Status of Atlantic salmon in the Morell, Mill, Dunk, West, and Valleyfield Rivers, Prince Edward Island, in 1995

by

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Table of Contents

Abstract

Salmon, historically abundant in Prince Edward Island, were eliminated from most streams following European colonization. Since the mid-1980s enhancement and stocking efforts have re-established salmon runs on several PEI rivers, particularly the Morell. Total conservation targets based on 2.4 eggs m^{-2} of river area are 537 large salmon and 288 small salmon for the five most important salmon streams on PEI, including 159 large salmon and 85 small salmon for the Morell.

Salmon stocking on PEI relies chiefly on fish that are reared in semi-natural open impoundments and released as 2+ smolts. About 66,291 juvenile salmon were stocked in PEI streams in 1995, including approximately 15,568 2+ parr and smolts in the Morell. A licence stub survey indicated salmon fishing effort of 7,669 rod-days in 1995, including 5,073 on the Morell, and a retained catch of 484 small salmon, including 449 on the Morell. In addition, a native harvest of 20 fish was reported.

Adult salmon trapped at the Leard's Pond fishway on the Morell River totaled 201, but fish also entered the pond without being enumerated. A trap on the lower Morell captured 127 salmon. The combined composition of trapped fish was 6% small wild, 87% small hatchery, 3% large wild, and 4% large hatchery. Electrofishing densities of juvenile salmon, measured at 15 sites and scaled up to the entire Morell basin, yielded estimates of 35,077 fish in July-August and 35,927 fish in November-December.

The Bayesian mark-recapture estimate of run size for the Morell was 1550 fish. Run size as indicated by head-of-tide traps was 30 in the Mill River, 50 in the Dunk River, and 62 in the Valleyfield River.

The return rate of small salmon for the Morell, based on the mark-recapture estimate, was 5.2%. Return rates in the Mill and West Rivers, stocked primarily with semi-natural fish, were higher than those of the Valleyfield, where most stocking has been directly from the hatchery. Angler and native exploitation on the Morell totaled 35% of returning small salmon. Potential spawn deposition on the Morell in 1995 was 159% of target, of which hatchery fish supplied 127% and wild fish supplied 33%.

If the wild fish run remains unchanged and hatchery fish return at the rate calculated for 1995, then 1030 small and large salmon will return to the Morell in 1996.

Hatchery fish remain the mainstay of PEI salmon runs and, without stocking, fishermen's expectations and spawning targets will not be met. Continuing habitat degradation from siltation works in opposition to the enhancement work done on PEI streams. PEI rivers would have a better chance of re-building natural salmon runs if this form of pollution could be brought under control.

Résumé

Le saumon était autrefois abondant à l'Île de Prince Edouard, mais il était éliminé de la plupart des ruisseaux suite à la colonisation européenne. Depuis le milieu des années 1980, l'amélioration de l'habitat et le stockage ont rétabli le saumon dans quelques rivières de l'ÎPE, notamment la Morell. Les cibles totales, basées sur 2.4 oeufs m^{-2} de superficie de rivière, sont 537 gros saumons et 288 petits saumons pour les cinq rivières principales de l'île. Ceci inclut 159 gros saumons et 85 petits saumons pour la Morell.

La méthode principale du stockage du saumon à l'ÎPE est d'élever les juvéniles de façon semi-naturelle dans les réservoirs, et de les relâcher au stade saumoneau à l'âge de 2+ ans. À peu près 66291 saumons ont été stockés à l'ÎPE en 1995, dont approximativement 15568 2+ tacons et saumoneaux dans la Morell. Un relevé basé sur le retour des talons attachés aux permis de pêche a indiqué un effort de pêche de 7669 jours en 1995, dont 5073 sur la Morell, et une prise retenue de 484 petit saumons, dont 449 sur la Morell. En plus, une récolte autochtone de 20 poissons était rapportée.

Deux cent un saumons étaient attrapés dans l'échelle aux poissons à Leard's Pond sur la Morell, mais d'autres poissons accèdent à l'étang sans être comptés. Une trappe en aval a capturé 127 saumons. Les poissons capturés étaient composés de 6% petit sauvage, 87% petit écloserie, 3% gros sauvage, et 4% gros écloserie. Les densités des juvéniles, mesurées par la pêche électrique et extrapolées au bassin versant de la Morell, donnent 35077 juvéniles en juillet-août et 35927 juvéniles en novembre-décembre.

Selon l'analyse marquage-recapture de Bayes, 1550 saumons sont entrés dans la Morell en 1995. Les trappes à la limite de la marée ont compté 30 saumons dans la Rivière Mill, 50 dans la Dunk, et 62 dans la Valleyfield.

Le taux de retour des petits saumons dans la Morell, basé sur l'analyse marquage-recapture, était 5.2%. Les taux de retour dans la Mill et la West, où la plupart des poissons stockés sont d'origine semi-naturelle, étaient supérieurs aux taux mesurés dans la Valleyfield, où les poissons stockés viennent principalement directement de l'écloserie. Le taux d'exploitation par les pêcheurs et les autochtones était 35% des petits saumons qui entraient dans la Morell. La déposition d'oeufs dans la Morell était 159% de la cible, dont 127% était fourni par les saumons provenant des écloseries et 33% était fourni par les saumons sauvages.

Si le retour des saumons sauvages reste inchangé, et si les saumons d'origine écloserie retournent au taux calculé pour 1995, 1030 petits et gros saumons retourneront à la Morell en 1996.

La majorité des saumons qui entrent dans les rivières de l'ÎPE proviennent de l'écloserie, et sans le stockage ni les attentes des pêcheurs ni les cibles de dépositions d'oeufs ne seront satisfaites. La dégradation continue de l'habitat par les sédiments s'oppose au travail d'amélioration effectué dans les ruisseaux de l'ÎPE. Les populations naturelles de saumons auraient une meilleure chance de se rétablir si on pourrait mettre à terme cette forme de pollution.

Introduction

Because of its insular status, Prince Edward Island has a low diversity of freshwater fishes, and native game fish are limited to brook trout and Atlantic salmon. Early accounts indicated an abundance of salmon in the Island's short, barrier-free rivers, with fish arriving on the north shore in June and July and on the south shore in September and October (Dunfield 1985). A substantial commercial salmon fishery developed during the first half of the 18th century, with the greatest activity focused on the St. Peters Bay area.

Despite the imposition of fishing restrictions as early as 1780, salmon declined rapidly and were eliminated from many rivers early in the 19th century (Dunfield 1985). Nevertheless a commercial fishery persisted. Some 10.5 tonnes of salmon were exported in 1865, and 727 kg were taken from the St. Peters Bay area in 1893 (Dunfield 1985). In the 20th century the salmon resource declined further, and by the mid-1970s few or no fish were being taken on the Morell River, which is the largest river of St. Peter's Bay (Table 1, Figs. 1-3).

At the present time, brook trout are ubiquitous in PEI streams, but salmon are commonly found in only a few of the larger rivers. Rainbow trout have been widely introduced, and have become established in a few places.

In the early 1980s concerted efforts were launched to restore the Atlantic salmon populations of PEI rivers. Through the combined efforts of federal and provincial agencies and volunteer groups, enhancement programs were initiated on the Mill and Morell Rivers (Bielak et al. 1991; Figs. 1 and 2). These programs included habitat improvement, selective breeding of early-run genetic stocks, and the development of semi-natural pond rearing of smolts. The semi-natural rearing facility at Profitt's Pond on the Mill River watershed began rearing salmon in 1985, and the Mooney's Pond facility on the Morell began operation in 1989. At both sites, volunteer groups (the O'Leary Wildlife Federation, the Morell River Management Co-op) raised fish furnished by the Cardigan Salmonid Enhancement Centre of the Department of Fisheries and Oceans. These enhancement efforts were most successful in the Morell River, which by the late 1980s yielded annual angling harvests of several hundred salmon.

Habitat enhancement and stocking efforts have also been directed at the Dunk, West, and Valleyfield Rivers, and, in 1994, a new semi-natural rearing facility was set up at Gilbert's Pond near Montague.

The Morell River, in east-central PEI, drains an area of 171 km^2. This document gives an update of the Atlantic salmon resource in the Morell, which remains the most important salmon stream on PEI. It also reports stocking and monitoring efforts in the Mill, Dunk, West, and Valleyfield Rivers. In this paper, adult salmon under 63 cm in fork length are referred to as "small salmon" and fish this length or greater are called "large salmon." Most fish classified as small salmon have spent one winter at sea and most fish classified as large salmon have spent two or more winters at sea.

The status of Atlantic salmon on the Morell and on PEI has been previously reviewed by Ducharme (1977), Bielak et al. (1991), Davidson and Bielak (1992), Davidson and Angus (1994), and Cairns et al. (1995).

Description of Fisheries

In most PEI waters the 1995 angling season for Atlantic salmon was 15 June - 15 September, but other open seasons applied in some rivers. In the Morell River, salmon fishing opened on 1 June and continued to 14 October at most sites (Table 2). In the main branch from MacKay's to the Forks (Fig. 2) the salmon season continued to 31 October, and in Leard's Pond it continued to 30 November. The extension of salmon fishing to 31 October also applied to the Valleyfield River below MacRae's Dam, the West River below Rte. 249, the Dunk River below Scales' Pond, and the Mill River below Route 148. A requirement to use barbless hooks when angling salmon was introduced in 1995 for all salmon fishing after 15 September.

The daily bag limit was one small salmon and the season limit was seven. Retention of large salmon was prohibited.

Residents of Prince Edward Island between the ages of 16 and 64 who are not farmers, commercial fishermen, or aboriginals were required to purchase a licence in order to fish for trout on PEI in 1995. Residents over 65 required a free courtesy licence. Farmers and commercial fishermen, who did not previously need any licence to fish trout, had to obtain a farmer/fisher licence, issued gratis, in 1995. Non-residents required a non-resident trout licence. To fish for salmon, an angler required both a salmon licence and the appropriate trout licence.

The number of angling licences issued on PEI in 1995 is as follows:

Resident trout	9,392
Courtesy resident trout (over 65)	1,566
Farmer/Commercial Fisher	1,513
Non-resident trout	1,028
Total trout	13,499
Salmon	633

The Department of Fisheries and Oceans and the PEI Native Council concluded an agreement providing for a native allocation of 400 small Atlantic salmon from the Morell River in 1995.

Target

Spawning targets for Prince Edward Island salmon are set as numbers of adults required to fully utilize available habitat. It is assumed that populations attain this target if egg deposition by spawning adults reaches or surpasses 2.4 eggs per m^2 of non-tidal, non-impounded river area.

Fecundities and sex ratios of Morell salmon are given in Tables 3-4. River areas for the Mill, Dunk, West, Morell, and Valleyfield Rivers are derived from habitat surveys in which the width of the wetted area was measured in cross-stream transects (data compiled in Cairns et al. 1995). The Morell contains 237,176 m^2, of

which 74,727 m^2 (32%) is upstream from Leard's Pond (Table 5).

Spawning requirements are calculated in Table 6 according to the method below (Morell River data are used as an example). Note that some figures do not sum exactly because of rounding.

i) Number of eggs required for the river = river area x 2.4 eggs /m^2. [237,176 x 2.4 = 569,222]

ii) Number of large females required to produce these eggs = number of eggs/fecundity. It is assumed that all eggs come from large females. This assumption is justified because large females produce more eggs than small females, and because most small salmon are males. [569,222/4963 = 115].

iii) Number of large males required = number of large females x (100 minus percent of large salmon that are female)/percent of large salmon that are female. This gives the number of large males that would accompany the required number of large females, given the sex ratio measured in previous years. [115 x (100 - 72.1)/72.1 = 44].

iv) Total number of large salmon required = number of large female salmon required + number of large male salmon required. [115 + 44 = 159].

v) Male deficit = number of large females required - number of large males required. This gives the number of additional males required to provide each spawning female with a mate. [115 - 44 = 70].

vi) Total number of small salmon required, if small salmon meet the male deficit = 100 x male deficit/percent of small salmon that are male. [100 x 70/82.5 = 85].

The Morell requirements were estimated at 159 large salmon and 85 small salmon, including 50 large and 27 small salmon above Leard's Pond. Total requirements for the five rivers are 537 large salmon and 288 small salmon.

In addition to the Morell's natural spawning needs, there is a requirement for 20 large salmon and 50 small salmon for use as broodstock at the Cardigan Salmonid Enhancement Centre. These fish are collected from the trap at Leard's Pond.

Fisheries data

Stocking

Most salmon stocked on PEI are cultured through a process known as semi-natural rearing. Fish are hatched at the Cardigan Salmonid Enhancement Centre and are placed in Mooney's, Profitt's, or Gilbert's Ponds in the spring following their year of hatching. These are artificial impoundments which have barriers at their inlets and outlets to prevent fish from escaping. The fish are fed artificial food in these ponds, but they are exposed to natural mammalian and avian predation. Natural food is also available. The fish are released into streams as age 2+ smolts. At Profitt's Pond, the smolts are collected by lowering the pond level and concentrating the fish with seines. At Mooney's, the fish are collected by lowering the pond and waiting for the fish to enter the pond's outlet where they are trapped. Fish from both ponds are trucked in tanks to their release sites. Fish at Mooney's are also seined at the end of the smolt run period and remaining fish are permitted to enter the river on their own accord.

Numbers of juvenile salmon stocked in major PEI streams are given in Tables 7 and 8. An estimated 15,568 juvenile salmon were stocked in the Morell River in 1995, the lowest total since 1986 (Table 7). All of these fish were from Mooney's Pond. The smolt release from Mooney's began on 1 May, continued until it was interrupted on 7 May by a snowstorm, and resumed on 13 May (Fig. 5). On the evening of 13 May the barrier screens were removed and remaining fish were allowed to freely leave the pond. Prior to screen removal, 649 2+ parr and 9382 2+ smolts were counted and released into the Morell. The number of fish leaving the pond after screen removal was roughly estimated as 1213 parr and 4324 smolts on the basis of trapping returns at a smolt trap above Indian Bridge. Calculation methods and assumptions are detailed in Cairns et al. (1996). Estimates of fish leaving the pond after screen removal are very approximate, particularly for parr leaving the pond, many of which may have remained in the river and not headed to sea.

In total, Mooney's Pond yielded an estimated 3,778 2+ parr and 20,609 2+ smolts in spring 1995, which represent 33.2% of the number placed in the pond in June 1994 (Cairns et al. 1996).

The Mill, Dunk, West, and Valleyfield Rivers received from 3,501 to 5,459 semi-naturally reared 2+ parr and smolts in spring 1995 (Table 8). In addition, 2+ smolts were stocked in the West and Valleyfield directly from the Cardigan Salmonid Enhancement Centre, and 1+ parr were stocked in the Valleyfield and Midgell Rivers.

Angler mail-out survey

This survey, sponsored by the PEI Wildlife Federation, covered the 1994 fishing year through a questionnaire mailed to 1130 holders of PEI angling licences. Cairns (1996) provides details of methods and results. The retained salmon catch, as estimated through a question on fishing activity by river, totaled 142 small salmon for PEI. This included 89 small salmon on the Morell River (Tables 1 and 9). Estimates of retained catch for other streams ranged from five (Trout and Valleyfield Rivers) to 20 (West River).

Licence stub survey

In 1995 the Prince Edward Island Fish and Wildlife Division introduced a licence stub system for salmon licences. Daily fishing diaries were printed on tear-off stubs attached to the licence (Fig. 4), and anglers were asked to return the stubs at the end of the season using the postage paid business reply return address on the reverse side. On 11 December 1995, reminder cards were mailed to licence-holders from whom cards had not been received. The reminder cards had daily diaries as well as seasonal summaries (Fig. 4), and also had business reply addresses. US stamps were affixed to reminder cards sent to American addresses. Reminder

cards were numbered with the stub serial number to allow detection of cases where both the stub and reminder were returned.

Mailing and return statistics are as follows:

Number of licences issued	633
Number of stubs returned before 11 Dec	30
Percent of stubs returned before 11 Dec	4.7
Number of stubs returned after 11 Dec	29
Total number of stubs returned	59
Percent of stubs returned	9.3
Number of licences with legible addresses	614
Number of reminder cards mailed	589
Number of reminder cards returned as undeliverable	35
Number of reminder cards returned by anglers	168
Percent of reminder cards returned by anglers	28.5
Number of anglers who returned both stubs and reminder cards	6
Total number of non-redundant cards	221
Number of non-redundant cards as a percent of licences issued	34.9
Total number of non-redundant cards with full catch and effort data	200
Non-redundant cards with full data as a percent of licences issued	31.6
Number of non-redundant replies with full data who fished	161
Percent of non-redundant replies with full data who reported fishing	80.5

Survey results indicated a PEI-wide salmon fishing effort of 7,669 rod-days in 1995, including 5,073 rod-days on the Morell. The survey estimated retained sport catches of 449 small salmon on the Morell, six on the Trout, 13 on the West, 16 in the Valleyfield, and none in other rivers.

Native fishing reports

The Prince Edward Island Native Council, which represents off-reserve Micmacs, requires natives under its jurisdiction to fill in daily summaries of their fishing activities. Summary cards indicated a retained catch of 20 hatchery-reared fish, of which four were angled and 16 were netted. All fish were taken in August near the outlet of Mooney's Pond. One netted fish was a large salmon (data from the Morell River Management Co-op).

Research data

Morell smolt movements

A smolt trap was operated near head of tide on the Morell River in May 1995 for the purpose of enumerating wild smolts exiting the river for the sea. Cairns et al. (1996) describe this project in detail; only the main points are recounted here.

The trap was set up above Indian Bridge (Fig. 2). It consisted of webbing supported by a wood and steel frame. The trap leaders, also of webbing, extended about halfway across the river.

It was anticipated that numbers of wild smolts could be estimated by using adipose-clipped stocked fish, released upstream, to calculate capture efficiency. However, this objective was confounded because some stocked fish were unclipped. In addition, trapping had to be suspended from 7-12 May because of high water following a heavy snowfall.

Smolt counts at the trap closely tracked releases of stocked fish, with large numbers of fish being caught within 1-5 hours of releases at Mooney's Pond and Grant's (Fig. 5). Only a small fraction of the fish taken at the trap were unclipped. Indeed, the proportion of unclipped fish at the trap was lower than that of a sample taken from Mooney's Pond. This indicates that very few if any wild smolts were taken by the trap.

There are three possible explanations for this result: either the 1995 wild smolt run was very low, the run occurred when the trap was not in operation (before 1 May, between 7 and 12 May, or after 23 May, Fig. 5), or wild fish avoided the trap at a higher rate than hatchery fish.

Morell adult movements

Upstream movements of Atlantic salmon have been monitored at the Leard's Pond fishway since 1981 (Table 10, Fig. 6). In 1994, 1995, and possibly earlier, some salmon ascended to Leard's Pond without passing through the fishway (Cairns et al. 1995). In 1994, only 2 female salmon were released from the trap into the Leard's pond, but 62 salmon redds were counted above Leard's in fall 1994 and 0+ salmon were found at all electrofishing sites above Leard's in 1995 (except Gill Road which is inaccessible to salmon because of Mooney's Dam). Hence comparisons of counts from Leard's with those of earlier years must be made with caution.

Two hundred and one salmon were captured at the Leard's trap in 1995. This represents a recovery from the 65 fish taken in 1994, but it is still much lower than typical returns of 1986-1993. However, this does not necessarily mean that true returns to Leard's Pond have declined since the 1980s, given the apparent ability of some fish to enter the pond without being trapped.

The composition of trapped fish in 1995 was as follows:

Run	Small salmon		Large salmon	
	Wild	Hatchery	Wild	Hatchery
Early[a]	5	134	0	5
Late	9	38	5	5
Total	14	172	5	10

[a]Prior to 1 September

The Morell salmon stock includes both early- and late-run fish, but early fish are numerically dominant (Fig. 7). Wild fish tend to be more numerous in the late run than in the early run. These trends again appeared in 1995. Unlike most other years, there was a complete hiatus of fish movement between the early and late runs, with no fish entering the trap between 3 August and 19 September.

A second adult counting facility was operated at Nathan's Hole in the tidal section of the lower river in 1995 (Fig. 2). This fence consisted of electrical conduit set in steel rails, with a conduit in every second hole in

order to pass trout and other species. The fence continued as plastic construction grid (similar to snow fence) on the shallow western side of the river. Because of concerns that the fence might be holding some salmon from ascending the river, it was operated on an intermittent schedule, with trapping interrupted by two-day gaps (summer) and one week-gaps (fall) (Fig. 8).

This trap captured 127 salmon, with a seasonal catch distribution similar to that of the Leard's trap (Fig. 8). Catch composition was as follows:

Run	Small salmon		Large salmon	
	Wild	Hatchery	Wild	Hatchery
Early	1	108	0	1
Late	5	6	4	2
Total	6	114	4	3

Salmon captured at the Nathan's Hole fence were marked by fin punching or with a numbered plastic tag attached by a stainless steel wire behind the dorsal fin. The fin punching pattern varied weekly, allowing the approximate time of capture to be identified in recaptured animals.

Sixteen of the marked fish were recaptured at Leard's, 12 before 1 September and four after (Fig. 8). Most recaptures occurred within two weeks of capture (Table 11). Only one fish, marked in the early-run period, was recaptured at Leard's after 1 September. Three marked fish were voluntarily reported by anglers and one was reported during a creel census interview (Table 14).

Movements in other rivers

Counting facilities were operated in the Mill, Dunk, and Valleyfield Rivers in 1995 (Table 12). The Mill River trap captured 3 small and 27 large salmon, mostly late in the fall. The Dunk trap operated only in spring and summer, and captured 50 small salmon. On the Valleyfield, 58 small and 4 large salmon were trapped.

Morell electrofishing

Densities of juvenile salmon were measured by electrofishing at 15 sites in the Morell in July-August and October-November 1995 (Table 13, Fig. 2). At five survey sites, densities were estimated through multiple sweeps within stream sections that were bounded by barrier nets. These sites were the same as those used in 1994. In addition, single-sweep surveys without barrier nets were conducted at 10 new sites. Crew composition, equipment, and methods were similar in the multiple sweep and single-sweep surveys (except for the number of sweeps and the absence of barrier nets).

Densities in multiple-sweep sites were estimated by the Zippin method (Zippin 1958). Densities in single-sweep sites were estimated from the capture efficiency of Sweep 1 as measured in the sites with multiple sweeps (Table 13).

Fish were assigned ages on the basis of length frequency plots (Fig. 9). In July-August, fish under 9.2 cm fork length were classified as 0+ and in October-November fish under 10.75 cm were classified as 0+.

Densities ranged from 0 (Gill Road) to 42.6 (Old Cardigan III) juvenile salmon·100m^{-2} (Table 13). Electrofishing densities and river area measurements (Table 5) were used to estimate total populations of juvenile Atlantic salmon in the Morell. This yielded estimates of 17,674 0+ and 20,595 1+ salmon in July-August, and 17,403 and 15,332 1+ salmon in October-November (Table 14).

Redd surveys

Redd surveys located 309 salmon redds in the Morell River in 1995, the lowest number of the time series (Table 15). No redd counts are available for the Mill and Dunk Rivers in 1995. In the West River, two of eight sectors were surveyed, with one showing an increase in redds from 1994 and one a decrease (Table 15).

Estimation of stock parameters

The capture of incoming salmon at Nathan's Hole and their subsequent recapture at Leard's Pond fishway makes possible a mark-recapture estimate of run size. One hundred twenty seven salmon were captured and marked at Nathan's. Sixteen of these were recaptured at Leard's, of a total catch there of 201. Assuming a 10% tagging mortality (Chaput et al. 1996), the effective marked population is 114.3. Run size estimation parameters using the Petersen method with Chapman's correction (Ricker 1975:78) and the Bayesian method (Gazey and Staley 1986) are as follows:

Peterson estimate with Chapman's correction:	1,369
Bayesian estimate:	
Median	1,550
upper 95% confidence limit	990
lower 95% confidence limit	2,630
Mean	1,626
Mode	1,440

The probability distribution of the Bayesian estimate is given in Fig. 10. The best estimate of run size is taken as the Bayesian median, 1550 fish.

For other rivers, run size is taken as the number of fish counted at head-of-tide traps (Table 12). Run size for 1995 is thus 30 adult salmon in the Mill River, 50 in the Dunk, and 62 in the Valleyfield. No estimate is available for the West because the fish fence did not operate in 1995.

Assessment results

Return and exploitation rates

The return rates of stocked Atlantic salmon to rivers where they were released can be calculated by tracing cohorts through time (Table 16). This analysis assumes that fish stocked as 0+ and 1+ parr leave the river as 2+ smolts, that fish stocked as 1+ smolts, 2+ parr, and 2+ smolts leave the river immediately after release, that small salmon have spent one winter at sea, and that large salmon have spent two winters at sea. The analysis also assumes that no fish return to the river a second time.

Return rates for fish stocked above Leard's Dam ranged from 0.5% to 9.0% (Table 16, Fig. 11). The

return rate for semi-natural fish hatched in 1992 and returning as small salmon in 1995 was 1.1%. Leard return rates must be viewed with caution because returns are underestimated for 1994 and 1995, and possibly earlier, because of fish circumventing the counting trap. These rates measure returns to Leard's Dam, after the fish have been subject to angling exploitation in the river. Hence they are not directly comparable to return rates calculated from head-of-tide counts in other rivers.

Return rates at the Leard's fishway peaked in the mid-1980s, and have declined since (Fig. 11). It is not known if this decline is due to fewer fish arriving at the dam or to a progressive increase in the proportion of fish that circumvent the counting trap.

Fig. 12 plots the number of adults trapped at Leard's against the number of juveniles released above Leard's. In general, fish raised semi-naturally showed better return rates than those raised entirely in a hatchery. The plot shows a curvilinear pattern, with stockings of intermediate size yielding the greatest returns. However, this does not necessarily imply a causal relation, since the low return rates of the two largest stockings (released in 1990 and 1992) could be due to changes in the capture efficiency of the Leard's trap or to fluctuations in marine survival unrelated to stocking numbers.

The number of redds above Leard's Dam appear to be unrelated with the number of fish stocked, but redd numbers are strongly correlated with the number of salmon released from the Leard's fishway ($r=0.90$, $P<.05$) (Table 17, Figs. 13-14).

The return rate of small hatchery fish for the entire Morell, calculated from the mark-recapture estimated run size, is 5.2% (Table 16). The return rate of large hatchery fish is 0.3%. The estimated 61 large hatchery fish that entered the Morell in 1995 presumably originated from the 1+ smolts stocked in 1993 (Table 7).

The calculation of return rates for wild fish requires an estimation of smolt exodus, which is not available for the Morell. Juvenile densities measured by electrofishing in the previous year can be aggregated to produce a watershed-wide population estimate, which in turn can generate a estimation of smolts. Wild small salmon returning in 1995 would have been 1+ parr in 1993. No broad-scale electrofishing surveys were conducted in that year, so calculation of wild return rates is not possible.

Reported returns to other rivers are minimal values, as some angling takes place below the fish traps. Rates were highly variable (Table 16, Fig. 11). Return rates for the Mill and West Rivers were generally much higher than those of the Valleyfield, where most fish stocked have been 0+ and 1+ parr.

On the Morell, the small salmon harvest was estimated as 469 fish, out of an estimated small salmon run of 1352. This is an exploitation rate of 35% (Table 18). Estimated exploitation rates for other rivers varied from 0 to 100%. These figures must be viewed with caution because of uncertainties in harvest estimates due to small sample sizes.

Spawning requirements

Potential spawning by Atlantic salmon released from the Leard's trap rose sharply in the mid-1980s but fell again in the 1990s (Table 19, Fig. 15). Calculated spawning potential above Leard's for 1995 was 43% of requirements, but this underestimates true spawning potential because the trap did not capture all fish entering the pond.

Spawning deposition for the entire Morell can be calculated from the salmon run estimated from mark-recapture, with adjustment for angler exploitation (Table 20). Given the proportions of small/large and hatchery/wild fish recorded at the Nathan's and Leard's traps, the estimated 1550 fish of the run include 95 small wild, 1352 small hatchery, 43 large wild, and 61 large hatchery fish. Reducing these numbers by angler and native exploitation (Table 9) leaves a spawning escapement of 978 small and 103 large fish. These fish have a collective spawning potential of 906,381 eggs, which is 159% of spawning requirements (Table 20). Hatchery fish alone can amply meet spawning requirements (127% of target), but wild fish potential is only 33% of target.

Ecological considerations

Hydrological data for Prince Edward Island rivers, including temperature records from three Morell sites (Fig. 2), are presented by Caissie (1996). The summer of 1995 was moderately warm, with daytime water temperatures rising to the mid-20s at headwater thermograph sites (Fig. 2). However, water temperatures were less extreme than those recorded in the hot 1994 summer.

Forecasts/prospects

The Morell salmon run consists of wild and hatchery-reared fish, with the latter predominating. It is not possible to predict 1996 returns of wild salmon because the 1994 and 1995 smolt runs were not measured, and because return rates of wild salmon are unknown.

In the absence of any formal model, the best estimate of wild returns in 1996 is the same number that returned in 1995 (estimated as 95 small and 43 large, Table 20).

For hatchery salmon, 1996 returns can be predicted from return rates estimated for the 1995 run. If 2+ salmon released in 1995 return as small salmon at the rate calculated for the 1995 run (5.2%), then 810 small hatchery salmon will return to the Morell in 1996. Similarly, if 2+ salmon released in 1994 return as large salmon at the same rate as in the 1995 run (0.3%), then 82 large hatchery salmon will return to the Morell in 1996.

Prospective 1996 numbers are summarized as follows:

Small wild	95
Small hatchery	810
Large wild	43
Large hatchery	82
Total	1030

It must be emphasized that these figures are based on a large number of uncertain assumptions, and should be considered as rough guidelines rather than as exact predictions. Assumptions used in generating these figures include, but are not limited to, the following: that wild smolt production is similar from year to year, that sea survival is similar from year to year, that the 1995 run was accurately estimated, that the wild/hatchery breakdown of the 1995 run is accurate, that return rates are linearly related to numbers of fish stocked, and that return rates of large salmon released as 2+ fish are similar to those of large salmon released as 1+ smolts.

Management considerations

The salmon fishery of the Morell River continues to rely primarily on fish of hatchery origin. The river will likely continue to meet angler expectations and spawning targets as long as it is stocked with 2+ smolts reared in semi-natural ponds. If stocking is curtailed, wild fish will be unable to satisfy angler demand and egg deposition will fall below target.

Most rivers on Prince Edward Island have high silt loading which is deleterious to salmonid survival and reproduction. Siltation threats are currently increasing due to the expansion of the potato industry. In addition, salmonids face risks from pesticide spills such as the one which killed 40,000 juvenile salmon in Profitt's Pond in July 1995. The degradation of Prince Edward Island fish habitat by siltation and pesticide spills negates much of the enhancement work undertaken by government agencies and volunteer groups. If these pollutants could be kept in check, rivers would have a better chance of building runs of wild salmon that satisfy angler demands and meet spawning targets.

Research recommendations

Given the central importance of counts at Leard's Pond fishway, the route from the river into the pond should be made secure so that all salmon must pass through the trap before entering the pond. In 1995, the barriers were repeatedly examined but no breaches were found. In 1996, investigations should take a more active approach, with the installation of additional barriers or traps that would capture any salmon attempting to circumvent the trap, and hence reveal the route that is used.

A counting facility should be installed on the Morell to directly measure the wild smolt run. A time series of smolt counts would clarify the river's ability to produce wild smolts, and allow return rates of wild salmon to be calculated, provided estimates of run size and composition are available.

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Table 1

Atlantic salmon sport catches on the Morell River, 1955-1995. Harvest 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). Data for 1991, 1992, and 1994 are from angler mail-out surveys (Macfarlane and Guigion 1992, 1993; Cairns 1996). Harvest figures for 1995 are from a licence stub survey, and include a native harvest of 19 small and 1 large salmon.

Year	Salmon caught and retained			Salmon caught and released			Fishing effort	Licences
	Small	Large	Total	Small	Large	Total	(rod-days)	issued
1955			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				2088	
1983	7	2	9				686	321
1984	7	0	7				675	68
1985	47	N/A	47				1007	117
1986	236	N/A	236				2725	279
1987	476	N/A	476				N/A	461
1988	643	N/A	643				4994	719
1989	167	N/A	167				4506	646
1990	768	N/A	768				9000	793
1991	657	N/A	657	1033	164	1197	11552	716
1992	781	N/A	781			1044	11700	928
1993	N/A	N/A	N/A				N/A	829
1994	89	0	89	111	99	210	4911	587
1995	469	1	470	146	95	241	5073	633

Table 2
Fishing seasons on the Morell River, 1995.

Area	Includes sites	Period[a]						
		15 Apr-28 Apr	5 May-19 May[b]	9 May-31 May	1 Jun-15 Sep	16 Sep-14 Oct	15 Oct 31 Oct	1 Nov 30 Nov
From river mouth to just above MacKays	Anderson's, Morell, MacKay's	T	T	T	T,S	-	-	-
From just above MacKay's to Forks	Indian Bridge, Mooney's Bridge, Grant's	T	-	T	T,S;ff	S;ff,bo	S;ff,bo	-
West Branch between the Forks and just below Leard's Pond	Leard's Bridge, Landing Pool	T	-	T	T,S;ff	S;ff,bo	-	-
Leard's Pond	Leard's Pond	T	-	T	T,S;ff	S;ff,bo	S;ff,bo	S;ff,bo
West Branch above Leard's Pond	West Branch stream crossings on Peakes Road (Route 320), Pisquid Pond	T	-	T	T,S	-	-	-
East Branch between the Forks and Hazelgreen Road (Route 329)	Crane's	T	-	T	T,S;ff	S;ff	-	-
East Branch above Hazelgreen Road (Route 329)	Kneabone's, Everglades, Martinvale	T	T	T	T,S	-	-	-

[a]T = open season for trout, S = open season for Atlantic salmon, ff = fly fishing only, bo = barbless hooks only
[b]Closed period for the release of stocked salmon smolts

Table 3
Mean lengths, weights, and fecundities of female salmon sampled from the Morell River, 1989 and 1994.

Size	Mean length in cm (N)	Mean weight in kg (N)	Mean fecundity (N)
Small salmon	56.1 (68)	1.51 (17)	3143 (68)
Large salmon - 1989	73.8 (24)	4.08 (24)	4963 (24)
- 1994	73.0 (17)	3.91 (17)	N/A
- combined	73.5 (41)	4.01 (41)	N/A

Table 4
Sex ratios for large and small Atlantic salmon from the Leard's Pond fishway, Morell River, 1986-1990 and 1994.

Year	Small salmon				Large salmon			
	Males		Females		Males		Females	
	N	%	N	%	N	%	N	%
1986	520	84.8	93	15.2	N/A	–	N/A	–
1987	471	82.3	101	17.7	5	12.8	34	87.2
1988	547	76.0	173	24.0	11	37.9	18	62.1
1989	196	87.5	28	12.5	15	37.5	25	62.5
1990	131	72.8	49	27.2	29	37.7	48	62.3
1994	33	91.7	3	8.3	4	13.8	25	86.2
Totals	1,898	82.5	447	17.5	64	27.9	150	72.1

Table 5
Area of non-tidal, non-impounded waters of the Morell River and its tributaries. Data from R. MacFarlane, D.L. Guignion, and T. Dupuis (unpubl.).

Location	Survey date	Water area (m^2)
Main Branch		
Indian Bridge to Mooney's Bridge	July 1991	56,843
Mooney's Bridge to Grant's Bridge (Rte 320)	July 1991	28,941
Grant's Bridge to Main Forks	July 1991	6,710
Subtotal		92,494
West Branch		
Main Forks to Leard's Dam	July 1991	29,269
Head of west arm of Leard's Pond to a point about 1 km downstream from Peakes Road (Rte. 320)	July 1990	25,931
Point about 1 km downstream from Peakes Road to the large spring about 200 m downstream from the upper of the two crossings of the Peakes Road	July 1990	13,044
Large spring about 200 m downstream from the upper of the two crossings of Peakes Road to the dam at Mooney's Pond	July 1990	4,501
Subtotal		72,745
South Branch		
Head of south arm of Leard's Pond to the most downstream crossing of the Old Cardigan Road	July 1990	13,941
Most downstream crossing of the Old Cardigan Road to MacAuley's Dam	July 1990	10,038
East tributary of South Branch, from forks above MacAuley's Pond to 48 Road (Rte. 5)	July 1992	2,601
West Tributary of South Branch, from forks above MacAuley's Pond to 48 Road	July 1992	4,671
Subtotal		31,251
East Branch		
Main Forks to Crane's Bridge	Oct 1991	5,451
Crane's Bridge to Hazelgreen Road (Rte. 329)	Oct 1991	13,035
Hazelgreen Road to next forks upstream	Oct 1991	9,309
Forks above Hazelgreen Road to Everglades dam	Sept 1991	6,582
Forks above Hazelgreen Road to a point 0.6 km downstream from road at Martinvale (Rte. 321)	Sept 1991	6,309
Subtotal		40,686
Total for South and West Branches above Leard's Pond		74,727
Total, all branches		237,176

Table 6
Calculated spawning requirements of the Mill, Dunk, West, Morell, and Valleyfield Rivers, based on the biological characteristics of Morell River salmon, and a spawning requirement of 2.4 eggs per m^2 of non-tidal, non-impounded river area. River areas were calculated from habitat surveys (Cairns et al. 1995). Calculated spawning requirements are based on the assumption that all eggs come from large females. See text for details of calculation.

	Mill	Dunk	West	Morell	Morell above Leard's	Valleyfield	Total
River area (m^2)	58,300	193,078	184,500	237,176	74,727	127,500	800,554
Eggs required at 2.4 eggs per m^2	139,920	463,387	442,800	569,222	179,345	306,000	1,921,330
Mean fecundity (Table 3)	4,963	4,963	4,963	4,963	4,963	4,963	
Number of large female salmon required	28	93	89	115	36	62	387
Percent of large salmon that are female (Table 4)	72	72	72	72	72	72	
Number of large male salmon required	11	36	35	44	14	24	150
Total number of large salmon required	39	129	124	159	50	86	537
Male deficit (number of females - number of males)	17	57	55	70	22	38	237
Percent of small salmon that are male (Table 4)	83	83	83	83	83	83	
Total number of small salmon required, if small salmon meet the male deficit	21	69	66	85	27	46	288
Total number of salmon required	60	199	190	244	77	131	825

Table 7
Numbers of juvenile Atlantic salmon stocked in the Morell River, 1978-1995, and their stages at release. All fish were released in late April or May except 0+ and 1+ parr, which were released in the fall.

Year	Genetic stock	Rearing location	Numbers released and location[a]					Total released
			Parr			Smolt		
			0+	1+	2+	1+	2+	
1978	NW Miramichi	Cardigan SEC	14,943					14,943
1979	NW Miramichi	Cardigan SEC	23,012					32,693
	Restigouche		9,681					
1981	NW Miramichi	Cardigan SEC					691	691
1982	Miramichi (EM)[b]	Cardigan SEC	34,764				3,645	38,409
1983	Miramichi (EM)	Cardigan SEC	9,000 Ke					9,000
1985	Miramichi mixed[c]	Cardigan SEC					1,256 Mo	21,425
							2,661 Pe	
							2,553 Ke	
							1,379 Ma	
							2,579 Le	
		Profit's Pond					1,237 Mo	
							4,175 Pe	
							3,091 Ke	
							1,227 Ma	
							1,267 Le	
1986	NW Miramichi (EM)	Cardigan SEC					728 Pe	14,628
							801 Ke	
		Profit's Pond			193 Pe		3,387 Pe	
					86 Ke		4,845 Ke	
					291 Le		1,235 Ma	
							3,062 Le	
1987	NW Miramichi (EM)	Cardigan SEC					764 Mo	28,784
							764 Pe	
							763 Ke	
							764 Ma	
		Profit's Pond			467 Mo		4,384 Mo	
					1,694 Pe		9,276 Pe	
					588 Ke		4,504 Ke	
					730 Ma		4,086 Ma	
1988	Miramichi mixed	Cardigan SEC				1,030 Mo		20,097
						750 Ma		
						1,624 Pe		
						1,002 Ke		
						1,501 Cr		
		Profit's Pond			224 Mo		1,800 Mo	
					113 Ma		915 Ma	
					244 Pe		2,747 Pe	
					380 Ke		3,750 Ke	
					50 Mr		957 Mr	
					160 Cr		1,842 Cr	
					37 Gr		971 Gr	
1989	Morell (HR-small salmon)[d]	Profit's Pond			446 Mo		2,779 Mo	22,210
					243 Pe		2,792 Pe	
					74 Ke		1,969 Ke	
					72 Ma		1,850 Ma	
					226 Cr		2,841 Cr	
					499 Gr		8,419 Gr	
1990	Morell mixed (HR)	Mooney's Pond			398 Mo		48,475 Mo	59,810
		Profit's Pond			681 Gr		10,256 Gr	
1991	Morell mixed (HR)	Mooney's Pond			18 Mo		24,638 Mo	36,496
					3 Ma		1,997 Ma	
					2,032 Gr		7,808 Gr	
1992	Morell mixed (HR)	Mooney's Pond		2200[e] Mo	339 Mo		35,524 Mo	45,622
					29 Pe		2,342 Pe	
					1,483 Gr		2,468 Ma	
							3,437 Gr	
1993	Mor. mixed (HR)	Cardigan SEC				14,372 Mo		19,379
						5,007 Pe		
1994	Morell mixed (HR)	Mooney's Pond[f]			136 Mo		10,814 Mo	26,000
					7 Ma		4,360 Ma	
					594 Gr		10,089 Gr	
1995	Morell mixed (HR)	Mooney's Pond[g]			1,270 Mo		6,552 Mo	15,568
					503 Ca		2,230 Ca	
					89 Gr		4,924 Gr	

NOTES

[a]Release locations are Mooney's Pond outlet (Mo), Peakes Road Bridge (Pe), Kenny's Hole and vicinity (Ke), Old Cardigan Road (Ca), MacAuley's (Ma), Leard's Pond (Le), Martinvale (Mr),

[b]EM - early migrating stock

[c]Mixed - Both early and late migrating stock were taken for transfer because of the small number of eggs available

[d]HR - Progeny from previous hatchery stocking in the Morell River

[e]These fish were the survivors of a die-off of salmon in Mooney's Pond in the summer of 1992. Numbers are approximate.

[f]Actual counts of fish released into Mooney's Pond outlet were 97 parr and 7704 smolts. These numbers were increased by 40% to account for fish which were released without counting. Totals do not include an unknown number of fish which escaped through a gap in the stoplogs.

[g]Actual counts of fish released into Mooney's Pond outlet were 649 parr and 9382 smolts. Numbers of fish leaving the pond after removal of the counting device were estimated as roughly 1213 parr and 4324 smolts, on the basis of calculations involving the trapping efficiency of the Indian Bridge smolt trap (see text).

Table 8
Stocking dates and numbers of juvenile Atlantic salmon in the West, Dunk, Mill, Valleyfield, and Midgell Rivers, 1985-1995.

Year	Rearing location	Stage stocked	Date stocked	Numbers stocked				
				West River	Dunk River	Mill River	Valleyfield River	Midgell River
1985	Cardigan SEC	2+ smolt	June 6	0	0	1,609	0	0
	Profit's Pond	2+ smolt	May 21-30	0	0	733	0	0
1986	Profit's Pond	2+ parr	May 15-28	0	0	580	0	0
		2+ smolt	May 15-28	0	0	2,417	0	0
1987	Profit's Pond	2+ parr	May 16-19	0	0	595	0	0
		2+ smolt	May 16-19	0	0	2,555	0	0
1988	Cardigan SEC	1+ smolt	May 23	1,390	0	0	0	0
	Profit's Pond	2+ parr	May 12-13	0	0	349	0	0
		2+ smolt	May 12-13	0	0	3,079	0	0
1989	Cardigan SEC	1+ parr	May 8-12	0	0	0	2,491	0
		1+ smolt	May 8-12	0	0	0	6,299	0
	Profit's Pond	2+ smolt	May 15	1,324	0	0	0	0
		2+ parr	May 12-16	0	0	74	0	0
		2+ smolt	May 12-16	0	0	2,991	0	0
1990	Cardigan SEC	0+ parr	Nov 16-Dec 10	0	0	0	89,003	0
		1+ smolt	May 27-30	0	0	0	738	0
	Profit's Pond	2+ parr	May 4-8	0	0	25	0	0
		2+ smolt	May 4-8	0	0	3,082	0	0
1991	Cardigan SEC	0+ parr	Nov 13-15	0	0	0	55,723	0
		0+ parr	Nov 20-23	50,750	0	0	0	0
		1+ smolt	May 7 - June 5	0	0	0	5,259	0
	Profit's Pond	2+ parr	May 6-10	0	0	159	0	0
		2+ smolt	May 6-10	0	717	1,873	0	0
	Mooney's Pond	2+ smolt	May 10-11	0	1,300	0	0	0
1992	Cardigan SEC	0+ parr	Nov 12	0	0	0	32,494	0
		2+ smolt	May 13-16	0	0	0	1,693	0
	Profit's Pond	2+ parr	May 4-5	0	0	169	0	0
		2+ smolt	May 4-5	1,260	0	3,657	0	0
	Mooney's Pond	1+ parr	Sept 21-Oct 1	0	0	0	10,014	0
			Sept 28-29	10,173	0	0	0	0
		2+ smolt	May 13-16	0	0	0	10,307	0
			May 11-20	10,221	0	0	0	0
1993	Cardigan SEC	0+ parr	Oct 13	0	0	0	14,467	0
			Dec 1	0	0	0	0	20,000
		1+ parr	June 16-23	0	0	0	28,898	0
	Profit's Pond	1+ parr	May 28-June 22	0	17,225	0	0	0
		2+ parr	May 3-4	0	0	200	0	0
		2+ smolt	May 3-4	0	5,325	2,772	0	0
1994	Cardigan SEC	0+ parr	Nov 26	0	0	0	20,000	20,000
		1+ smolt	May 9-10	0	0	0	5,896	0
			May 12-15	3,965	0	0	0	0
	Profit's Pond	2+ parr	May 2-3	209	341	127	0	0
		2+ smolt	May 2-3	3,355	7,259	2,584	0	0
	Mooney's Pond	2+ smolt	Apr 28-May 7	0	0	0	1,980	0
1995	Cardigan SEC	1+ parr					11,585[a]	9,367[b]
		2+ smolt	Apr 19-May 5	5037			6,220	
	Profit's Pond	2+ parr	May 1-2		280	364		
		2+ smolt	May 1-2		5179	3923		
	Mooney's Pond	2+ parr	May 13	2,915			3,937	
		2+ smolt	May 13	586			1,330	

[a]Stocked July 5
[b]Stocked November 27

Table 9
Salmon harvest on Prince Edward Island in 1994 from a mail-out survey (Cairns 1996), and effort and harvest in 1995 from a licence stub survey.

	Morell	Mill	Trout	Dunk	West	Valley-field	Mont-ague[a]	St. Peters	Cardigan	All rivers
1994 mail-out survey										
Estimated total catch										
Small salmon kept	89	11	5	11	20	5				142
Small salmon released	111	104[b]	6	38	38	28				324[b]
Large salmon released	99	0	0	5	84[b]	5				193[b]
All catches	299	115[b]	11	54	142[b]	38				659[b]
1995 licence stub survey										
Percent of respondents who fished river	72	2	3	4	16	4	1	1	1	80
Estimated total number of anglers who fished the river	453	9	19	25	101	22	6	3	3	506
Mean number of rod-days per angler who fished the river	11.2	9.0	13.5	12.9	12.7	28.1	1.5	3.0	1.0	15.1
Estimated total rod-days	5073	85	256	326	1282	624	9	9	3	7669
Mean catch per rod-day										
Small salmon kept	0.089	0.000	0.025	0.000	0.010	0.025	0.000	0.000	0.000	0.063
Small salmon released	0.029	0.000	0.012	0.010	0.030	0.015	0.333	0.667	0.000	0.027
Large salmon released	0.019	0.000	0.012	0.000	0.017	0.025	0.000	0.333	0.000	0.018
All salmon	0.136	0.000	0.049	0.010	0.057	0.066	0.333	1.000	0.000	0.109
Estimated total catch										
Small salmon kept	449	0	6	0	13	16	0	0	0	484
Small salmon released	146	0	3	3	38	9	3	6	0	209
Large salmon released	95	0	3	0	22	16	0	3	0	139
All catches	690	0	13	3	73	41	3	9	0	832
Native harvest[c]										
Small salmon	19									19
Large salmon	1									1
Total lethal harvest	469	0	6	0	13	16	0	0	0	504

[a]1994 harvest estimates for the Valleyfield also include the Montague
[b]Harvest estimates appear to be unreasonably high. Numbers may be unreliable due to small sample sizes.
[c]Data from PEI Native Council logbooks and from the Morell River Management Co-op

Table 10
Atlantic salmon counted at the Leard's Pond fishway, 1981-1995.

Year	Small salmon					Large salmon					All salmon			
	Wild	Hatch-ery	Total	% wild	% small	Wild	Hatch-ery	Total	% wild	% large	Wild	Hatch-ery	Total	% wild
1981	0	39	39	0.0	86.7	6	0	6	100.0	13.3	6	39	45	13.3
1982	6	27	33	18.2	91.7	1	2	3	33.3	8.3	7	29	36	19.4
1983	1	1	2	50.0	50.0	0	2	2	0.0	50.0	1	3	4	25.0
1984	3	2	5	60.0	55.6	2	2	4	50.0	44.4	5	4	9	55.6
1985	2	12	14	14.3	93.3	1	0	1	100.0	6.7	3	12	15	20.0
1986	1	619	620	0.2	99.0	2	4	6	33.3	1.0	3	623	626	0.5
1987	2	1166	1168	0.2	94.5	2	66	68	2.9	5.5	4	1232	1236	0.3
1988	8	1386	1394	0.6	94.1	2	87	89	2.2	6.0	10	1471	1481	0.7
1989	12	323	335	3.6	72.8	0	125	125	0.0	27.2	12	448	460	2.6
1990	44	365	409	10.8	86.7	4	59	63	6.3	13.3	48	424	472	10.2
1991	33	294	327	10.1	89.3	11	28	39	28.2	10.7	44	322	366	12.0
1992	64	843	907	7.1	95.2	8	38	46	17.4	4.8	72	881	953	7.6
1993	44	584	628	7.0	98.3	0	11	11	0.0	1.7	44	595	639	6.9
1994	8	28	36	22.2	55.4	2	27	29	6.9	44.6	10	55	65	15.4
1995	14	172	186	7.5	92.5	5	10	15	33.3	7.5	19	182	201	9.5
Total	242	5861	6103			46	461	507			288	6320	6608	
Mean	16	391	407	4.0	92.4	3	31	34	9.1	7.7	19	421	441	4.4

Table 11
Recoveries of salmon tagged at the Nathan's Hole fish trap, 1995.

Marks		Size and	Capture	Recapture	Recapture	Time at	Comments
Tags	Fin punches[a]	Origin[b]	date	date	location	large (d)	
	1 uc		14-16 Jun	21 Jun	Leard's fishway	35-37	
00144		SH	30 Jun	3 Jul	Leard's fishway	3	
00141		SH	29 Jun	4 Jul	Leard's fishway	5	
00143		SH	30 Jun	4 Jul	Leard's fishway	4	
	1 uc		14-16 Jun	4 Jul	Leard's fishway	18-20	
	1 lc	SH	28 Jun-2 Jul	4 Jul	Leard's fishway	2-6	
00142		SH	30 Jun	6 Jul	Leard's fishway	6	
00135		SH	15 Jun	10 Jul	Leard's fishway	25	
	1 d	SH	3-9 Jul	10 Jul	Leard's fishway	1-6	
	1 d	SH	3-9 Jul	10 Jul	Leard's fishway	1-6	
00139		SH	28 Jun	19 Jul	Leard's fishway	21	
00158		SH	14 Jul	22 Jul	Leard's fishway	8	
	1 d	SH	3-9 Jul	5 Oct	Leard's fishway	88-94	
00679	2 uc, 1 lc, 1 d	LH	5 Oct	7 Oct	Leard's fishway	2	
00675	2 uc, 1 lc, 1 d	SH	4 Oct	17 Oct	Leard's fishway	13	
00681	2 uc, 1 lc, 1 d	SH	6 Oct	20 Oct	Leard's fishway	14	
00131		SH	12 Jun	5 Jul	Grant's	23	Angled, voluntary report
00130		SH	12 Jun	6 Jul	Indian Bridge	24	Angled, voluntary report
00136		SH	15 Jun	21 Jun	Indian Bridge	6	Angled, voluntary report
00182		SH		22 Jul	Leards Pond		Angled, reported in creel survey but tag number erroneous
Mean time at large[c]						16.4	

[a]Hole punch locations are upper caudal (uc), lower caudal (lc), and dorsal (d)
[b]S=small salmon, L=large salmon, W=wild salmon, H=hatchery-reared salmon
[c]Where release time is not known exactly, time at large is calcuated from the mid-point of the range of release dates

Table 12
Counts of Atlantic salmon and brook trout at counting facilities on the Mill, Dunk, West, and Valleyfield Rivers, 1986-1995.

Year	Direction	Mill River					Dunk River[a]				West River					Valleyfield River				
		Trout	Salmon				Trout	Salmon			Trout	Salmon				Trout	Salmon			
			Adult			Juvenile		Adult		Juvenile		Adult			Juvenile		Adult			Juvenile
			Small	Large	Total			Small	Large Total			Small	Large	Total			Small	Large	Total	
1986	Upstream															723			0	
1987	Upstream						937									-			-	
1988	Upstream						1,507									-			-	
1989	Upstream						4,189				-	31	19	50		1,220			0	
1990	Upstream	2,594			176		-				3,935	25	23	48		2,173	36		36	
	Downstream	-			-		-				2,986			-		-			-	
1991	Upstream	4,221			-		1,733				-			-		1,565	5		5	
1992	Upstream	-			-		1,132				-			-		741	25		25	
1993	Upstream	219	17	5	22		1,295		0		2,151	250 (248)[b]	12 (12)	262 (260)		1,027	84		84	
	Downstream	-			-		-		-		1,006			10	66	-			-	
1994[c]	Upstream	1,947	11 (11)	0	11 (11)		N/A		N/A		2,072	8 (4)	6 (6)	14[d] (10)		1,609	15	7	22	
	Downstream											1	1	2		-			-	
1995	Upstream	320	3	27	30		to come	50	50							1,401	58	4	62	95
	Downstream															39	3	0	3	19

[a]Counts from fish fence above Johnston's Bridge in 1995; counts from Scales Pond fishway in all other years.
[b]Brackets indicate hatchery-reared salmon
[c]Counting facilities operated from 30 May to 17 September (West River), from 27 May to 27 October (Mill River), and from 29 May to 3 November (Valleyfield River).
[d]Every second conduit was removed from the counting fence, allowing some small salmon to pass through the fence.

Table 13
Estimates of Atlantic salmon and brook trout densities at electrofishing sites on the Morell River, May 1994 and July-November 1995.

Site	Date	Water temperature (°C)	Area of site (m^2)	Atlantic salmon													Brook trout								
				Fish captured in sweep						Population estimates[a]							Fish captured in sweep					Population estimates[a]			
				1	2	3	4	Total	% of fish aged 1+	Total pop. in site	Sweep 1 as % of total	Fish density within site[b] 0+ fish/ 100 m^2	1+ fish/ 100 m^2	2+ fish/ 100 m^2	total fish/ 100 m^2	90% confidence interval	1	2	3	4	Total	Total pop. in site	Sweep 1 as % of total	Density (fish/ 100 m^2)	90% confidence interval
May 1994[c]																									
Smith's Spring	24 May	6	138.3	0	0	1		1	100	1		0.0	0.7	0.0	0.7		31	11	4		46	48.2		34.9	
Old Cardigan IIIC	24 May	12.8	264	11				11	91	19.9		0.7	6.9	0.0	7.5		22				22	39.8		15.1	
July-August 1995																									
Kenny's Hole	24 Jul		214.3	16	8	5		29	100.0	34.7	46.1	0.0	16.2		16.2		24	14	8		46	57	42.1	26.6	±36.7%
Leard's Bridge	26 Jul		231.2	22	17	10		49	14.3	72.5	30.3	26.9	4.5		31.4	±65.7%	2	0	1		3	3.8	52.6	1.6	
Crane's	27 Jul		369.9	22	9	8	1	40	42.5	42.3	52.0	6.6	4.9		11.4		51	31	11	13	106	119.4	42.7	32.3	±12.7%
Forks	31 Jul		387.3	37	20	7	2	66	21.2	68.3	54.2	13.9	3.7		17.6	±7.4%	40	12	5	2	59	59.9	66.8	15.5	±5.4%
Rowell's Riffle	4 Aug		329.2	21	8	1		30	13.3	30.7	68.4	8.1	1.2		9.3		40	35	13		88	115.6	34.6	35.1	±30.5%
Gill Road	11 Aug	20	87.3	1					100.0	2.0		0.0	2.3		2.3		30					60.8		69.7	
Mooney Tracks	15 Aug	19	151.6	31					67.7	62.0		13.2	27.7		40.9		21					42.6		28.1	
Upper Kenny's	10 Aug		203.7	9					100.0	18.0		0.0	8.8		8.8		49					99.4		48.8	
Old Cardigan III	10 Aug		159.5	34					70.6	68.0		12.5	30.1		42.6		39					79.1		49.6	
Oates'	22 Aug		273.2	8					75.0	16.0		1.5	4.4		5.9		27					54.8		20.0	
Above Landing Pool	8 Aug		415.7	21					9.5	42.0		9.1	1.0		10.1		10					20.3		4.9	
Martinvale	8 Aug		178.4	1					100.0	2.0		0.0	1.1		1.1		5					10.1		5.7	
Everglades	7 Aug		181.7	5					100.0	10.0		0.0	5.5		5.5		2					4.1		2.2	
Lower Crane's	9 Aug		215.0	8					75.0	16.0		1.9	5.6		7.4		14					28.4		13.2	
Grant's	8 Aug		380.0	9					55.6	18.0		2.1	2.6		4.7		17					34.5		9.1	
October-November 1995																									
Kenny's Hole	26 Oct	6	211.6	20	9	3		32	62.5	34.3	58.3	6.1	10.1		16.2		30	13	5		48	51.7	58.0	24.4	±15.4%
Leard's Bridge	25 Oct		222.8	32	18	9		59	47.5	69.8	45.8	16.5	14.9		31.3	±24.9%	0	1	0		1	1		0.4	
Crane's	24 Oct	7	372.3	31	18	12		61	42.6	79.6	38.9	12.3	9.1		21.4	±37.3%	26	15	10		51	66.3	39.2	17.8	±41.4%
Forks	27 Oct	8	403.5	64	33	16		113	26.5	129.5	49.4	23.6	8.5		32.1	±14.1%	15	7	3		25	27.6	54.3	6.8	
Rowell's Riffle	31 Oct	8	332.0	16	7	3		26	30.8	28.3	56.5	5.9	2.6		8.5		12	5	3		20	22.5	53.3	6.8	
Gill Road	6 Nov	5	88.7	0						0.0		0.0	0.0		0.0		18					36.5		41.2	
Mooney Tracks	1 Nov	6	155.4	25					40.0	50.0		19.3	12.9		32.2		5					10.1		6.5	
Upper Kenny's	1 Nov	5	197.7	3					33.3	6.0		2.0	1.0		3.0		17					34.5		17.4	
Old Cardigan III	1 Nov	6	155.3	27					66.7	54.0		11.6	23.2		34.8		7					14.2		9.1	
Oates'	7 Nov	5	273.2	5					40.0	10.0		2.2	1.5		3.7		9					18.3		6.7	
Above Landing Pool	2 Nov	6	451.0	30					20.0	60.0		10.6	2.7		13.3		27					54.8		12.1	
Martinvale	3 Nov	6	194.9	3					100.0	6.0		0.0	3.1		3.1		22					44.6		22.9	
Everglades	2 Nov	4	205.8	4					75.0	8.0		1.0	2.9		3.9		9					18.3		8.9	
Lower Crane's	2 Nov	4	229.7	13					23.1	26.0		8.7	2.6		11.3		13					26.4		11.5	
Grant's	3 Nov	5	399.0	15					46.7	30.0		4.0	3.5		7.5		13					26.4		6.6	
Means											50.0												49.3		

[a]Populations were estimated from multiple sweeps by the **Zippin** method. Where only one sweep was done, populations were estimated by the following formula:

$$\text{Total estimated population} = \frac{100 \times \text{Number of fish captured in sweep}}{\text{Mean percent of population captured in Sweep 1 in sites with multiple sweeps}}$$

For May 1994, mean percent of population captured in Sweep 1 was calculated from 4 **Zippin** calculations for brook trout and 1 **Zippin** calculation for Atlantic salmon in North Lake Creek, Bristol Creek, and the Morell River. The methods and crew for these trials were the same as those used to gather the May 1994 data presented above.

[b]In July-August, fish less than 9.2 cm were classified as 0+. In October-November, fish less than 10.75 cm were classified as 0+.

[c]Data from R.A. Cunjak (unpubl.)

Table 14
Estimates of Atlantic salmon populations in the Morell River, based on electrofishing density estimates and measurements of rearing habitat. Electrofishing data from Table 13 and from Cairns et al. 1995.

River section	River area (m^2)	Electrofishing sites	Estimated densities in electrofishing sites			Estimated populations			
			0+ fish/ 100 m^2	1+ fish/ 100 m^2	2+ fish/ 100/m^2[a]	0+ fish	1+ fish	2+ fish[a]	Returning adults[b]
1975									
West Branch									
Leard's Pond to Forks	29269	Below Leard's Pond	0.0	5.1	2.6	0	1493	746	15
Main stem	92494	Mean of Below Forks, Grant's, Mooney's Bridge & Below Indian Bridge	0.0	3.0	1.5	0	2729	1364	27
1984 - Wild-reared fish - Aug-Sep									
West Branch (including S. Branch)									
Above Leard's Pond	74727	Kenny's Hole	0.0	0.6	0.3	0	473	236	5
Leard's Pond to Forks	29269	Leard's Bridge	17.0	1.7	0.8	4987	487	244	5
East Branch	40686	Crane's	6.7	1.3	0.6	2714	521	260	5
Main stem	92494	Forks	9.8	7.2	3.6	9098	6615	3308	66
Total	237176					16799	8096	4048	81
1984 - Hatchery-reared fish[c] - Aug-Sep									
West Branch (including S. Branch)									
Above Leard's Pond	74727	Kenny's Hole	0.0	1.9	0.9	0	1418	709	14
Leard's Pond to Forks	29269	Leard's Bridge	0.0	1.3	0.7	0	391	196	4
East Branch	40686	Crane's	0.0	0.0	0.0	0	0	0	0
Main stem	92494	Forks	0.0	0.3	0.1	0	276	138	3
Total	237176					0	2084	1042	21
1985 - Aug-Sep									
West Branch (including S. Branch)									
Above Leard's Pond	74727	Kenny's Hole	0.0	2.7	1.4	0	2037	1018	20
Leard's Pond to Forks	29269	Mean of Leard's Bridge & Lower Leard's	10.7	6.8	3.4	3127	2001	1001	20
East Branch	40686	Crane's	2.5	2.0	1.0	1035	826	413	8
Main stem									
Forks to Mooney's Bridge	35651	Mooney's Bridge	7.2	4.1	2.1	2564	1468	734	15
Mooney's Bridge to Indian Bridge	56843	Rowell's Riffle	9.4	3.5	1.8	5326	2000	1000	20
Total	237176					12053	8332	4166	83
1994 - Aug-Sep									
West Branch (including S. Branch)									
Above Leard's Pond	74727	Kenny's Hole	109.3	30.1	15.1	81671	22501	11251	225
Leard's Pond to Forks	29269	Leard's Bridge	22.6	5.2	2.6	6606	1509	755	15
East Branch	40686	Crane's	37.3	2.1	1.1	15184	867	433	9
Main stem									
Forks to Mooney's Bridge	35651	Mean of Forks & Mooney's Bridge	13.8	7.2	3.6	4913	2580	1290	26
Mooney's Bridge to Indian Bridge	56843	Rowell's Riffle	1.0	5.5	2.7	585	3117	1558	31
Total	237176					108957	30575	15287	306
1994 - Dec									
West Branch (including S. Branch)									
Above Leard's Pond	74727	Kenny's Hole	31.5	0.0	0.0	23509	0	0	0
Leard's Pond to Forks	29269	Leard's Bridge	15.1	4.5	2.3	4411	1318	659	13
East Branch	40686	Crane's	9.3	0.9	0.5	3787	375	187	4
Main stem									
Forks to Mooney's Bridge	35651	Mean of Forks & Mooney's Bridge	3.0	1.5	0.7	1058	526	263	5
Mooney's Bridge to Indian Bridge	56843	Rowell's Riffle	0.0	5.1	2.5	0	2899	1449	29
Total	237176					32765	5117	2559	51
1995 - Jul-Aug									
West Branch									
Above Leard's Pond	43476	Mean of Mooney Tracks, Up. Kenny's, Kenny's Hole	4.4	17.6	8.8	1911	7640	3820	76
Leard's Pond to Forks	29269	Mean of Above Landing Pool, Leard's Br.	18.0	2.7	1.4	5271	796	398	8
South Branch	31251	Mean of Old Cardigan III, Oates'	7.0	17.2	8.6	2188	5388	2694	54
East Branch	40686	Mean of Martinvale, Everglades, Cranes, Lr. Crane's	2.1	4.3	2.1	858	1736	868	17
Main stem									
Forks to Mooney's Bridge	35651	Mean of Forks, Grant's	8.0	3.2	1.6	2852	1136	568	11
Mooney's Bridge to Indian Bridge	56843	Rowell's Riffle	8.1	1.2	0.6	4594	707	353	7
Total	237176					17674	17403	8701	174
(Table 14, continued)									
1995 - Oct-Nov									
West Branch									
Above Leard's Pond	43476	Mean of Mooney Tracks, Up. Kenny's, Kenny's Hole	9.1	8.0	4.0	3971	3479	1740	35
Leard's Pond to Forks	29269	Mean of Above Landing Pool, Leard's Br.	13.6	8.8	4.4	3966	2565	1283	26
South Branch	31251	Mean of Old Cardigan III, Oates'	6.9	12.3	6.2	2154	3850	1925	38
East Branch	40686	Mean of Martinvale, Everglades, Cranes, Lr. Crane's	5.5	4.4	2.2	2232	1802	901	18
Main stem									
Forks to Mooney's Bridge	35651	Mean of Forks, Grant's	13.8	6.0	3.0	4916	2144	1072	21
Mooney's Bridge to Indian Bridge	56843	Rowell's Riffle	5.9	2.6	1.3	3355	1491	745	15
Total	237176					20595	15332	7666	153

[a]Estimates for smolts heading to sea in the following spring, based on 50% mortality of 1+ fish.
[b]Assumes that 2% of smolts that exit the river return as adults.
[c]9,000 0+ parr were released at Kenny's Hole in November 1983

Table 15
Counts of Atlantic salmon redds in selected Prince Edward Island rivers, 1990-1995. Data from C. Crane and D. Biggar (Mill and Trout Rivers), C. Brydon, T. Dupuis and P. Curley (West River), S. Hill (Dunk River), and D.L. Guignion, R. MacFarlane, T. Dupuis, and I. Premdas (Morell River).

River	Sector	Number of salmon redds					
		1990	1991	1992	1993	1994	1995
Mill	Bridge on Rte 143 (Maggies Hole) to Roadside Hole, where the river comes close to road 2.01 km upstream from the Howlan railway bridge (Transects 10 - 102)				100		
	Roadside Hole to Howlan railway bridge (Transects 102 - 169)				55		
	Howlan railway bridge to the head of tide in Bloomfield Park (Transects 169-336)				156	144	
	Total				311		
Trout	From railroad bridge just below Leard's Pond to base of the former Getson's Dam (Transects 1-180)			33	58	33	
Dunk	Head of tide to Scales Pond	N/A	N/A	N/A	6	N/A	N/A
West	Sector 1 - Head of tide to first bridge above Crosby's Pond	6	N/A	15	6	17	13
	Sector 2 - First bridge above Crosby's Pond to bridge on Rte. 249 at Green Bay	41	19	168	77	25	44
	Sector 3 - Bridge on Rte 249 at Green Bay to bridge on Rte 249 at Emyvale	N/A	4	91	59	N/A	N/A
	Sector 4 - Bridge on Rte. 249 at Emyvale to the point where the main branch crosses Rte. 13 at Brookvale; also the tributary to the bridge on Rte. 235	N/A	5	N/A	22	17	N/A
	Sector 5 - From bridge on Rte. 235 at Brookvale, following the east branch to the bridge on Rte. 225 at Hartsville	N/A	0	N/A	N/A	N/A	N/A
	Sector 6 - From Bridge at Rte. 235 to Carragher's Pond, just above Rte. 244.	N/A	2	N/A	0	N/A	N/A
	Sector 7 - From the head of Carragher's Pond to the bridge at Rte. 245	N/A	0	N/A	N/A	N/A	N/A
	Sector 8 - Howell's Brook from the bridge on Rte. 245 to the bridge	N/A	3	N/A	0	0	N/A
Morell	Main Branch below Forks + West Branch from Forks to Leard's Dam	89	204	145	125	65	104
	West Branch above Leard's Pond	158	177	344	138	17	46[a]
	South Branch	207	118	306	77	45[a]	144
	East Branch	202	138	122	37	35	15
	Total above Leard's Pond	365	295	650	215		190
	Total	656	637	917	377		309

[a]Minimum count; some fish ascended the river after the redd survey was completed

Table 16

Return rates of Atlantic salmon stocked in PEI rivers. Fish from the Cardigan SEC and Profit's Pond, hatched in 1983-1985 and released above Leard's Dam, were distinguished on their return by nose tagging.

Hatching year (Yr)	Number and origin of fish stocked[a]				Number of salmon returning[b]			Total returns from cohort	Returns as a percent of releases
	0+ parr in Yr	1+ parr in Yr+1	1+ smolts in Yr+2	2+ parr & smolts in Yr+2	Small salmon in Yr+3	Large salmon in Yr+4	Unspecified salmon in Yr+3		
Morell above Leard's Dam[c]									
1983	9,000 C			10,428 C	96	10		106	0.5
				10,997 P	523	56		579	5.3
1984				1,529 C	74	6		80	5.2
				13099 P	1,094	79		1173	9.0
1985				3055 C	84	1		85	2.8
				25,729 P	1302	124		1426	5.5
1986			4405 C	10,173 P	323	59		382	2.6
1987				10225 P	365	28		393	3.8
1988				48,873 M	294	38		332	0.7
1989				26,656 M	843	11		854	3.2
1990				40,702 M	584	27		611	1.5
1991		2,200 M	19,379 C		28	10		38	0.2
1992				15,317 M	172	N/A		172	1.1
Entire Morell[d]									
1992 - small salmon only				26,000 M	1352			1352	5.2
1991 - large salmon only				19,379 C		61		61	0.3
Mill River									
1987	0	0	0	3,065 P			176	176	5.74
1990	0	0	0	3,826 P	17	0		17	0.44
1991	0	0	0	2,972 P	11	27		38	1.28
1992	0	0	0	2711 P	3	N/A		3	0.11
West River									
1986	0	0	1,390 C	0	31	23		54	3.88
1987	0	0	0	1,324 P	25	N/A		25	1.89
1990	0	0	0	11,481 M[e]	248	6		254	2.21
1991	50,750 C	10,173 M	0	0	4	N/A		4	0.007
Valleyfield River									
1987	0	0	6,299 C	0	36	0		36	0.57
1988	0	2,491 C	738 C	0	5	0		5	0.15
1989	0	0	5,259 C	0	25	0		25	0.48
1990	89,003 C	0	0	12,000 M[f]	84	7		91	0.09
1991	55,723 C	10,014 M	0	0	15	4		19	0.03
1992	32,494 C	28,898 C	5,896 C	1,980 M	58	N/A		58	0.08

[a]Origins are Profit's Pond (P), Cardigan Salmonid Enhancement Centre (C), and Mooney's Pond (M)

[b]Counts include hatchery fish only, where origin of fish was recorded. Return rates for the Mill, West, and the Valleyfield are minimal values as some angling takes place below the traps.

[c]Stocking numbers are fish released above Leard's Dam, return numbers are hatchery fish counted at Leard's Pond fishway

[d]Stocking numbers are the total released in the Morell watershed, return numbers are the hatchery-reared component of the mark-recapture estimate

[e]Includes 1,260 2+ smolts from Profit's Pond

[f]Includes 1,693 2+ smolts from Cardigan SEC

Table 17
Number of salmon stocked above Leard's Dam, number of salmon released above Leard's Pond Fishway, and number of salmon redds counted above Leard's Pond.

Hatching year (Yr)	Number and origin of fish stocked[a]				Number of salmon released above Leard's			Redds in Yr+3
	1+ parr in Yr+1	1+ smolts in Yr+2	2+ parr & smolts in Yr+2	Total for cohort	Small salmon in Yr+3	Large salmon in Yr+4	Total salmon in Yr+3	
1987			10225 P	10225	368	14	412	365
1988			48,873 M	48873	280	14	294	295
1989			26,656 M	26656	824	0	838	650
1990			40,702 M	40702	461	3	461	215
1991	2,200 M	19,379 C		21579	2	2	5	N/A
1992			15,317 M	15317	130	N/A	132	190

[a]Origins are Profit's Pond (P), Cardigan Salmonid Enhancement Centre (C), and Mooney's Pond (M)

Table 18
Exploitation rates of small Atlantic salmon returning to PEI rivers. Numbers of small salmon entering rivers are from the mark-recapture estimate (Morell) and trap counts (other rivers). Retained catch is from the 1994 angler mail-out survey and the 1995 licence stub survey (Table 9).

River	Number of small salmon entering river		Retained catch of small salmon		Percent exploitation	
	1994	1995	1994	1995	1994	1995
Morell		1352		469		35
Mill[a]	11	3	11	0	100	0
Dunk		50		0		0
Valleyfield	15	58	5	16	33	28

[a]Catch estimate is apparently erroneous due to small sample size, as 144 salmon redds were counted on the Mill in fall 1994.

Table 19

Total returns to Leard's Pond fishway, numbers released into Leard's Pond, and potential egg deposition in the Morell River above Leard's Pond from small and large Atlantic salmon, 1981-1995. The difference between returns and releases is due to broodstock removals. Potential egg depositions are not adjusted for human harvests. Depositions are based on the assumption that sex ratios are as given in Table 4 except where footnoted, fecundities are as in Table 3, and that all females spawn. Potential egg depositions are underestimated in in 1994 and 1995 and possibly earlier because some salmon apparently entered Leard's Pond without being counted.

Year	Total returns		Total released into Leard's Pond		Potential egg deposition above Leard's Pond			
	Small salmon	Large salmon	Small salmon	Large salmon	Small salmon	Large salmon	Total	Percent of target
1981	39	6	39	6	21451	21470	42921	24
1982	33	3	33	3	18151	10735	28886	16
1983	2	2	2	2	1100	7157	8257	5
1984	5	4	5	4	2750	14313	17063	10
1985	14	1	14	1	7700	3578	11279	6
1986	620	6	278[a]	3[b]	339444	14889	354333	198
1987	1168	68	658	54	361916	193229	555146	310
1988	1394	89	1290	20	709532	71566	781099	436
1989	335	125	330	48	181508	171760	353268	197
1990	409	63	368	44	202409	157446	359855	201
1991	327	39	280	14	154007	50097	204104	114
1992	907	46	824	14	453221	50097	503317	281
1993	628	11	461	0	253562	0	253562	141
1994	36	29	2[c]	3[b]	3143	14889	18032	10
1995	186	15	130	2[c]	71503	4963	76466	43

[a]108 females

[b]All females

[c]1 male, 1 female

Table 20

Origin and size composition and potential egg deposition of the 1995 Morell River salmon run.

	Small salmon			Large salmon			All salmon		
	Wild	Hatchery	Total	Wild	Hatchery	Total	Wild	Hatchery	Total
Nathan's Hole counts	6	114	120	4	3	7	10	117	127
Leard's counts	14	172	186	5	10	15	19	182	201
Total counts	20	286	306	9	13	22	29	299	328
Percent of total	6	87	93	3	4	7	9	91	100
Estimated number in run[a]	95	1352	1446	43	61	104	137	1413	1550
Estimated harvest[b]	31	437	468	0	1	1	31	438	469
Estimated escapement	64	914	978	42	61	103	106	975	1081
Estimated females in escapement[c]	11	160	171	30	44	74	42	204	245
Number of eggs deposited[d]	35160	502785	537945	150724	217712	368436	185884	720497	906381
Percent of river target[e]	6	88	95	26	38	65	33	127	159

[a]Based on the mark-recapture estimate of total run size, categorized by origin and size according to proportions in samples at Nathan's and Leard's

[b]Based on the licence stub survey and logbook reports of native harvest

[c]Based on 17.5% females among small salmon and 72.1% females among large salmon

[d]Based on fecundities of 3143 for small salmon and 4963 for large salmon

[e]Target is 569222 eggs, based on 2.4 eggs·m^2 in 237176 m^2 of habitat

Table 21
Potential egg deposition by Atlantic salmon in the Mill, Dunk, West, and Valleyfield Rivers. Depositions are based on fecundities given in Table 3 and sex ratios given in Table 4.

Year	Total returns		Escapement[a]		Egg deposition				
	Small salmon	Large salmon	Small salmon	Large salmon	Small salmon	Large salmon	Total	Target	Percent of target
Mill River									
1993	17	5	17	5	9350	17892	27242	139920	19
1994[b]	11	0	0	0	0	0	0	139920	0
1995	3	27	3	27	1650	96615	98265	139920	70
Dunk River									
1995	50	0	50	0	27501	0	27501	463387	6
West River									
1989	31	19	31	19	17051	67988	85039	442800	19
1990	25	23	25	23	13751	82301	96052	442800	22
1993	250	12	250	12	137506	42940	180446	442800	41
Valleyfield River									
1990	36	0	36	0	19801	0	19801	306000	6
1991	5	0	5	0	2750	0	2750	306000	1
1992	25	0	25	0	13751	0	13751	306000	4
1993	84	0	84	0	46202	0	46202	306000	15
1994	15	7	10	7	5500	25048	30549	306000	10
1995	58	4	55	4	30251	14313	44565	306000	15

[a]Harvest estimates are available for 1994 and 1995 only; for other years escapement is given as total returns
[b]Since 144 redds were counted on the Mill in fall 1994 (Table 15), the egg deposition estimated here must be erroneous

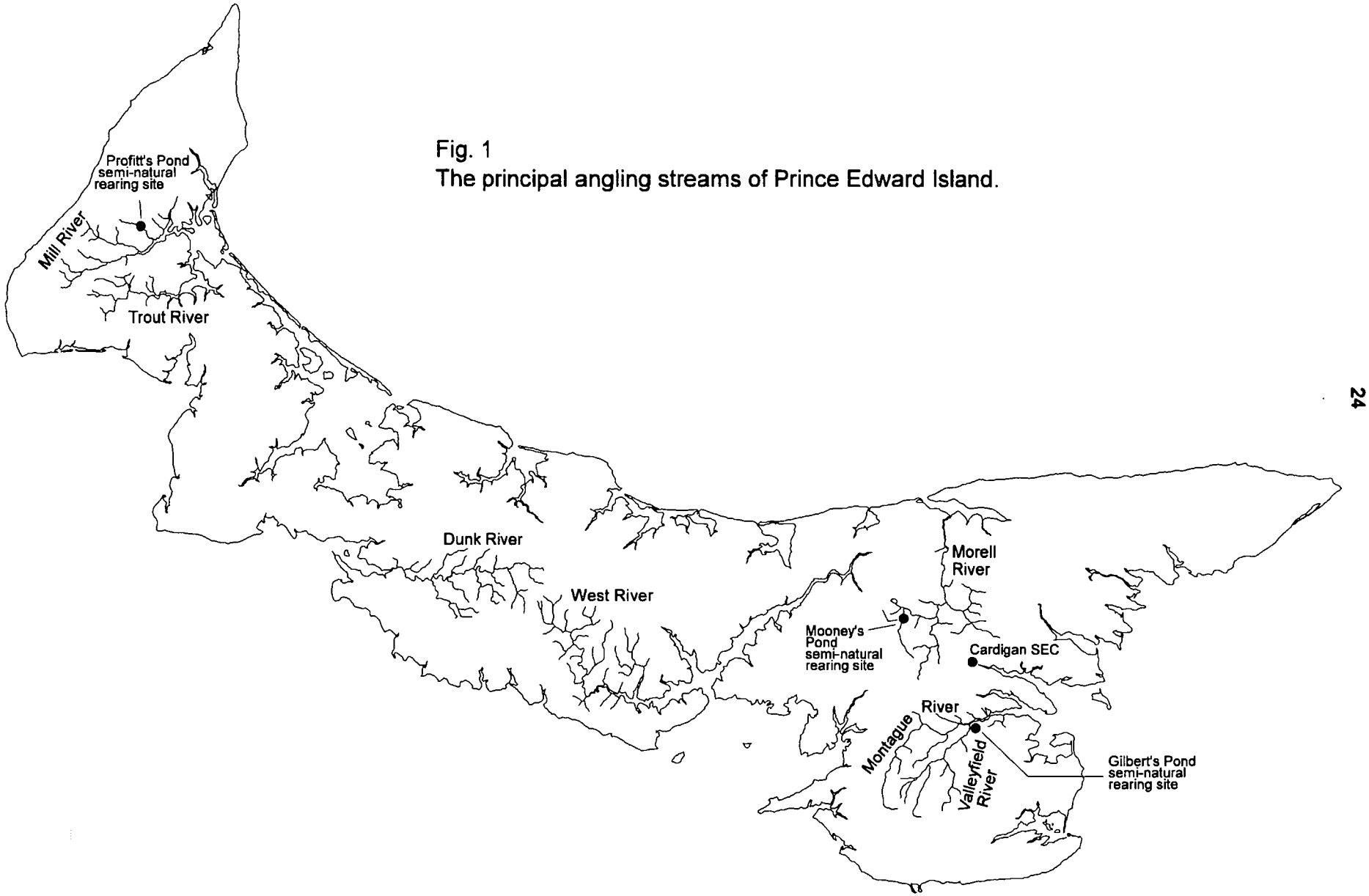


Fig. 1
The principal angling streams of Prince Edward Island.

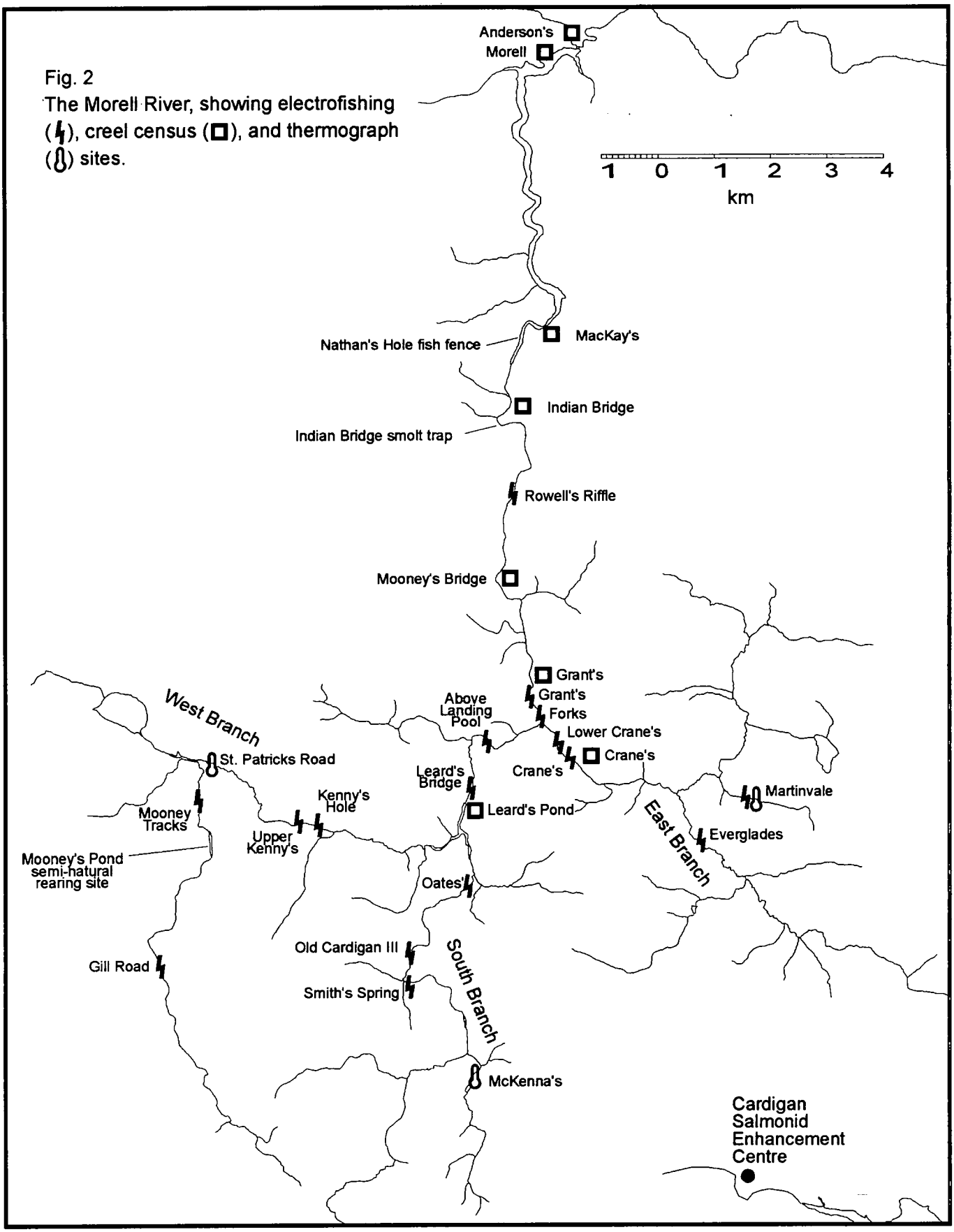


Fig. 2
The Morell River, showing electrofishing (ϟ), creel census (□), and thermograph (🌡) sites.

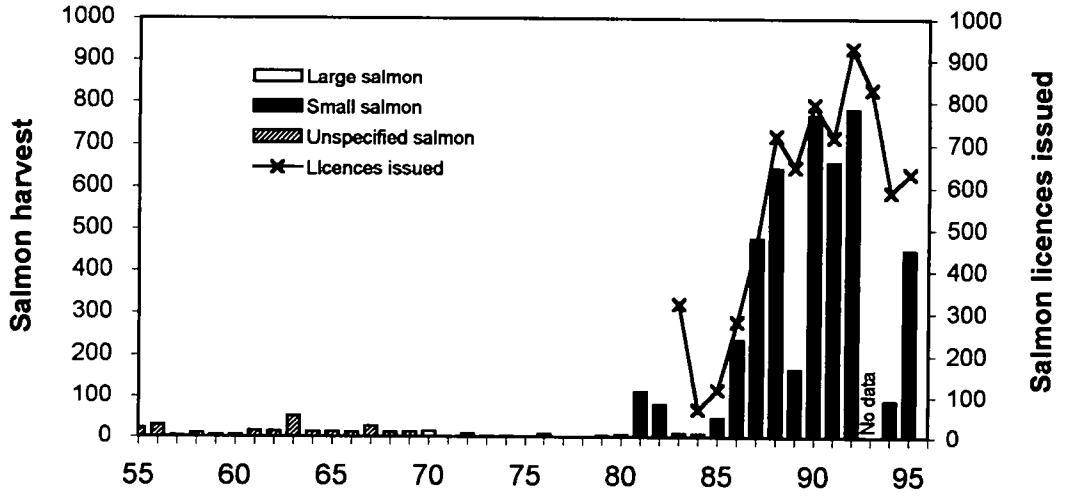


Fig. 3
Atlantic salmon sport catches on the Morell River, 1955-1995, and PEI salmon licence sales, 1983-1995.

1995 Salmon Report Card N° 729

Mo.	Date	River	Grilse: Number caught & kept	Grilse: Number caught & released	Large salmon: Number caught & released
Jun.	7	Example River	1 (1h)	2 (1h)	0
Jun.	9	Example River	0	0	2 (0h)

Please complete and return this card at the end of the fishing season, even if you did not fish for salmon in 1995. Fill in a new line every day you fish for salmon, even if you did not catch anything.

Indicate the number of fish you caught each day. Give the number of hatchery-reared fish you caught in brackets. The sketch on the back of the licence shows how to tell if the fish was reared in a hatchery.

If you run out of space, write the information on a separate sheet of paper. Put the paper in an envelope and tape this card to the envelope, with the address side out. No postage is required.

Check here if you did not fish for salmon in 1995. ☐

Daily log

Please indicate the number of grilse and large salmon you caught during each fishing day.

Give the number of hatchery-reared salmon in brackets. The sketch on the accompanying letter shows how to tell if the fish was reared in a hatchery.

Mo.	Date	River	Grilse: Number caught & kept (hatchery)	Grilse: Number caught & released (hatchery)	Large salmon. Number caught & released (hatchery)
Jun.	7	Example River	1 (1h)	2 (1h)	0
Jun.	9	Example River	0	0	2 (0h)

Seasonal summary

Please indicate your seasonal totals here.

Please check here if you did not fish for salmon on PEI in 1995. ☐

River	Number of days fished	Grilse: Number caught & kept (hatchery)	Grilse: Number caught & released (hatchery)	Large salmon: Number caught & released (hatchery)
Example River	25	7 (5h)	12 (11h)	5 (2h)

Fig. 4
Stub attached to 1995 PEI salmon licences (left), and reminder card sent to licence-holders who did not return their stubs (right).

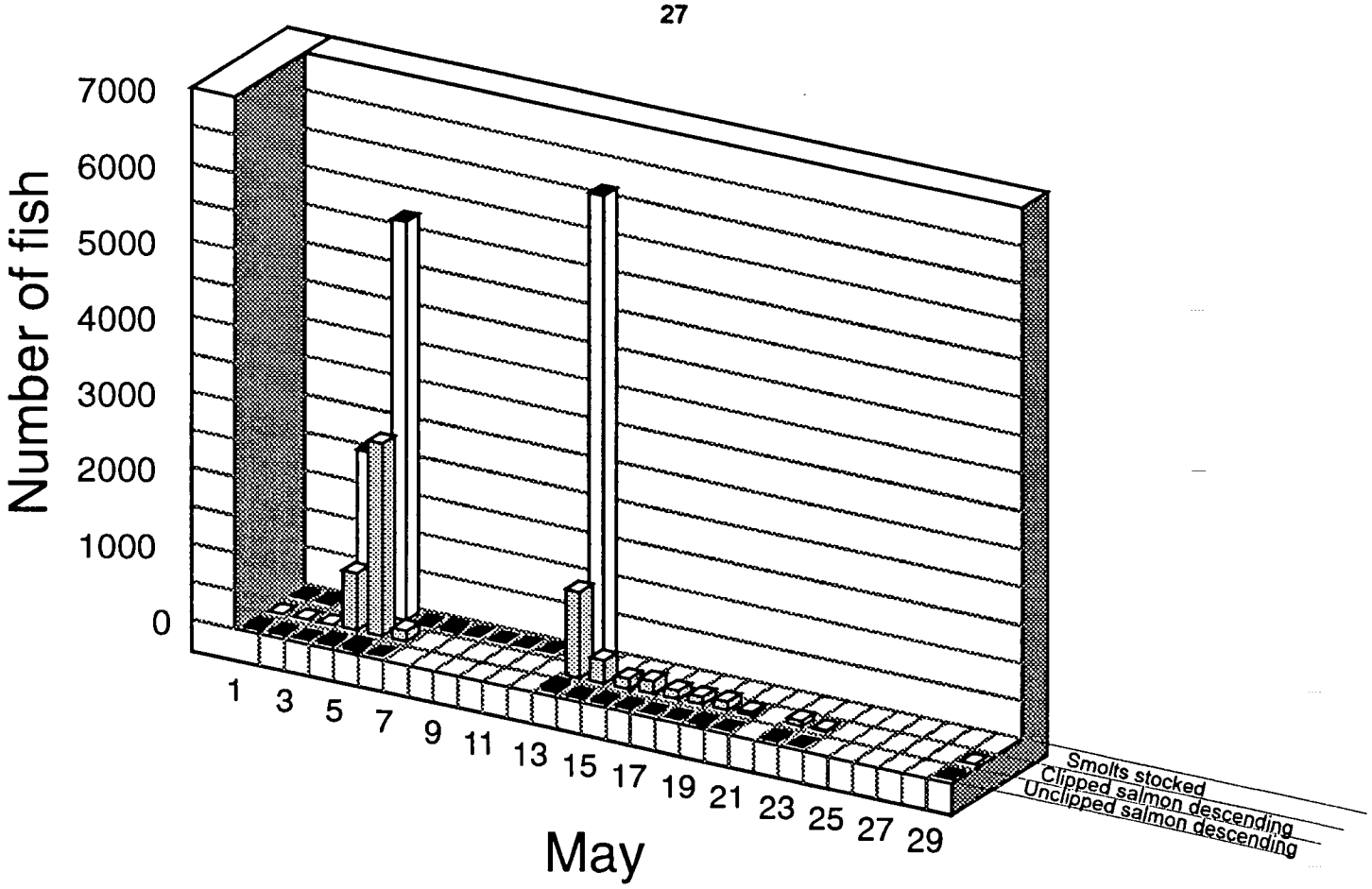


Fig. 5
Number of salmon smolts stocked in the Morell River and estimated movement of clipped and unclipped smolts at the Indian Bridge trap, May 1995. The number of smolts descending on 5 May is a minimum estimate. The column for number of smolts stocked on 13 May sums estimates for 13-23 May (see text).

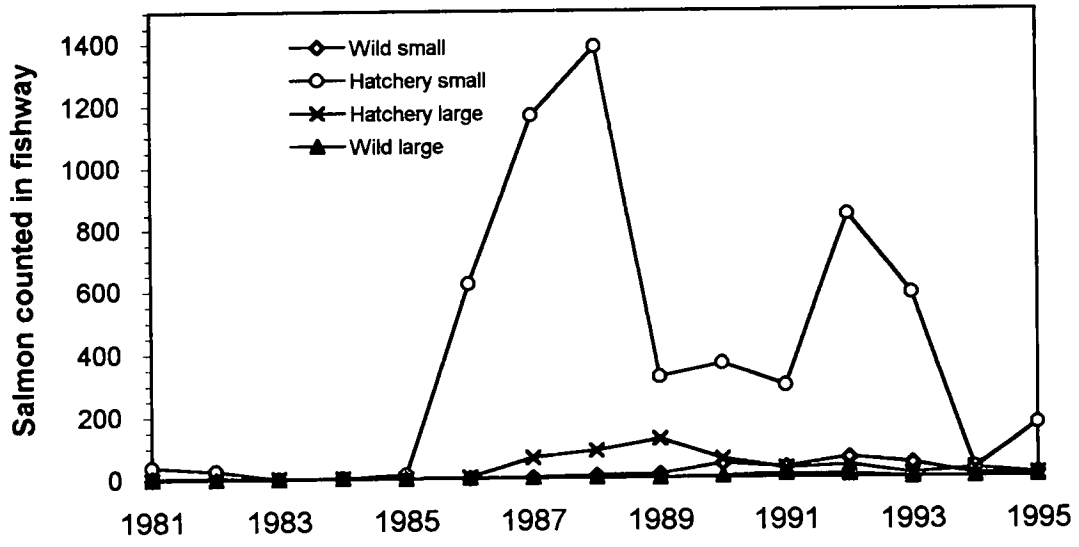


Fig. 6
Atlantic salmon returns to the Leard's Pond fishway, 1981-1995.

Fig. 7
Run timing of hatchery salmon (upper panels) and wild salmon (lower panels) ascending the Leard's Pond fishway, 1985-1995.

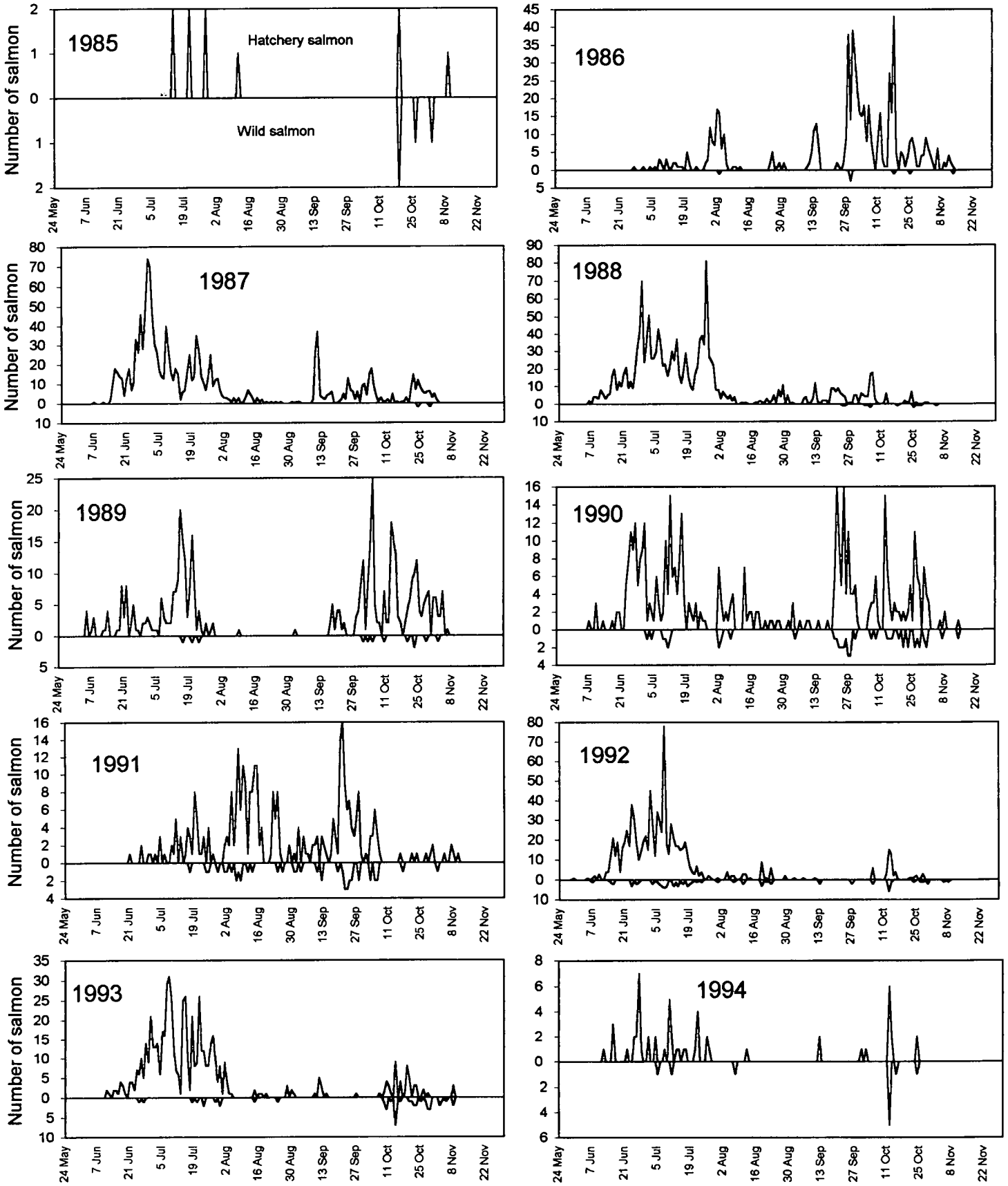
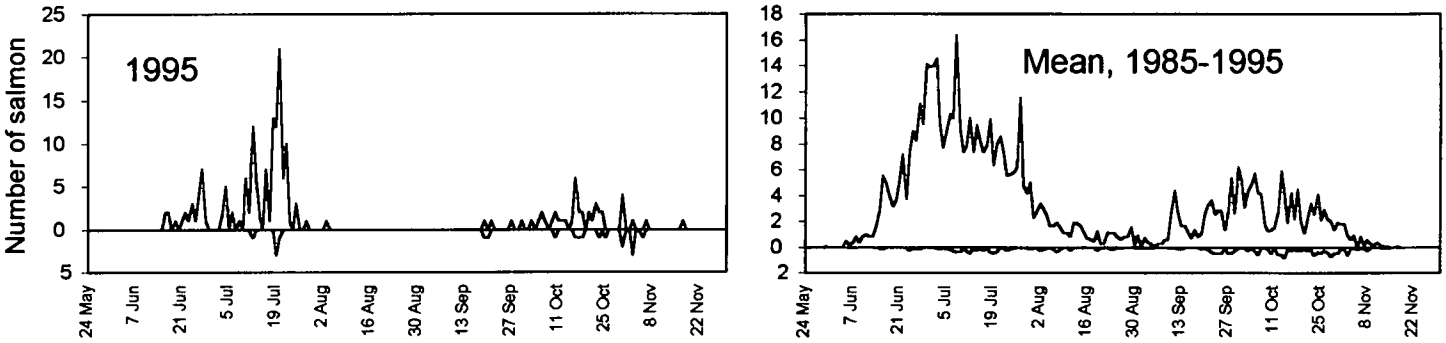


Fig. 7 (continued)



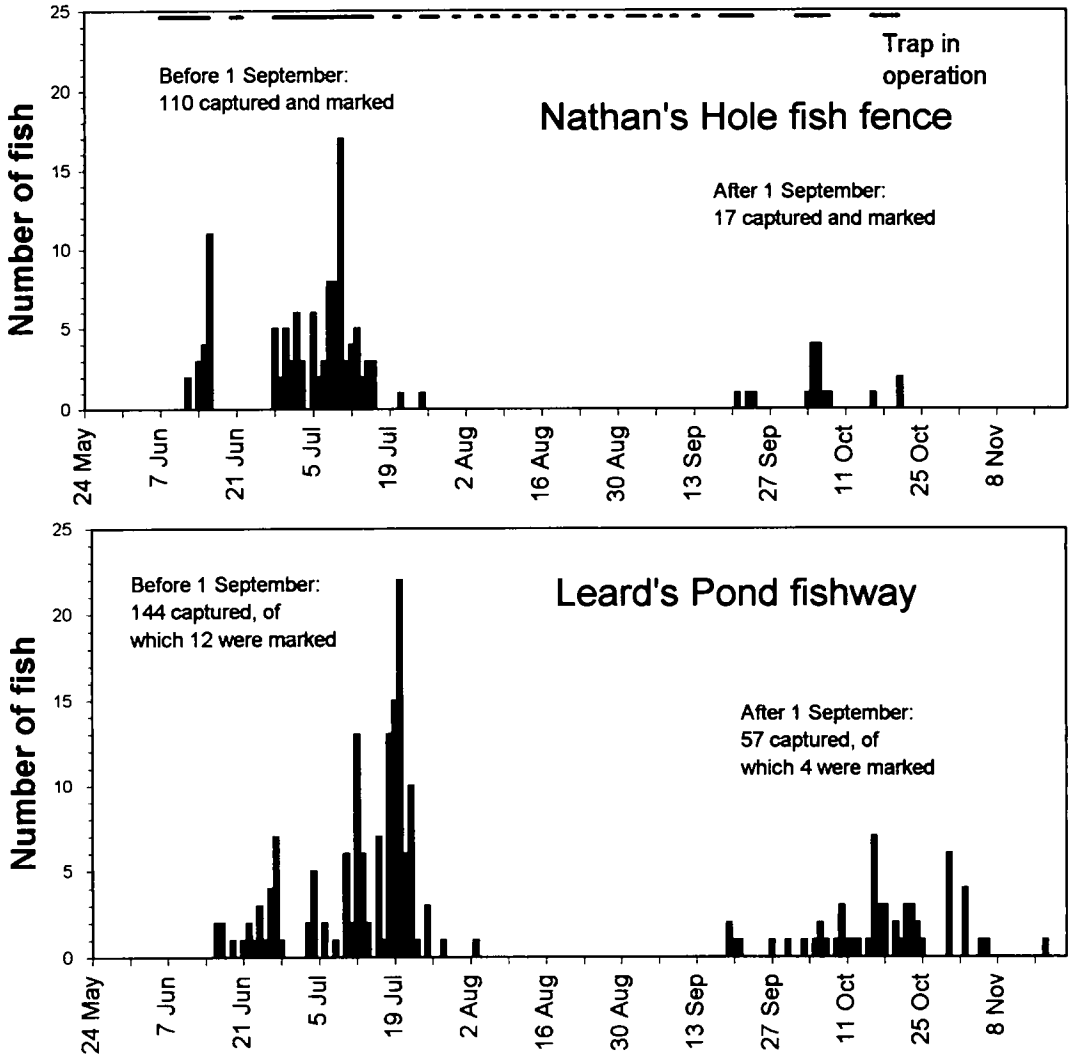


Fig. 8
Number of salmon counted at the Nathan's Hole fish fence and the Leard's Pond fishway, 1995.

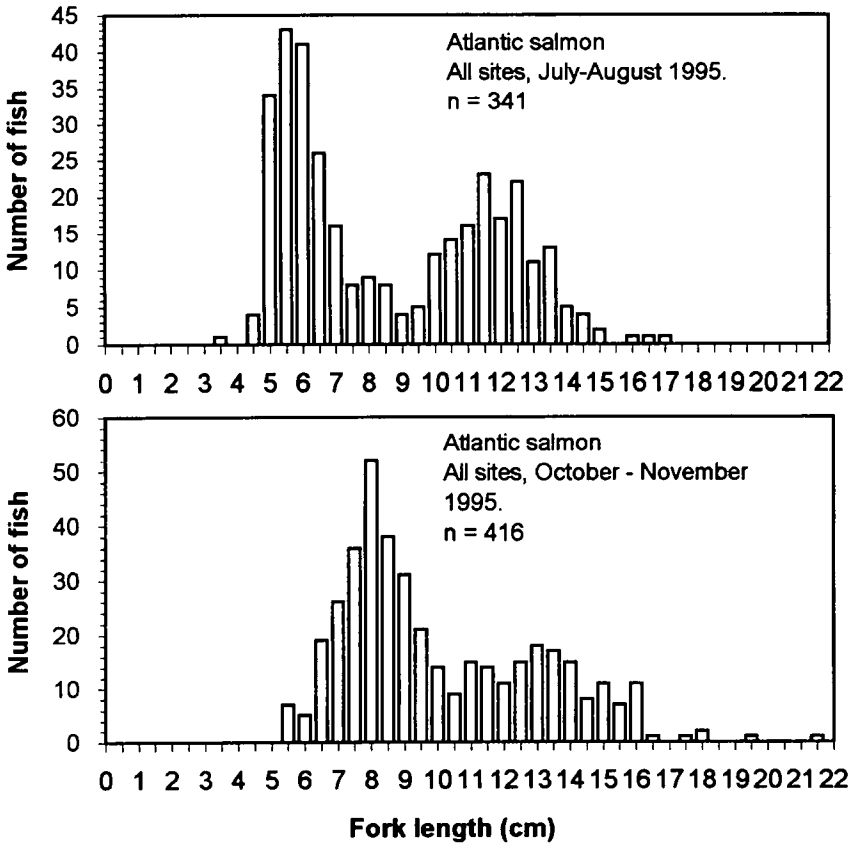


Fig. 9
Length frequencies of juvenile Atlantic salmon taken by electrofishing on the Morell River, 1995.

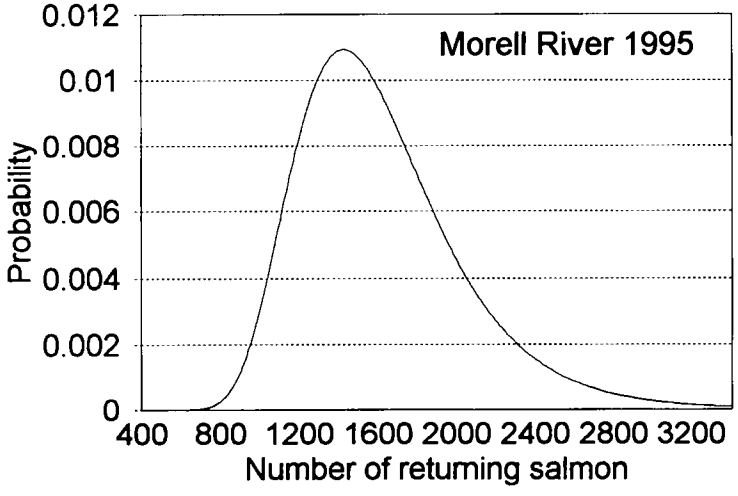
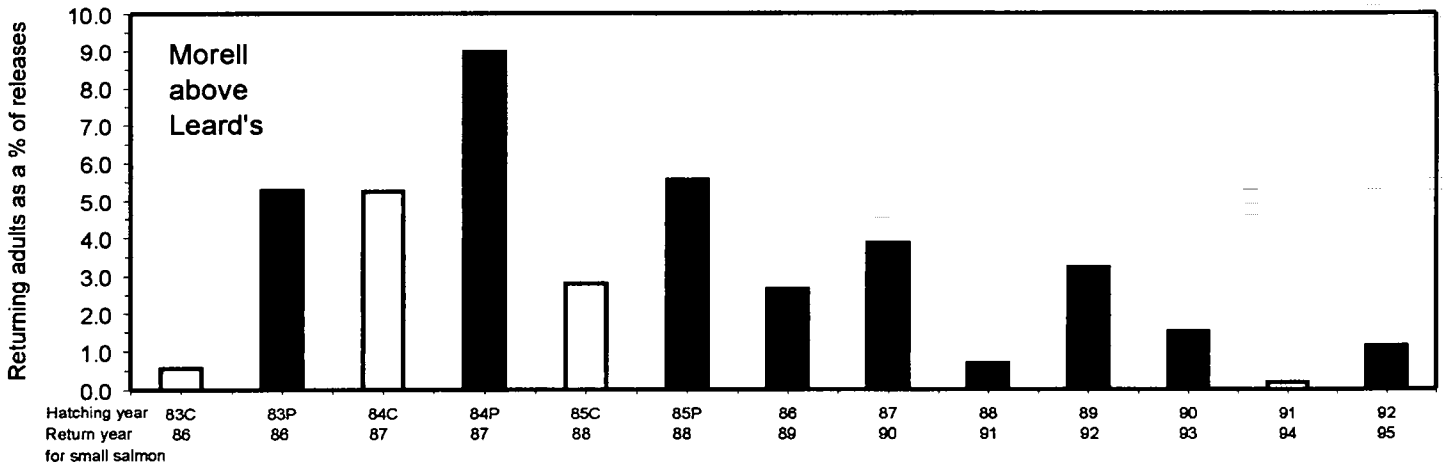


Fig. 10
Bayesian probabilities of mark-recapture estimates of the Morell River salmon run.



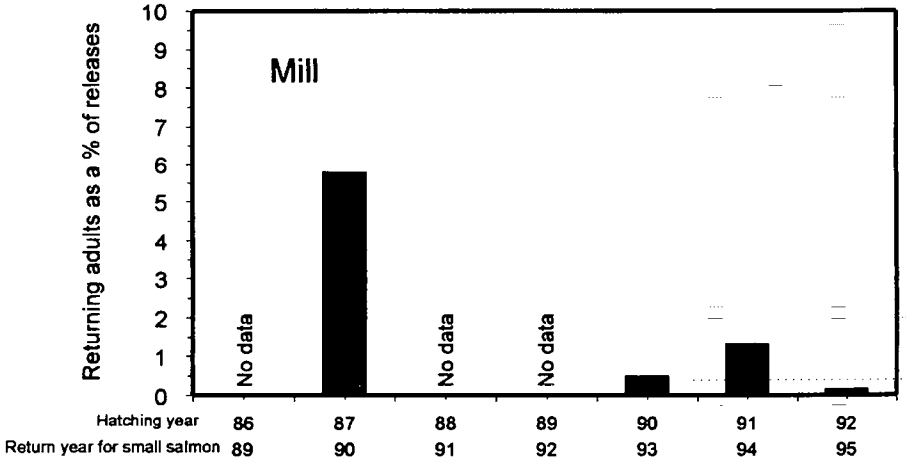
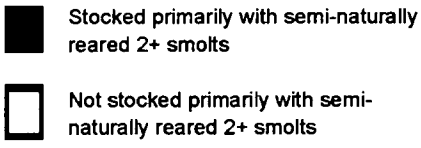
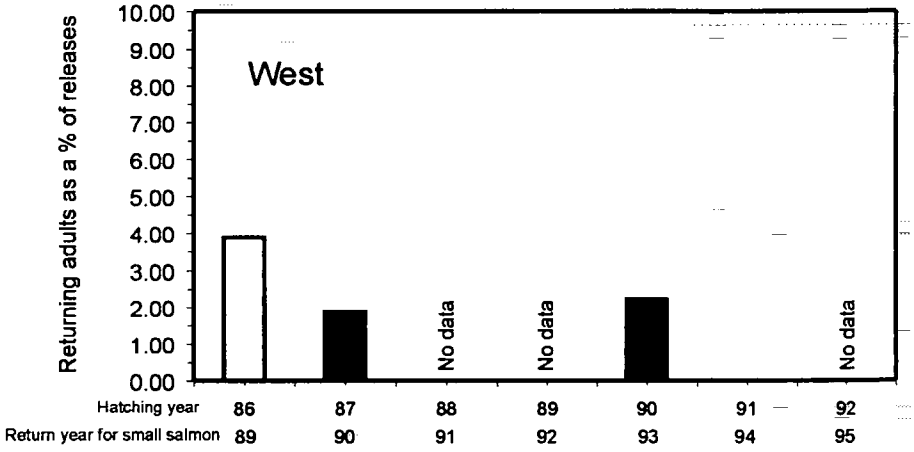


Fig. 11
Returns of adult salmon of hatchery origin to the Morell above Leard's Pond, and to the Mill, West, and Valleyfield Rivers. C=reared in the Cardigan SEC, P=reared in Profit's Pond semi-natural site.





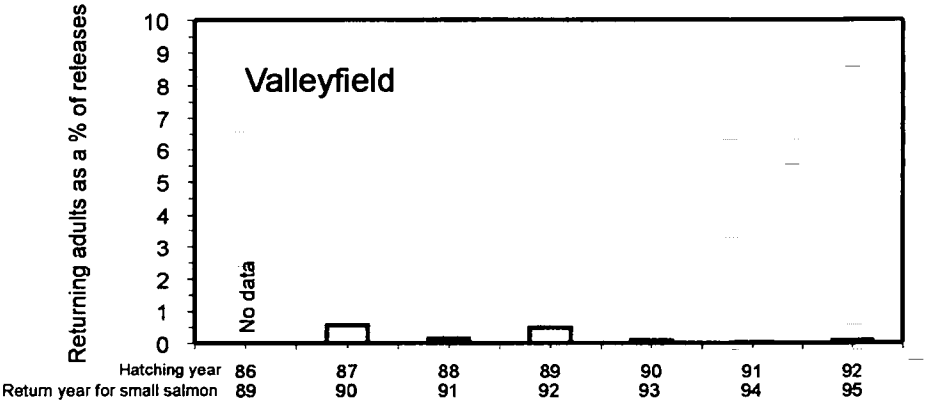


Fig. 12
The relation between the number of salmon stocked above Leard's Dam and subsequent counts of hatchery-reared adult fish from the same cohort at Leard's Pond fishway. Labels indicate the hatching year of the cohort. C=fish reared at the Cardigan SEC and P=fish reared at Profitt's Pond semi-natural rearing facility. Solid diamonds denote cohorts composed primarily of 2+ smolts reared in semi-natural ponds.

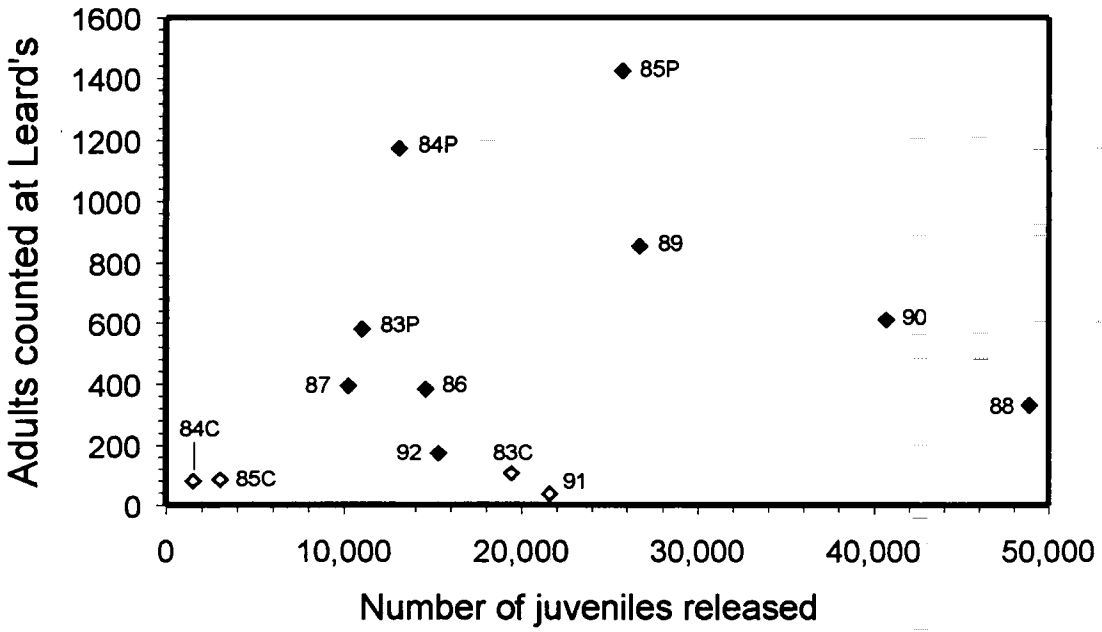


Fig. 13
Relation between number of juveniles, hatched in Yr 0 and stocked in the Morell River above Leard's Dam, and the number of salmon redds counted above Leard's Pond in Yr + 3. Labels indicate Yr+3.

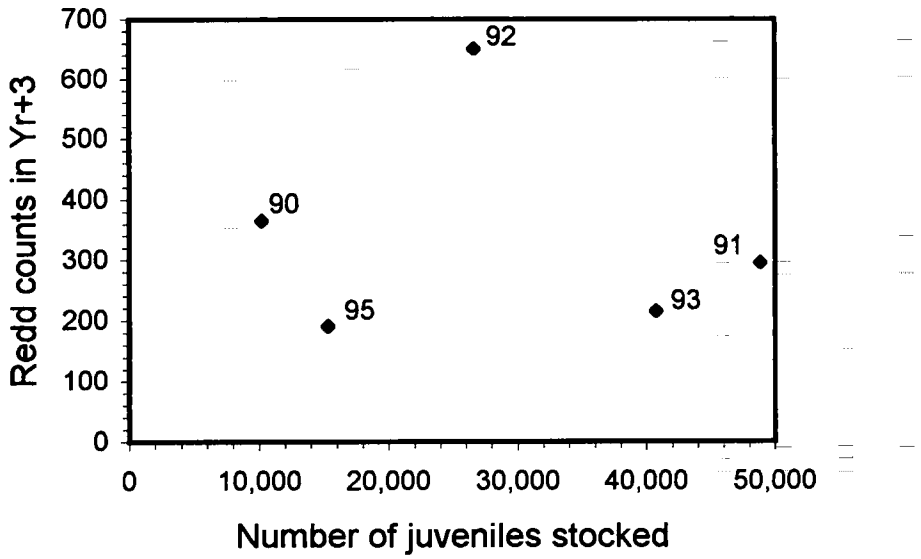
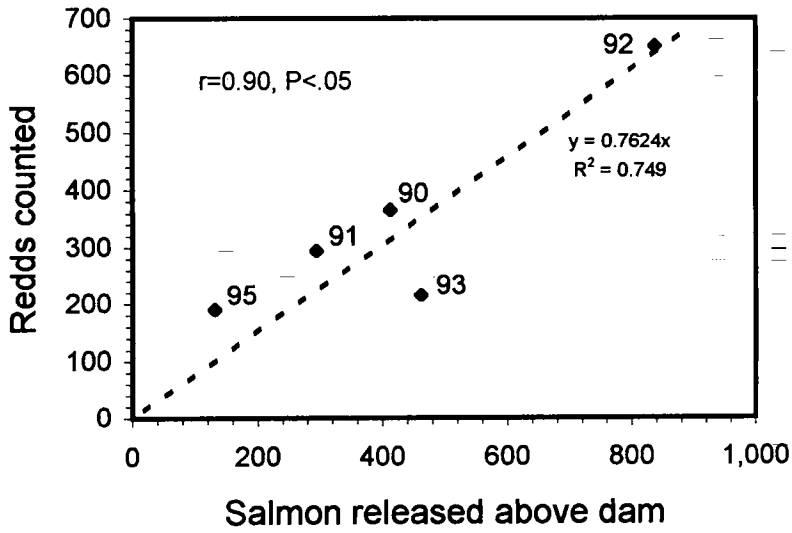


Fig. 14
Relation between the number of salmon released from the Leard's fishway into Leard's Pond, and the number of salmon redds counted above Leard's Pond in the same year. Labels indicate the year of the counts. The line, equation, and R^2 are based on a regression forced through the origin.



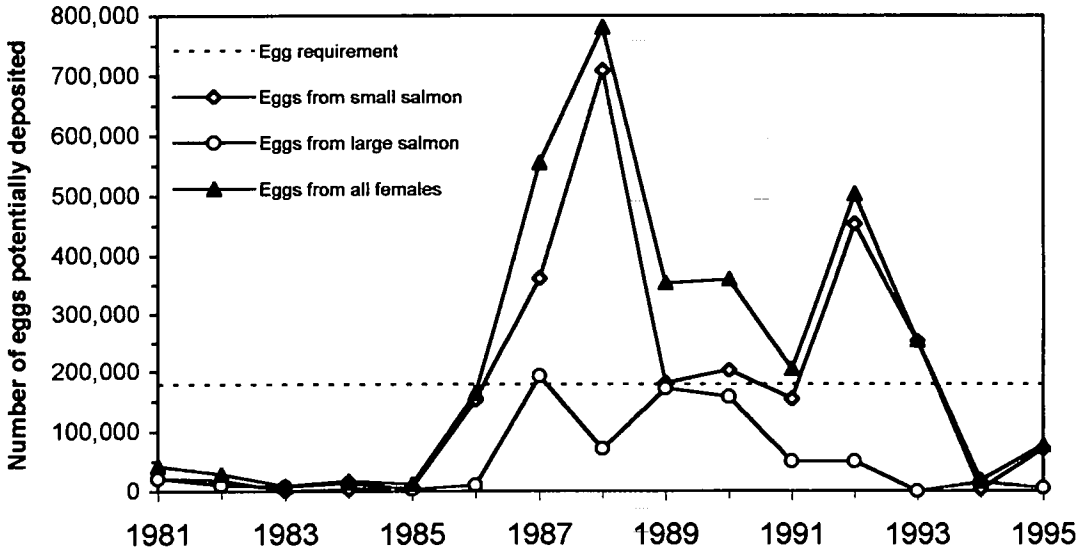


Fig. 15
Potential egg deposition by salmon released above Leard's dam, 1981-1995. Note that deposition is underestimated in 1994-1995 and possibly earlier because not all fish entering the pond were enumerated.