey located 59 salmon in the river. Most of these were at Grants (24) and in the pool below Leards Pond and the lower portion of the Leards fishway (28) (Table 9).

The efficiency of the Leards trap was not directly estimated in 1999. However, in September 1999 a seining of the pool below Mooneys Pond yielded 10 large salmon, as well as a sizable but uncounted number of small salmon. No large salmon were released into Leards Pond from the Leards trap in 1999. The presence of these fish at Mooneys suggests that the Leards trap had a low capture efficiency in 1999, but this efficiency cannot be quantitatively estimated.

Juvenile densities

Densities of juvenile Atlantic salmon averaged 18.9 and 21.0 fish 100 m^{-2} in 1998 and 1999, respectively (Table 10, Fig. 4). These are the highest mean densities recorded since 1994.

ASSESSMENT RESULTS

Counts at Leards Fishway do not indicate the salmon run of the Morell because of the problem of trap efficiency, and also because Leards is located in the upper part of the river and therefore only intercepts part of the Morell run. In 1998 and 1999 we attempted to determine the number of fish in the river by visual surveys. The number of salmon sightings recorded during the 1998 survey (242, Table 8) was much lower than the angling catch as estimated by the stub survey (440, Table 5). This suggests that the visual surveys encountered only a small portion of the total run. There is often a substantial angling fishery (and harvest) of salmon in Leards Pond (pers. obs.). Salmon cannot be visually counted in Leards Pond because of its depth and poor transparency. Absence of data from Leards Pond may explain, at least in part, the low totals of the visual surveys.

Numbers of Atlantic salmon entering Leards Pond, and their potential egg deposition, is not known exactly due to uncertainties in the capture efficiency of the Leards trap (Cairns 1997). Nevertheless the time series of counts, less broodstock removals, may indicate trends. Numbers rose sharply in the late 1980s, peaked in 1988, and have fluctuated in a downward trend since (Table 11, Fig. 5). Calculated egg deposition above Leards as a percent of conservation requirement was estimated at 243% in 1996 but has been below requirement since, falling to 9% in 1999. If capture efficiency has been low in years in which it was not measured, true egg deposition will be higher than that calculated, by an unknown amount.

FORECASTS/PROSPECTS

The Morell River salmon run depends largely on stocked fish. Despite a relatively consistent stocking effort in recent years, numbers of fish counted at the Leards fishway have fluctuated greatly in the same period. Angler catches have also fluctuated, although not to the same extent. Given the apparent high variability of returns to the Morell, there is no basis for predicting salmon runs in 2000.

MANAGEMENT CONSIDERATIONS

A recent review (DFO 2000) has concluded that the high sediment loading of PEI rivers is sufficient to explain the absence of salmon from most, if not all, of the streams in which they were formerly abundant, and the failure of stocking programs to re-establish substantial natural production in rivers other than the Morell. There were eight known pesticide-related fish kills in PEI in 1999. The major impact on salmon was on the Valleyfield River.

Cultivation of potatoes is a major contributor to sedimentation and the pesticides implicated in the fish kills had been applied to potatoes. Potato acreage has increased greatly on PEI in recent years.

Although firm data are lacking, it appears likely that 1999 salmon returns to the Morell as a whole were below conservation requirements. Returns in other PEI rivers have never met conservation requirements, and are usually far below them (Cairns 1997). Most salmon returning to the Morell are of hatchery origin and hatchery fish also dominate returns to other major PEI rivers (Cairns 1997). Given the artificial origin of most returning fish, no change to current management is recommended for hatchery-reared fish.

However, the runs on the Morell and the other major salmon rivers also include a wild component. There are also small streams (e.g. North Lake Creek) in which natural, unstocked runs persist (D. Guignion pers. comm.). The number of wild fish in these runs is far below conservation requirement, and these fish should be protected. It is therefore recommended that retention of wild-reared salmon, as indicated by the presence of an intact adipose fin, be prohibited on PEI.

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Table 1
Atlantic salmon sport catches on the Morell River, 1955-1999.

Year	Salmon caught and retained			Salmon caught and released			Fishing effort	Licences
	Small	Large	Total	Small	Large	Total	(rod-days)	issued for PEI
1955[a]			21				18	
1956			29				87	
1957			3				52	
1958			9				52	
1959			4				34	
1960			4				44	
1961			15				45	
1962			13				50	
1963			51				280	
1964			12				46	
1965			12				115	
1966			10				N/A	
1967			26				206	
1968			10				192	
1969			12				214	
1970	0	13	13				204	
1971	0	0	0				83	
1972	0	7	7				138	
1973	2	0	2				168	
1974	0	2	2				78	
1975	0	0	0				0	
1976	6	1	7				250	
1977	0	0	0				105	
1978	0	0	0				60	
1979	1	2	3				54	
1980	5	1	6				119	
1981	108	4	112				914	
1982	73	8	81				2,088	
1983	7	2	9				686	321
1984	7	0	7				675	68
1985	47	N/A	47				1,007	117
1986	236	N/A	236				2,725	279
1987	476	N/A	476				N/A	461
1988	643	N/A	643				4,994	719
1989	167	N/A	167				4,506	646
1990	768	N/A	768				9,000	793
1991[b]	657	N/A	657	1,033	164	1,197	11,552	716
1992	781	N/A	781			1,044	11,700	928
1993	N/A	N/A	N/A				N/A	829
1994	92	3	95	111	99	210	4,911	587
1995[c]	473	4	477	146	95	241	5,073	633
1996	422	4	427	270	150	420	4,156	697
1997	202	1	203	92	36	127	2,796	616
1998	265	2	267	133	68	200	2,809	520
1999	151	4	155	141	117	258	2,418	450

[a]Figures for 1955-1990 are estimates by DFO fisheries officers (Smith 1981; O'Neil and Swetnam 1984, 1991; Swetnam and O'Neil 1984, 1985; Bielak et al. 1991).

[b]Figures for 1991, 1992, and 1994 are from angler mail-out surveys (MacFarlane and Guignion 1992, 1993; Cairns 1996).

[c]Figures for 1995-1999 are angler harvest (including estimated hook and release mortality) from licence stub surveys, plus reported native harvest.

Table 2
Numbers of juvenile Atlantic salmon stocked in the Morell River, 1995-1999, and their stages at release (stocking numbers for 1978-1994 are given by Cairns et al. 1996.)

Year	Genetic stock	Rearing location	Numbers released and location[ab]				Total released
			Parr		Smolt		
			1+	2+	1+	2+	
1995	Morell mixed	Mooneys Pond[d]		1,270 Mo		6,552 Mo	15,568
				503 Ca		2,230 Ca	
				89 Gr		4,924 Gr	
1996	Morell mixed	Mooneys Pond[e]		5,573 Mo		41,019 Mo	46,592
1997	Morell mixed	Mooneys Pond[e]		5,597 Mo		41,203 Mo	46,800
1998	Morell mixed	Mooneys Pond[e]		5,453 Mo		40,138 Mo	45,591
1999	Morell mixed	Mooneys Pond[e]		Mo		Mo	45,224

[a]Release locations are Mooneys Pond outlet (Mo), Old Cardigan Road (Ca), and Grants (Gr).

[b]All fish were released in April or May.

[d]Includes fish counted at the outlet to Mooneys Pond, and estimations derived from counts at the Indian Bridge smolt fence (Cairns et al. 1997).

[e]Smolts leave in spring on their own accord, without being counted. Numbers are estimated from numbers of 1+ parr released in the pond in the previous year, removals to other systems, (1995 only), and assuming a 65% survival rate.

Table 3
Stocking dates and numbers of juvenile Atlantic salmon stocked in the Mill, Trout, Dunk, West, Midgell, and Valleyfield Rivers, 1995-1999. (Stocking numbers for 1985-1994 are given in Cairns et al. 1996).

Year	Rearing location	Stage stocked	Date stocked	Numbers stocked					
				Mill River	Trout River	Dunk River	West River	Midgell River	Valleyfield River
1995	Cardigan SEC	1+ parr						9,367[a]	11,585[b]
		2+ smolt	19 Apr-5 May				5,037		6,220
	Profitts Pond	2+ parr	1-2 May	364		280			
		2+ smolt	1-2 May	3,923		5,179			
	Mooneys Pond	2+ parr	13 May				2,915		3,937
		2+ smolt	13 May				586		1,330
	Gilberts Pond	2+ smolt	Spring						4,030[c]
1996	Mooneys Pond	2+ parr	24 Apr				212		140
		2+ smolt	24 Apr				2,005		2,010
	Munns Pond	2+ smolt	25-26 Apr				4,754		5,962
	Profitts Pond	2+ smolt	29-30 Apr	1,065		11,350			
	Cardigan SEC	1+ smolt	22 Apr						1,733
		1+ parr	1 Nov					8,564	
	Gilberts Pond	2+ smolt	Spring						5,460[c]
1997	Munns Pond	2+smolt					1,766		3,327
	Cardigan Hatchery	1+smolt	5 May						3,044
		1+parr	25 Sep					4,900	
	Gilberts Pond	2+smolt							5200[c]
1998	Munns Pond	2+smolt	25 Apr						5,400
	Profitts Pond	2+parr	Apr	136	1,830	616			
		2+smolt	Apr	1,842	15,691	4,562			
	Cardigan Hatchery	2+smolt	24 Apr				10,206		
	Gilberts Pond	1+parr	Late fall						4200[d]
1999	Munns Pond	2+smolt	03-May						3,200
	Profitts Pond	2+fish	26,27 Apr		21,000				
	Cardigan Hatchery	1+parr	Oct						3,500

[a]Stocked 27 November

[b]Stocked 5 July

[c]Smolts leave in spring on their own accord, without being counted. Numbers are estimated from numbers of 1+ parr released in the pond in the previous years, and assuming a 65% survival rate.

[d]Gilberts Pond breached in late fall 1998 (or possibly January 1999). It is assumed that the juvenile salmon that had been placed in the pond entered the river as 1+ parr.

Table 4
Mailing and return statistics for the PEI salmon licence stub survey, 1995 -1999.

	1995	1996	1997	1998	1999
Number of licences issued	633	697	616	520	450
Number of stubs returned	59	63	51	47	46
Percent of stubs returned	9.3	9.0	8.3	9.0	10.2
Number of reminder cards mailed	589	596	570	453	393
Number of reminder cards returned as undeliverable	35	28	33	35	23
Number of reminder cards returned by anglers	168	175	174	171	111
Percent of reminder cards returned by anglers	28.5	29.4	30.5	37.7	28.2
Total number of anglers who returned either stubs or cards	221	237	222	212	157
Number of anglers returning stubs/cards as a percent of licences issued	34.9	34.0	36.0	40.8	34.9
Number of anglers whose stubs/cards have full catch and effort data	200	214	208	192	150
Stubs/cards with full catch and effort data as a percent of licences issued	31.6	30.7	33.8	36.9	33.3
Stubs/cards with full data which reported fishing	161	172	158	149	115
Percent fishing	80.5	80.4	76.0	77.6	76.7

Table 5
Salmon fishing effort and harvest in Prince Edward Island rivers, 1994-1999. 1994 data are from a mail-out survey (Cairns 1996). All other data are from licence stub surveys.

Year	Percent of respond-ents who fished river	Estimated total number of anglers who fished river	Mean number of rod-days per angler who fished river	Estim-ated total rod-days	Mean catch per rod-day				Estimated recreational catch				Estimated total harvest, including hook and release mortality[a]						
					Small salmon kept	Small salmon released	Large salmon released	All salmon	Small salmon kept	Small salmon released	Large salmon released	All salmon	Small, recre-ational	Large, recre-ational	Native, small	Native, large	Total, small	Total, large	Total, small and large
~~Morell~~																			
1994									89	111	99	299	92	3			92	3	95
1995	72	453	11.2	5,073	0.089	0.029	0.019	0.136	449	146	95	690	454	3	19	1	473	4	477
1996	66	462	9.0	4,156	0.096	0.065	0.036	0.197	397	270	150	818	405	4	17	0	422	4	427
1997	59	361	7.7	2,796	0.071	0.033	0.013	0.117	198	92	36	326	201	1	1	0	202	1	203
1998	63	325	8.6	2,809	0.083	0.047	0.024	0.154	233	133	68	433	237	2	28	0	265	2	267
1999	65	291	8.3	2,418	0.061	0.058	0.048	0.167	147	141	117	405	151	4	0	0	151	4	155
~~Mill~~																			
1994									11	NA	0	NA	11	0			11	0	11
1995	2	9	9.0	85	0.000	0.000	0.000	0.000	0	0	0	0	0	0			0	0	0
1996	7	52	4.2	218	0.119	0.075	0.030	0.224	26	16	7	49	27	0			27	0	27
1997	6	36	5.1	181	0.049	0.000	0.016	0.066	9	0	3	12	9	0			9	0	9
1998	7	38	8.4	317	0.017	0.034	0.026	0.077	5	11	8	24	6	0			6	0	6
1999	5	24	3.9	93	0.194	0.097	0.000	0.290	18	9	0	27	18	0			18	0	18
~~Trout (Coleman)~~																			
1994									5	6	0	11	5	0			5	0	5
1995	3	19	13.5	256	0.025	0.012	0.012	0.049	6	3	3	13	6	0			6	0	7
1996	7	46	6.1	277	0.024	0.000	0.024	0.047	7	0	7	13	7	0			7	0	7
1997	11	65	7.6	498	0.048	0.042	0.006	0.095	24	21	3	47	24	0			24	0	24
1998	8	41	3.9	157	0.000	0.121	0.017	0.138	0	19	3	22	1	0			1	0	1
1999	7	30	4.1	123	0.073	0.049	0.049	0.171	9	6	6	21	9	0			9	0	9
~~Dunk~~																			
1994									11	38	5	54	12	0			12	0	12
1995	4	25	12.9	326	0.000	0.010	0.000	0.010	0	3	0	3	0	0			0	0	0
1996	7	52	6.8	352	0.009	0.306	0.037	0.352	3	107	13	124	6	0			6	0	7
1997	9	56	6.4	358	0.017	0.041	0.041	0.099	6	15	15	36	6	0			6	0	7
1998	13	65	11.2	729	0.019	0.007	0.015	0.041	14	5	11	30	14	0			14	0	14
1999	14	63	10.8	681	0.009	0.018	0.004	0.031	6	12	3	21	6	0			6	0	6
~~West~~																			
1994									20	38	NA	NA	21				21	0	21
1995	16	101	12.7	1,282	0.010	0.030	0.017	0.057	13	38	22	73	14	1			14	1	14
1996	24	166	6.1	1,006	0.061	0.055	0.042	0.159	62	55	42	160	64	1			64	1	65
1997	21	130	6.0	779	0.068	0.030	0.015	0.114	53	24	12	89	54	0			54	0	54
1998	18	95	6.9	653	0.017	0.004	0.017	0.037	11	3	11	24	11	0			11	0	11
1999	16	72	7.4	534	0.000	0.022	0.006	0.028	0	12	3	15	0	0			0	0	0
~~Valleyfield~~																			
1994									5	28	5	38	5	0			5	0	5
1995	4	22	28.1	624	0.025	0.015	0.025	0.066	16	9	16	41	16	0			16	0	17
1996	12	85	5.5	466	0.077	0.049	0.042	0.168	36	23	20	78	37	1			37	1	37
1997	7	41	11.2	465	0.032	0.038	0.019	0.089	15	18	9	41	15	0			15	0	16
1998	8	41	8.1	330	0.000	0.074	0.000	0.074	0	24	0	24	1	0			1	0	1
1999	6	27	4.0	108	0.000	0.000	0.000	0.000	0	0	0	0	0	0			0	0	0

Table 5 (continued)

Year	Percent of respond-ents who fished river	Estimated total number of anglers who fished river	Mean number of rod-days per angler who fished river	Estim-ated total rod-days	Mean catch per rod-day				Estimated recreational catch				Estimated total harvest, including hook and release mortality						
					Small salmon kept	Small salmon released	Large salmon released	All salmon	Small salmon kept	Small salmon released	Large salmon released	All salmon	Small, recre-ational	Large, recre-ational	Native, small	Native, large	Total, small	Total, large	Total, small and large
~~Montague~~[b]																			
1994																			
1995	1	6	1.5	9	0.000	0.333	0.000	0.333	0	3	0	3	0	0			0	0	0
1996	0	0	NA	0	NA	NA	NA	NA	0	0	0	0	0	0			0	0	0
1997	3	21	6.0	124	0.095	0.000	0.000	0.095	12	0	0	12	12	0			12	0	12
1998	6	30	7.6	228	0.071	0.071	0.000	0.143	16	16	0	33	17	0			17	0	17
1999	4	18	6.2	111	0.054	0.081	0.189	0.324	6	9	21	36	6	1			6	1	7
												0							
~~All rivers~~																			
1994									142	NA	NA	NA	142						
1995	80	506	15.1	7,669	0.063	0.027	0.018	0.109	484	209	139	832	491	4	19	1	491	4	495
1996	81	563	11.5	6,478	0.082	0.073	0.037	0.192	534	472	238	1,244	548	7	17	0	548	7	555
1997	76	468	11.2	5,254	0.061	0.034	0.015	0.109	320	178	77	575	325	2	1	0	325	2	327
1998	78	404	13.5	5,457	0.052	0.043	0.021	0.115	282	233	114	628	289	3	28	0	289	3	292
1999	75	339	12.0	4,068	0.046	0.046	0.037	0.129	186	189	150	525	192	5	0	0	192	5	196

[a]Assumed to be 3%.

[b]1994 Montague data are included with those of the Valleyfield.

Table 6

Atlantic salmon counted at Leards fishway and released into Leards Pond after broodstock removals, 1981-1999.
No data available for 1998.

Year	Small salmon						Large salmon						All salmon				
	Counted in trap					Re-	Counted in trap					Re-	Counted in trap				Re-
	Wild	Hatch-ery	Total	% wild	% small	leased in pond[a]	Wild	Hatch-ery	Total	% wild	% large	leased in pond[a]	Wild	Hatch-ery	Total	% wild	leased in pond[a]
1981	0	39	39	0.0	86.7	39	6	0	6	100.0	13.3	6	6	39	45	13.3	45
1982	6	27	33	18.2	91.7	33	1	2	3	33.3	8.3	3	7	29	36	19.4	36
1983	1	1	2	50.0	50.0	2	0	2	2	0.0	50.0	2	1	3	4	25.0	4
1984	3	2	5	60.0	55.6	5	2	2	4	50.0	44.4	4	5	4	9	55.6	9
1985	2	12	14	14.3	93.3	14	1	0	1	100.0	6.7	1	3	12	15	20.0	15
1986	1	619	620	0.2	99.0	278	2	4	6	33.3	1.0	3	3	623	626	0.5	281
1987	2	1,166	1,168	0.2	94.5	658	2	66	68	2.9	5.5	54	4	1,232	1,236	0.3	712
1988	8	1,386	1,394	0.6	94.1	1,290	2	87	89	2.2	6.0	20	10	1,471	1,481	0.7	1,310
1989	12	323	335	3.6	72.8	330	0	125	125	0.0	27.2	48	12	448	460	2.6	378
1990	44	365	409	10.8	86.7	368	4	59	63	6.3	13.3	44	48	424	472	10.2	412
1991	33	294	327	10.1	89.3	280	11	28	39	28.2	10.7	14	44	322	366	12.0	294
1992	64	843	907	7.1	95.2	824	8	38	46	17.4	4.8	14	72	881	953	7.6	838
1993	44	584	628	7.0	98.3	461	0	11	11	0.0	1.7	0	44	595	639	6.9	461
1994	8	28	36	22.2	55.4	2	2	27	29	6.9	44.6	3	10	55	65	15.4	5
1995	14	172	186	7.5	92.5	130	5	10	15	33.3	7.5	2	19	182	201	9.5	132
1996[b]	78	470	548	14.2	88.0	498	10	65	75	13.3	12.0	65	88	535	623	14.1	563
1997	32	185	217	14.7	94.3	209	4	9	13	30.8	5.7	11	36	194	230	15.7	220
1999[c]	15	66	81	18.5	94.2	30	0	5	5	0.0	5.8	0	15	71	86	17.4	30
~~Totals and means~~																	
Total	367	6,582	6,949			5,451	60	540	600			294	427	7,120	7,547		5,745
Mean	20.4	365.7	386.0	14.4	85.1	302.8	3.3	30.0	33.3	25.5	14.9	16.3	23.7	395.6	419.3	13.7	319.2

[a]Number adjusted for removals for broodstock and other purposes at Leards. This number does not reflect broodstock removals at Mooneys.

[b]Estimated number of fish ascending Leards Dam based on the fishway trapping efficiencies calculated for 1996 (40.0%).

[c]Includes 21 small hatchery, 1 small wild, and 5 large wild salmon which were seined from the pool below Leards Dam on 9 September

Table 7
Mark-recapture estimates of Atlantic salmon entering the West Branch of the Morell River above Leards Dam in 1997.

	Number
Counts at Leards Dam, 7 June-30 July	
Small salmon entering traps	191
Large salmon entering traps	5
Small salmon removed for pathology examination	5
Large salmon removed for broodstock	2
Small salmon put in pond	186
Large salmon put in pond	3
Total salmon put in pond	189
Small salmon dye-marked and put in pond	115
Large salmon dye-marked and put in pond	2
Total salmon dye-marked and put in pond	117
Captures at pool below Mooneys Pond, 23 July and 1 August	
Small salmon captured	51
Large salmon captured	1
Total salmon captured	52
Small captured that had dye-marks	28
Large captured that had dye-marks	0
Total captured that had dye-marks	28
Percent of captures that had dye-marks	54.9
Mark-recapture estimate of number of fish entering Leards Pond in June-July	
Assuming no mortality between release and re-capture	
Baysian median	224
95% confidence limits	178-303
Trap efficiency (percent)	84.4
Assuming 10% mortality between release and re-capture	
Baysian median	202
95% confidence limits	160-273
Trap efficiency (percent)	93.6

Table 8
Counts of Atlantic salmon in the Morell River, 1998.

Site	29 June				~25 July				~10 August				25 August			
	Small	Large	Total	Method[a]	Small	Large	Total	Method	Small	Large	Total	Method	Small	Large	Total	Method
Pool below Mooneys Pond	19	3	22	Seine	31	0	31	Seine	28	2	30	Seine	27	0	27	Seine
Pool below road near Mooneys Pond	0	0	0	Snorkel				NS[c]				NS				NS
Mooneys Bridge to Leards	1	0	1	Wading				NS				NS				NS
Leards to Indian Bridge	5	0	5	Canoe				NS				NS				NS
Indian Bridge to MacKays	19	3	22	Snorkel				NS				NS				NS
Cranes	0	0	0	Snorkel				NS				NS				NS
Leards	0	2	2	Snorkel				NS				NS				NS
Forks	0	0	0	Snorkel				NS				NS				NS
Grants	1	0	1	Snorkel				NS				NS				NS
Mooneys Road	0	0	0	Wading[d]				NS				NS				NS
Smolt fence pool above Indian Bridge				NS				NS				NS				NS
Total	45	8	53													

Site	14 September				21 October				Total			
	Small	Large	Total	Method[a]	Small	Large	Total	Method	Small	Large	Total	Method
Pool below Mooneys Pond	1	1	2	Snorkel	75	15	90	Seine				
Pool below road near Mooneys Pond	0	0	0	Snorkel				NS				
Mooneys Bridge to Leards				NS				NS				
Leards to Indian Bridge	1	0	1	SC[b]				NS				
Indian Bridge to MacKays	0	1	1	Snorkel				NS				
Cranes	0	0	0	Snorkel				NS				
Leards	1	0	1	Snorkel				NS				
Forks	2	0	2	Snorkel				NS				
Grants	3	1	4	Snorkel				NS				
Mooneys Road				NS				NS				
Smolt fence pool above Indian Bridge	0	0	0	Snorkel				NS				
Total	8	3	11						214	28	242	

[a]Most snorkel counts were assisted by waders or observers on the bank

[b]Spot counts; only part of area surveyed

[c]Not surveyed

[d]Assisted by observers on the bank

Table 9
Counts of Atlantic salmon in the Morell River, 16 July 1999.

	Small	Large	Total	Method
Indian Bridge to MacKays	3	0	3	Snorkel, wading, canoe
Forks to Indian Bridge (other than Mooneys Rd and Grar	0	0	0	Canoe
Mooneys Road gabions	0	0	0	Canoe, wading
Above uppermost gabion at Mooneys Road	1	0	1	Canoe
Grants	20	4	24	Snorkel, wading, canoe, count from bridge
Forks Pool	0	0	0	Snorkel, wading
Leards to Forks (other than Arts Hole)	0	0	0	Canoe
Arts Hole	2	0	2	Canoe
Pool below Leards Pond (incl. inside fishway)	21	7	28	Snorkel, spotting
West Branch, Mooneys Pond to head of Leards Pond	0	0	0	Walking
Pool below Mooneys Pond	1		1	Seine
Cranes (at bridge and in old pond site)	0	0	0	Snorkel, wading
Total	48	11	59	

Table 10
Densities (fish 100 m^{-2}) of Atlantic salmon and brook trout as measured by electrofishing on the Morell River, 1975-1999.

Date	*Indian Bridge*	*Rowells Riffle*	*Mooneys Bridge*	*Grants*	*Forks*	*Above Landing Pool*	*Lower Leards*	*Leards Bridge*	*Kennys Hole*	*Upper Kennys*	*Mooney Tracks*	*Gill Road*	*Oates*	*Old Cardigan III*	*Smiths Spring*	*Lower Cranes*	*Cranes*	*Everglades*	*Martinvale*	Mean
~~Atlantic salmon~~																				
8-12 Sep 1975	0.6		1.5	3.8	5.9			5.1												3.4
22 Aug - 11 Sep 1984					17.3			20.0	2.5								8.0			11.9
21 Aug - 5 Sep 1985		12.9	11.3				14.3	20.7	2.7								4.6			11.1
24-May-94														7.6	1.4					4.5
23 Aug - 7 Sep 1994		6.9	4.5		41.2			25.5	149.0								40.0			44.5
15-27 Dec 1994		3.1	1.3		4.1			12.2	20.0								6.0			7.8
24 Jul - 22 Aug 1995		9.9		4.9	17.9	9.9		35.5	17.7	8.6	42.2	2.3	5.9	41.9		7.6	12.7	5.7	1.3	14.9
24 Oct - 7 Nov 1995		9.1		7.6	34.7	13.0		34.3	17.0	3.0	29.8	0.0	3.7	34.1		11.6	23.3	3.9	2.9	15.2
14 Aug - 4 Sep 1996		8.3		6.5	21.7	4.5		34.4	10.5	14.8	24.6	9.5		4.7		14.6	18.0	0.0	0.0	12.3
26 Aug - 24 Sep 1997		18.4		11.2	30.8	8.5		28.0	16.1	3.8	11.3	0.0		12.2		17.5	14.6	8.1	6.3	13.4
11 Aug - 16 Sep 1998		5.7	0.6		22.7			45.8	16.4								22.4			18.9
10 - 21 Sep 1999		1.9	1.4		18.2			34.5	43.0								26.8			21.0
Mean	0.6	8.5	3.4	6.8	21.4	9.0	14.3	26.9	29.5	7.5	27.0	2.9	4.8	20.1	1.4	12.8	17.6	4.4	2.6	14.9
~~Brook trout~~																				
8-12 Sep 1975	5.1		6.5	8.8	14.2			5.5												8.0
22 Aug - 11 Sep 1984					7.8			0.0	8.2								9.3			6.3
21 Aug - 5 Sep 1985		12.6	5.4				5.4	5.0	34.8								13.3			12.8
24-May-94														16.7	34.9					25.8
23 Aug - 7 Sep 1994		9.8	5.4		14.3			0.0	32.0								125.1			31.1
15-27 Dec 1994		4.3	0.6		5.6			3.8	30.0								12.5			9.5
24 Jul - 22 Aug 1995		37.1		9.3	15.7	4.7		1.9	29.1	46.9	28.6	69.0	19.9	48.0		13.3	36.0	2.3	6.3	24.5
24 Oct - 7 Nov 1995		7.3		6.6	7.4	11.7		1.0	25.6	16.8	6.8	41.5	6.6	8.8		11.6	19.4	8.7	21.6	13.4
14 Aug - 4 Sep 1996		5.3		7.7	7.5	4.0		0.0	34.1	23.2	31.8	47.3		9.3		22.4	11.7	2.9	6.1	15.2
26 Aug - 24 Sep 1997		3.9		10.3	4.7	3.5		9.4	38.7	35.8	16.9	44.3		10.1		16.5	26.8	11.5	7.6	17.1
11 Aug - 16 Sep 1998		18.3	6.0		4.9			2.1	55.9								31.6			19.8
10 - 21 Sep 1999		30.3	4.6		3.8			5.2	39.3								40.0			20.5
Mean	5.1	14.3	4.8	8.5	8.6	6.0	5.4	3.1	32.8	30.7	21.0	50.5	13.2	18.6	34.9	16.0	32.6	6.4	10.4	17.0

Table 11
Atlantic salmon available to spawn above Leards Dam and their potential egg depositions, 1981-1999. Potential spawners are adjusted for broodstock removals at both Leard and Mooneys, but not for human harvests.

	Potential spawners		Egg deposition above Leard's Pond[a]			
	Small salmon	Large salmon	Small salmon	Large salmon	Total	Percent of target
1981	39	6	21,451	21,470	42,921	24
1982	33	3	18,151	10,735	28,886	16
1983	2	2	1,100	7,157	8,257	5
1984	5	4	2,750	14,313	17,063	10
1985	14	1	7,700	3,578	11,279	6
1986	278	3	152,907	10,735	163,642	91
1987	658	54	361,916	193,229	555,146	310
1988	1,290	20	709,532	71,566	781,099	436
1989	330	48	181,508	171,760	353,268	197
1990	368	44	202,409	157,446	359,855	201
1991	280	14	154,007	50,097	204,104	114
1992	824	14	453,221	50,097	503,317	281
1993	461	0	253,562	0	253,562	141
1994	2 [b]	3 [c]	3,143	14,889	18,032	10
1995	130	2	71,503	4,963	76,466	43
1996 [d]	498	65	273,912	161,298	435,210	243
1997	158	10	86,904	24,815	111,719	62
1998	(no data available)					
1999	30	0	16,501	0	16,501	9

[a]Based on fecundities from Davidson and Bielak 1992 and sex ratios from Davidson and Bielak 1992 and Cairns et al. 1995

[b]1 male, 1 female

[c]All females

[d]Adjusted for trap efficiency measured in 1996 (40%)

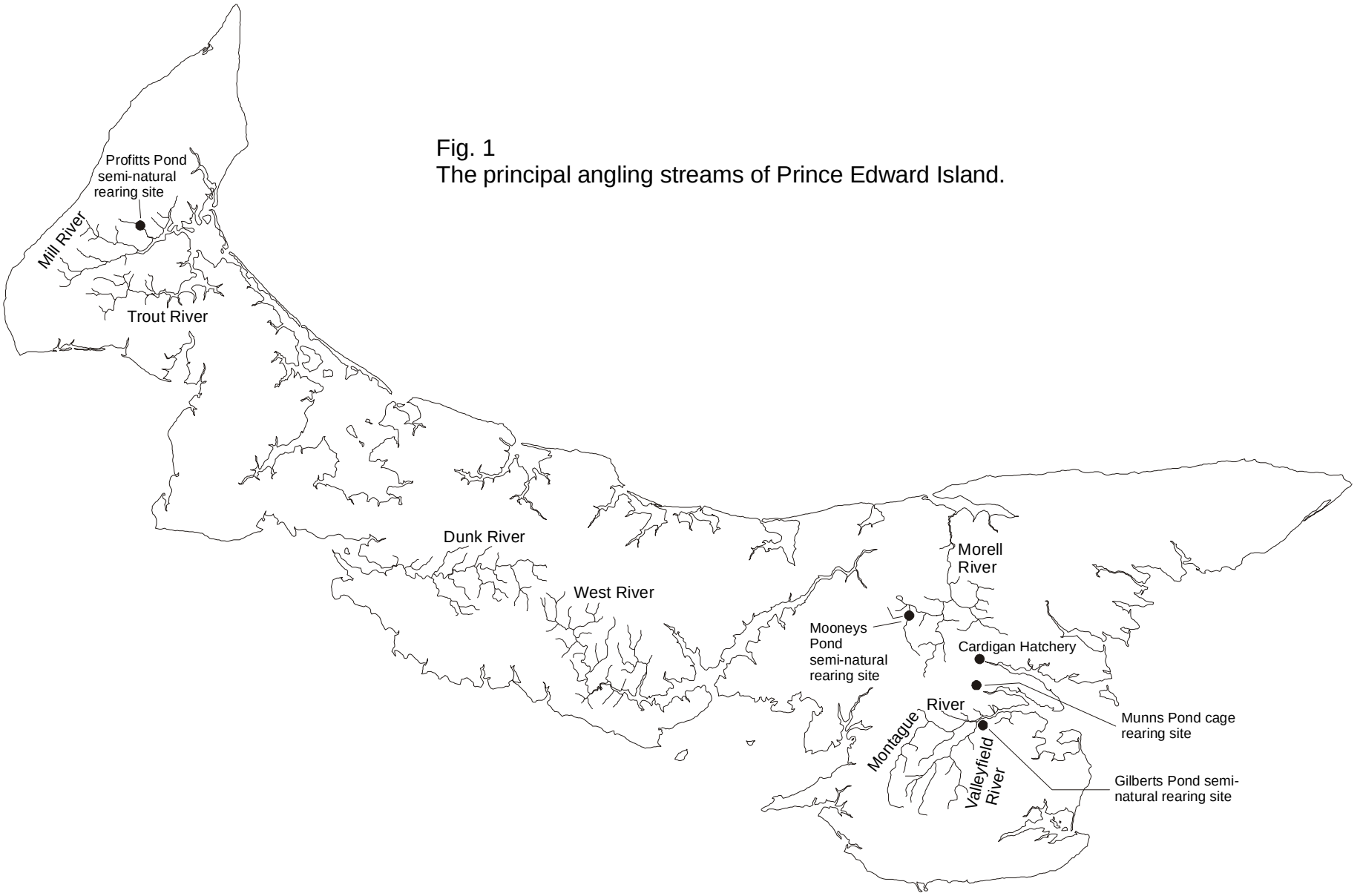
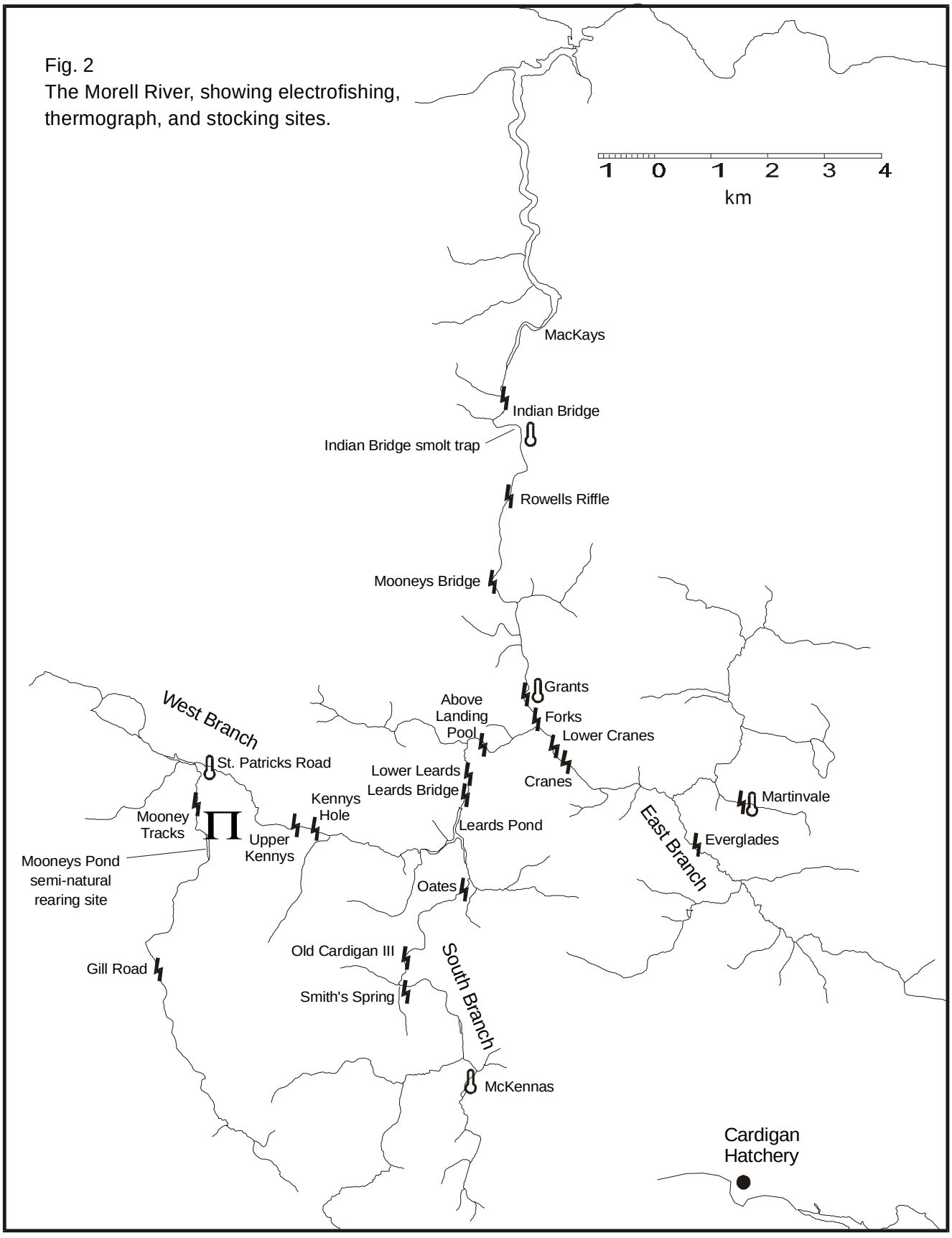


Fig. 1
The principal angling streams of Prince Edward Island.

Fig. 2
The Morell River, showing electrofishing, thermograph, and stocking sites.



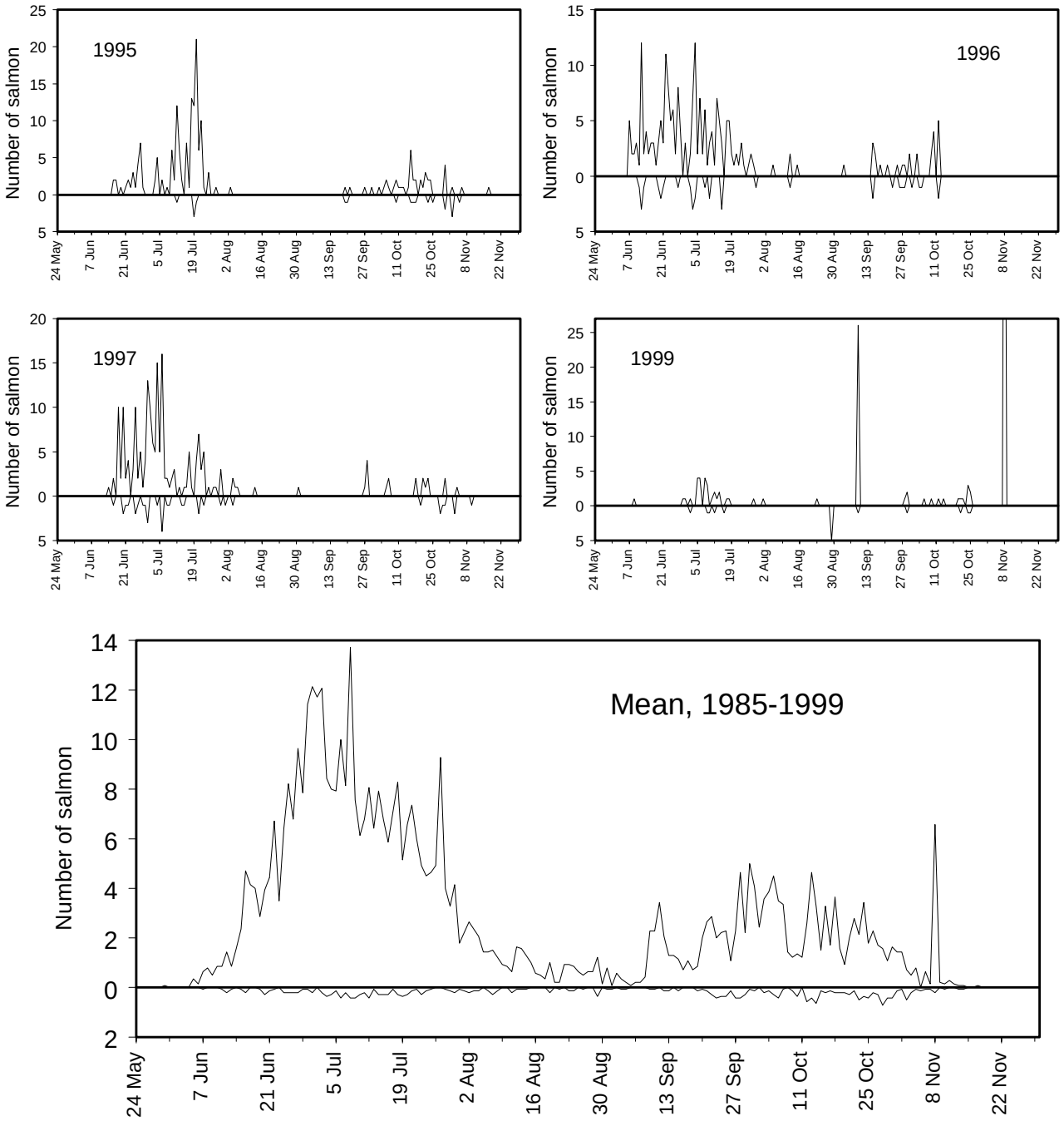


Fig. 3

Numbers of hatchery (upper panels) and wild (lower panels) salmon ascending the Leards Pond fishway 1995-1999. Fish recorded on 9 September 1999 were seined below the fishway.

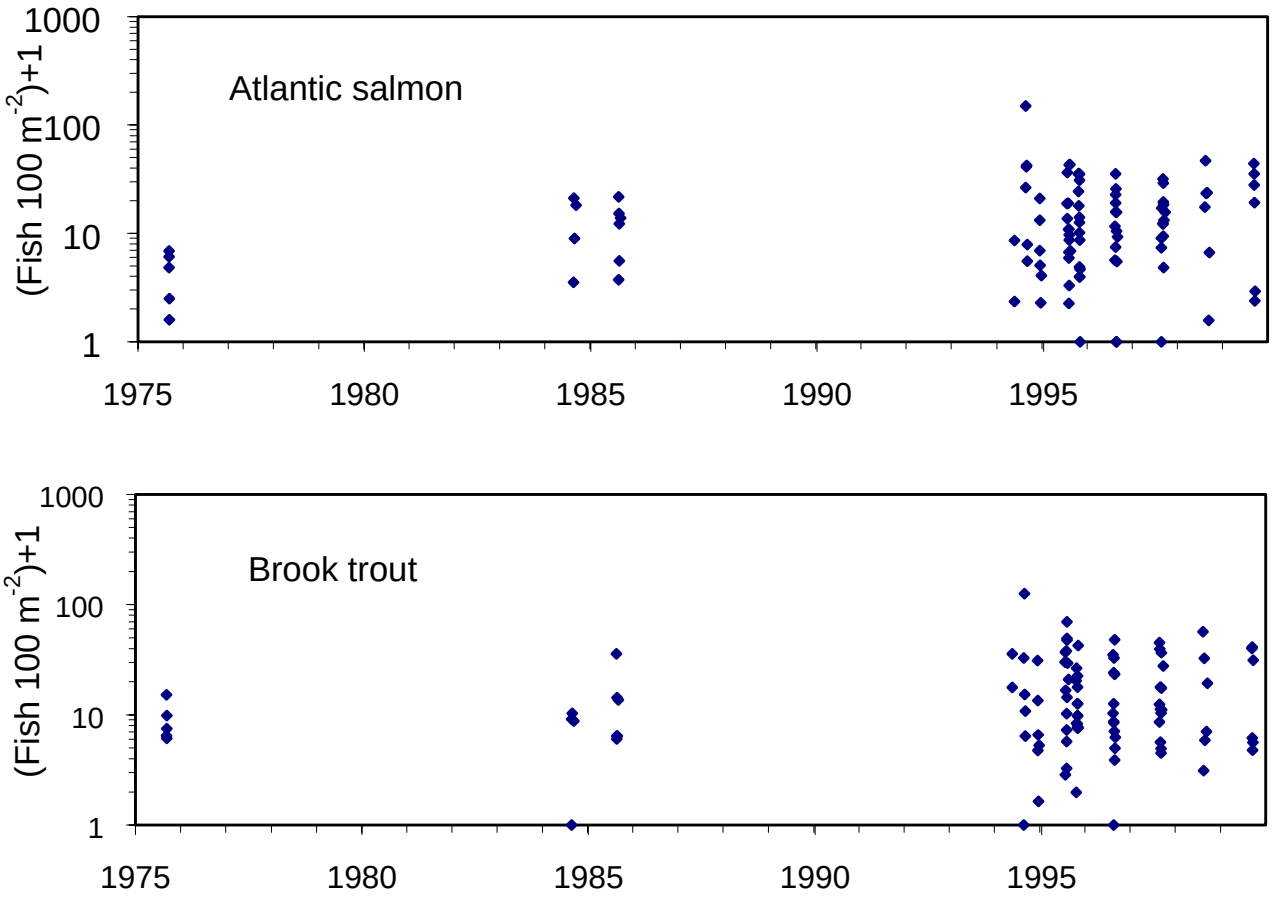


Fig. 4
Densities of Atlantic salmon and brook trout in the Morell River as measured by electrofishing.

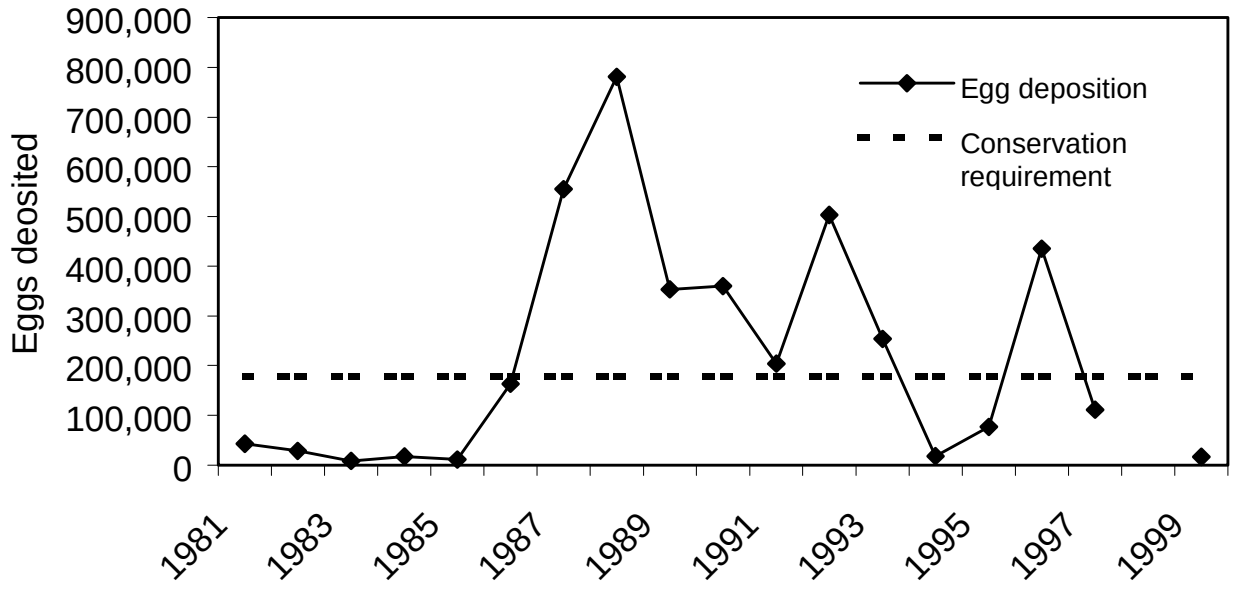


Fig. 5
Potential egg deposition by salmon released above Leards dam, 1981-1999.