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Status of the Atlantic salmon (*Salmo Salar* L.) Stock of Harry's River/Pinchgut Brook, Newfoundland, 1999

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ABSTRACT

The number and the proportion of small salmon at the counting fence on the Pinchgut Brook tributary of Harry's River increased in 1999 but were within 10% of those in 1998. The number of large salmon remained the same as in 1998. The conservation egg deposition requirement was not achieved on the Harry's River in 1999. The Harry's River salmon stock has achieved at most only 52% of the requirement in the last eight years. This is alarming considering the recreational salmon fishery has been restricted to catch and release angling since 1996 and that the commercial fishery has been closed since 1992. Uncertainties associated with the estimation of spawning escapement and egg deposition on Harry's River as a whole based on counts at Pinchgut Brook tributary were analysed using a probability density function. The results indicated that there was a greater than 100% probability that the conservation requirement was not achieved on the Harry's River in 1999. Increased juvenile densities in recent years indicate a positive outlook for this stock. However, poor environmental conditions in freshwater and continuing evidence of illegal removals continue to raise concerns. It is recommended that the recreational fishery on this stock continue to be managed in such a way that the spawning stock is maximised.

RÉSUMÉ

Le nombre et la proportion de petits saumons à la barrière de dénombrement de Pinchgut Brook, tributaire de Harry`s River, ont augmenté en 1999, sans dépasser de plus de 10 % des valeurs de 1998. La proportion de gros saumons est demeurée la même qu'en 1998. La ponte n'a pu satisfaire les besoins de conservation du stock de Harry`s River en 1999. Ces derniers n'ont, au mieux, été atteints qu'à 52 % des besoins de conservation au cours des huit dernières années. Cela est inquiétant étant donné que la pêche récréative est limitée à la pêche par capture et remise à l'eau depuis 1996 et que la pêche commerciale est interdite depuis 1992. Les incertitudes associées à l'estimation de l'échappée des géniteurs et de la ponte dans Harry`s River dans son ensemble, fondée sur les dénombrements dans Pinchgut Brook, ont été analysées à l'aide d'une densité de probabilité. D'après les résultats obtenus, la probabilité que les besoins de conservation du stock de Harry`s River n'aient pas été atteints en 1999 dépasse 100 %. L'accroissement des densités de juvéniles au cours des dernières années montre qu'il y a possibilité d'amélioration de l'état du stock. Cependant, les mauvaises conditions environnementales en eau douce et la poursuite évidente du braconnage continuent de soulever des inquiétudes. Il est recommandé de continuer à gérer la pêche récréative de ce stock de manière à maximiser le stock de géniteurs.

INTRODUCTION

This is the fifth assessment of the status of the Atlantic salmon stock of Harry's River since 1995. Harry's River is the most northerly of the eight scheduled Atlantic salmon rivers flowing into Bay St. George, Salmon Fishing Area (SFA) 13 (Fig. 1). The recreational fishery on this river was under quota management until 1995 and has been closed to retention angling since 1996.

Recreational fishing success on Harry's River peaked during 1953-60 when the mean catch-per-unit-effort (CPUE) for small and large salmon was 0.95 (Appendix 1). In the next 10 years (1961-70), angling effort increased by 119% but the catch did not increase to the same degree resulting in a 48% decrease in CPUE. The highest catches were in 1964 (2,673 small (<63 cm) and 373 large (>=63 cm)), making Harry's River the largest salmon producing river in Bay St. George. This was the largest catch ever recorded from a Bay St. George river (Mullins et al., MS 1989) and represented about 30% of the total Bay St. George catch in that year. In comparison, the catch on Harry's River in 1995 represented only 13% of the Bay St. George total catch. In 1971-77, angling effort continued to increase, but the mean catch of small salmon actually decreased by 24%, and the mean catch of large salmon decreased by 75% compared to the previous 10 year mean. In 1978-83, and again in 1984-89, delaying the opening dates for the commercial and recreational fisheries did not result in improvements in salmon abundance in the river (Claytor and Mullins, MS 1990). The mean catch in 1978-83 was only 524 small and 35 large salmon, suggesting that the stock was continuing to decline. This decline, particularly of large salmon, was evident in all Newfoundland rivers, and in 1984 anglers were restricted to catch and release only of large salmon. In 1987, individual river quotas for small salmon were introduced on several SFA 13 rivers including a quota of 350 small salmon on Harry's River. The low juvenile densities recorded in electrofishing surveys on Harry's River in 1987 and 1988 suggested that future recruitment would be low (Claytor and Mullins, MS 1989). This turned out to be the case with the recreational fishery on Harry's River being open the entire season in only two years since 1986.

In 1993-95, after the introduction of the commercial salmon fishery moratorium, large salmon showed signs of improvement but recreational catches of small salmon remained among the lowest on record. Estimates of spawning escapements in those years indicated that numbers of both small and large salmon remained at a low level (Mullins et al., 1997).

The present assessment provides an estimate of the total spawning escapement of salmon on Harry's River in 1999 based on counts at the counting fence operated on Pinchgut Brook tributary since 1992 and spawning surveys of the entire river system in 1995-97. The status of the resource is assessed relative to established conservation requirements and relative to previous years with consideration for associated uncertainties. The methodology closely follows

that of previous assessments (Mullins et al., MS 1999; Mullins et al., MS 1997; and Mullins et al., MS 1996).

METHODS

RECREATIONAL SALMON FISHERY

Recreational catches and effort in 1996-99 were based on the licence stub return system (O'Connell et al. MS 1998). This system of collection is not directly comparable to traditional methods used by DFO River Guardians prior to 1996. In addition, season opening and closing dates, bag limits, quotas and closures due to low water levels in some years also limit comparability of catch and effort statistics between years.

Year	Season	Bag Limit	Quota	Closures
1992	20 June-7 Sept.	8 (2 per day)	5000 SFA 13; 350 river	Closed 2 August SFA quota reached
1993	12 June-6 Sept.	8 (1 per day)	5000 SFA 13; 350 river	Closed 22 August river quota reached
1994	1 July-15 Aug.	3+3 (2 per day)	350 river	Closed 8 August due to low returns
1995	10 June-4 Sept.	3+3 (2 per day)	nil	Closed to retention 16 July due to low returns
1996	15 June-2 Sept.	No retention	nil	Closed above Home Pool
1997	14 June-1 Sept.	No retention	nil	Closed above Home Pool
1998	13 June-7 Sept.	No retention	nil	Closed above Home Pool
1999	1 June-7 Sept.	No retention	nil	1. Closed above Home Pool 2. Closed 24 June - 30 July due to low water levels.

ADULT SALMON COUNTS – PINCHGUT BROOK

Adult salmon have been enumerated annually at a counting fence on Pinchgut Brook since 1992. The counting fence is located at the mouth of the tributary approximately 48km upstream from the mouth of Harry's River (Fig. 2). With the exception of the addition of a second counting trap in 1997-99, the installation has not changed since 1992.

The total spawning escapement (SE) on Pinchgut Brook tributary is calculated as:

$$SE_{Pgut} = C - RC - HRM$$

Where:

C = total count of salmon at the counting fence
RC = total recreational catch above the counting fence
HRM = hook-and-release mortalities (10% of hooked and released fish) above the counting fence.

Angling removals include 10% mortality of hooked and released fish. Angling has not been permitted on the Pinchgut Brook tributary since 1996.

Water temperatures (C) were recorded at the counting fence in 1994-99 using a 'Hobo-temp' temperature logger.

Environment Canada and the Newfoundland Department of Environment and Labour, Water Resources Management Division provided water discharge information for Harry's River. Data were collected from gauging station number 02YJ001 located below the highway bride on Harry's River near site #3 (Fig. 2).

SPAWNING ESCAPEMENTS AND EGG DEPOSITIONS - HARRY'S RIVER

a) Spawning Escapements

The total spawning escapement on Harry's River (TSE) was calculated based on spawning escapements on Pinchgut Brook according to the formula:

$$TSE = SE_{Pgut} / Prop_{Pgut}$$

Where:

SE_{Pgut} = spawning escapement on Pinchgut Brook
$Prop_{Pgut}$ = proportion of Harry's River salmon that spawn on Pinchgut Brook

The proportion of Harry's River salmon that spawn in the Pinchgut Brook tributary was derived based on the average proportion of redds on Pinchgut Brook from three spawning surveys of the entire river system conducted in November of 1995, 1996 and 1997 (Mullins et al., 1997; Mullins et al., 1996). The number of redds counted during the surveys were adjusted based on the proportion of the tributary that was surveyed. Unproductive or inaccessible areas were not surveyed (Claytor and Mullins, MS 1989; Porter et al., MS 1974; Downer, MS 1968). Spawning surveys were not conducted in 1998 or 1999.

The total spawning escapement on Harry's River was apportioned into small and large size categories based on the proportion of small and large salmon observed at the counting fence on Pinchgut Brook.

A mark-recapture experiment conducted on Harry's River in July 1995 provided an estimate of the total spawning escapement that was equal to that derived based on counts at the counting fence and spawning surveys in 1995 (Mullins et al., MS 1996).

b) Estimation of Conservation Requirements

The conservation egg deposition requirement, was calculated based on 2.4 eggs/m^2 (Elson, 1975), for fluvial habitat (Elson, 1957) and 368 eggs/ha (O'Connell et al., MS 1991) for lacustrine habitat. The egg deposition rate for fluvial habitat includes an adjustment for egg losses due to poaching and disease, whereas, the egg deposition rate for lacustrine habitat does not include an adjustment.

Conservation requirements were calculated separately for Harry's River as a whole and for Pinchgut Brook tributary based on the amount of fluvial and lacustrine habitat available to salmon. Calculations were according to the formula:

CR = (fluvial area x 2.4) + (lacustrine area x 368)

The habitat available on Harry's River (Porter and Chadwick, MS 1983 Mullins et al., MS 1996; Mullins et al., MS 1997) and Pinchgut Brook tributary (Porter et al., MS 1974; Mullins et al., MS 1996) is as follows:

River	Fluvial Area (m^2)	Lacustrine Area (ha)
Harry's River	26,394	4,068
Pinchgut Brook	1,655	1,036

Lacustrine habitat measurements for Harry's River include lakes greater than 10 ha in surface area (Mullins et al., MS 1997). This value was updated from 3,546 ha (Mullins et al., MS 1996, Reddin and Mullins, MS 1996) based on revised map measurements. The surface area of lakes was measured directly from digitised 1:50,000 scale topographic maps (Mullins et al., MS 1996).

Lacustrine habitat measurements for Pinchgut Brook tributary include 45% (684 ha) of the surface area of George's Lake. This is equivalent to the proportion of the total length of all tributaries flowing into George's Lake comprised by the Pinchgut Brook. George's Lake comprises 56% of the total lacustrine habitat on the Harry's River system (Porter et al., MS 1974).

River	Conservation Requirements			
	Eggs	Spawners		
		Small	Large	Total
Harry's River	7,831,584	4,068	92	4,160
Pinchgut Brook	1,030,160	535	12	547

The conservation requirement expressed in terms of the number of spawners is based on average biological characteristics in 1992-96 (Mullins et al., MS 1997).

c) Potential Egg Deposition

Potential egg depositions (ED) by small and large salmon were estimated by the following formulae based on available biological information:

$$\mathbf{ED = SE \times PF \times F}$$

Where:

SE = spawning escapement
PF = proportion female
F = fecundity

$$\mathbf{F = RF \times MW}$$

Where:

RF = relative fecundity (# eggs/kg)
MW = mean weight of females

The relative fecundity of 1,540 eggs/kg of body weight was used for both small and large salmon (Porter and Chadwick, MS 1983; Anon. 1978). Fecundity data available for Flat Bay Brook in Bay St, George suggests approximately 1,850 eggs/kg (C. Bourgeois, DFO pers. comm.)

Mean weight and proportion female for small salmon in 1999 were taken from pooled data for 1992-99 because sample sizes at the counting fence were small (<30). Sex identification was based on both internal and external sexing. Mean weight and proportion female for large salmon (5.06 kg per female and 0.868) were from samples collected on other rivers in Bay St. George in 1953-94 (Reddin and Mullins, MS 1996). The biological characteristics used to estimate egg depositions in 1999 were as follows:

Small salmon			Large salmon		
Mean Wt. Females (kg)	**Fecundity**	**Prop. Female (N)**	**Mean Wt. Female (kg)**	**Fecundity**	**Prop. Female (N)**
1.52 (255)	2340	0.698 (338)	5.06	7792	0.868 (7)

There is some uncertainty in the egg deposition estimate because of the possibility of error in the estimated values used in the calculations such as the estimates of spawning escapement and biological characteristics. The uncertainty was expressed in the form of a probability density function using simulation techniques. The technique involved recalculating the egg deposition estimate 5000 times while allowing some of the values used in the calculation to vary with each calculation or simulation. The following parameter values were allowed to vary within a uniform distribution with each simulation step: 1) the proportion of spawning on Pinchgut Brook; 2) the proportion of small and large salmon at the counting fence; 3) fecundity and 4) the proportion of females. Fecundity was allowed to vary by a 20% coefficient of variation. The frequency and probability distributions of the resulting egg deposition estimates were plotted to determine the mode and the 2.5^{th} and 97.5^{th} percentiles.

The percentage of the egg deposition requirement (CR) achieved was calculated according to the formula:

% Achieved = ED (small + large) / CR

RESULTS

RECREATIONAL SALMON FISHERY

Harry's River was designated as a Class IV under the recreational salmon fishery management plan introduced in 1999. This means that the fishery was catch and release angling only, the same as in 1996-98. The fishery opened 1 June and closed 7 September 1999. The opening date was about two weeks earlier than in 1998 but the closing date was the same. The headwaters upstream of Home Pool (Fig. 2), which includes Pinchgut Brook tributary, remained closed to all angling. Low water levels from 24 June to 30 July resulted in the river being temporarily closed to angling. Preliminary analysis of data from licence stub returns indicated that 116 small and 42 large salmon were hooked and released on Harry's River in 1999 (Appendix 1). This was the lowest catch of small salmon on record and among the lowest for large salmon. It is possible that the closure due to low water levels in 1999 would have resulted in lower catches. The river classification system introduced in 1999 resulted in increased opportunities for retention angling on a number of rivers including the Humber

River which is adjacent to Harry's River. Transfer of effort to other rivers may also have contributed to lower on hook and release catches on Harry's River. Effort information was not available from the licence stub return data in 1999.

Anglers have reported increased sightings of salmon on Harry's River in recent years lending support to the suggestion that the stock has improved. However, it is not known what effect low water levels may have had on these sightings. Snorkel surveys in other rivers in Bay St. George (Porter, MS 1999) indicate that large numbers of salmon tend to hold up in a few pools in the river. Salmon would probably be more visible under low water conditions.

ADULT COUNTS – PINCHGUT BROOK

The Pinchgut Brook counting fence was installed 20 June 1999 and removed 7 October. A total of 608 small and 63 large salmon were counted at the fence (Table 1, Fig. 3). The number of small salmon was 3% higher than in 1998 and 9% higher than the 1992-98 mean. The number of large salmon was the same as in 1998 and 50% higher than the 1992-98 mean. The proportion large salmon was slightly less than in 1998 but 36% higher than the 1992-98 mean.

The installation date in 1999 was eight days later than in 1998. However, based on the low numbers of fish counted in the first few days of operation, it is unlikely that a large numbers of fish would have migrated upstream before the installation date (Fig. 4). Peak counts of both small and large salmon coincided with peak water levels throughout the season (Fig. 4). Very few fish were counted after mid-September indicating that the run was over before the removal of the counting fence. Even in 1996, when the counting fence was installed 24 May, the first salmon was not counted until mid-June indicating that it was highly unlikely that salmon entered Pinchgut Brook before the installation of the fence in any year of operation. The earliest installation date was in 1996 when the peak spring runoff occurred in February.

Year	**Date of Operation**
1992	4 July to 23 September
1993	17 June to 18 October
1994	22 June to 18 October
1995	19 June to 17 October
1996	24 May to 17 October
1997	13 June to 15 October
1998	12 June to 22 September
1999	20 June to 7 October

Harry's River is considered a late-run river compared to others in Bay St. George (Reddin and Mullins, MS 1996). Results of a counting fence operation near mouth of the river in 1967 (Downer, MS 1968) indicated that approximately 50% of the run entered the river after mid-July (Mullins et al., MS 1996). In the eight years of operation at Pinchgut Brook located 48 km upstream from the mouth of the river, the run timing (defined as the date of 50% of the cumulative count) of small salmon was mid-July or later (Fig. 5).

The relative stability of the run timing of small salmon (mid-July and early August) at Pinchgut Brook (Fig. 6) suggested that it might be possible to predict the total run size based on cumulative counts at the fence. Regressions of cumulative weekly counts on total counts of small salmon in 1992-97 were significant for counts to 26 July (R^2=0.8342 $p<0.05$) and after (Mullins et al., MS 1999). This relationship (y=1.0718x + 182.58) successfully predicted the total count in 1998 to within 10%. However, the same relationship under-estimated the count in 1999 by more than 100%. Severe low water conditions such as occurred in 1999 limit the accuracy and usefulness of in-season predictions based on run timing.

Run timing in 1999 was severely delayed compared to 1992-98 (Fig. 6). The date of 50% of the cumulative count of small salmon was the latest in the time series. This was caused by several weeks of extremely low water flow in 1999 (Fig. 4). Counts at the fence improved with following the rise in water levels that occurred after mid-August. Water levels remained high from mid-August until the counting fence was removed in early October.

SPAWNING ESCAPEMENTS AND EGG DEPOSITIONS

a. Harry's River

The results show that 1,643 small (min. 1,483; max. 1,842) and 171 large (min. 154; max. 191) salmon spawned on Harry's River in 1999 based on 37% (min. 33%; max. 41%) of the total spawning occurring on Pinchgut Brook (Table 2). This was 2% higher than in 1998 and 17% higher than the 1992-98 mean.

Potential egg depositions on Harry's River in 1999 were 49% of the conservation requirement (Table 2, Fig. 7). This was the same as in 1998, but 17% higher than the 1992-98 mean and more than four times higher than in 1992. Harry's River would require spawning escapements of approximately 4,160 small and large salmon to achieve its conservation egg deposition requirement.

The status of the Harry's River salmon stock in 1992-99 remains at a low level compared to the early 1960s when the conservation requirement was exceeded by as much as 30% based on analysis of historical angling catches

(Reddin and Mullins, MS 1996). The counting fence that was operated near the mouth of Harry's River in 1967 indicated that only 2,002 salmon (+/- 500 due to incomplete counts) entered the river in that year based on partial counts (Downer, 1968). The total recreational salmon fishery catch in 1967 was 954 salmon suggesting that overexploitation of the stock is not a recent occurrence.

Nevertheless, the status of the stock in 1992-99 represents an improvement compared to the 1970s and 1980s when 40% or less of the conservation requirement was achieved (Fig. 8). The suggestion that Harry's River has experienced higher returns in recent years is consistent with the views expressed by anglers, based on sightings of fish in the river. However, there were years in the past when spawning escapements were much higher.

b. Pinchgut Brook

Although the conservation requirement was not achieved on Harry's River as a whole in 1999, it was achieved on Pinchgut Brook and perhaps on other headwater tributaries. Potential egg depositions on Pinchgut Brook were 138% of the conservation requirement (Table 3, Fig. 7). This was slightly higher than in 1998 and 13% higher than the 1992-98 mean and more than three times higher than the percentage achieved in 1992.

There are several factors that must be considered in the analysis of salmon spawning escapements on Pinchgut Brook and other tributaries relative to Harry's River as a whole. The lower reaches of the main stem of Harry's River are considered to be of lower productivity in terms of spawning compared to the tributaries (Claytor and Mullins, MS 1989; Porter et al., MS 1974; Downer, MS 1968). Therefore, excluding the lower reaches (0-18 km), 84% of the remaining accessible spawning habitat occurs in the tributaries. Spawning surveys in 1995-97 indicated that Pinchgut Brook tributary is the primary spawning area for Harry's River with 33-41% of the spawning escapement. Pinchgut Brook is the uppermost tributary on the system and contains the largest proportion of the spawning habitat. Therefore, it is not surprising that egg depositions would be high in this part of Harry's River compared to other tributaries and the main stem.

Conservation requirements are based on accessible parr rearing habitat and not spawning habitat. With only 40% (~2,465 x 100 m^2 units) of the total fluvial parr rearing habitat, Pinchgut Brook (with only 6% of the total) and other headwater tributaries produce juvenile salmon that must disperse downstream into George's Lake and other parts of the main stem for rearing. Beall et al. (1994) reported dispersal of one-year-old parr up to 2,400 m downstream from the spawning site in summer.

SOURCES OF UNCERTAINTY

a. *Spawning Surveys*

Spawning surveys were carried out on Harry's River in mid-November 1995-97. Pinchgut Brook tributary which comprises s 21.9% of the total length of accessible tributaries on Harry's River accounted for 37% of the adjusted redd counts in 1997, 33% in 1996, 41% in 1995 (Mullins et al., MS 1999). These estimates were comparable with 34.6% estimated in 1967 (Downer, 1968).

The differences indicate a relatively low annual variability in the distribution of spawning. A certain amount of annual variation in the distribution of spawners within the system is to be expected because of annual differences in water levels and the effect of straying of adult salmon to other tributaries. The higher percentage of spawners on the Pinchgut Brook system in 1997 compared to 1996 may have been due, in part, to such a natural redistribution of spawners within the river system.

The adjusted redd counts on the Pinchgut Brook system represented less than one redd per female based on estimates of the percentage of female small and large salmon recorded at the counting fence. It is possible that some redds were not counted in the survey. However, because this type of error would have been consistent throughout the system, it would not have affected the proportion of redds counted on Pinchgut Brook. Results of an experiment in an area of known redd numbers at the beginning of each survey indicated that counting errors and differences between survey crews were low overall. The similarity between crews meant that counting efficiency was similar for all tributaries surveyed. Redd recognition would have improved over the course of the survey.

Results of daily monitoring that a test site on one tributary from early October until no new redds were observed indicated a low likelihood that spawning was incomplete at the time of the survey. Spawning at the test site peaked when the mean daily water temperature reached 7-12 C and by mid-November no new redds were observed. The substrate in most tributaries of Harry's River is relatively stable. Hence, while some flattening of redds may be expected over time, it is unlikely that redds would have been flattened to the point of being unrecognisable at the time of the survey. Water levels were stable at the test site during the spawning period in 1997.

b. Proportion of small and large salmon

The proportion of small and large salmon in the population was estimated based on the counts at the counting fence assuming that Pinchgut Brook is representative of the system as a whole. These values are used to apportion the total spawning escapement into the numbers of small and large salmon. If the

proportion of large salmon on Pinchgut Brook were actually lower than in the population as a whole it would result in an underestimation of the number of large salmon and potential egg depositions. Large salmon deposit more eggs per fish than small salmon.

c. Biological characteristics

The relative fecundity value used to estimate potential egg deposition, is a default value derived from estimates for a number of rivers (Anon., 1978). However, it is recognised that there are differences between rivers and annual variations in this value that would affect the calculation of egg deposition. The mean weight of females is also estimated based on pooled data from a number of years. Uncertainty in using a mean value is introduced by annual differences that are not reflected in a mean value and by varying samples sizes that affect the precision of weight estimates.

The results of simulations to incorporate uncertainty into the estimate of egg deposition indicated that the estimate for Harry's River in 1999 represented the modal value (Fig. 9a). The frequency distribution of the simulated results did not include any points as high as the conservation requirement of 7.8 million eggs (Fig. 9a). Expressed as a probability distribution, there was a 100% probability that egg depositions on Harry's River in 1999 totalled less than 5.5 million eggs (Fig. 9b). In contrast, there was a 100% probability that egg depositions on Pinchgut Brook exceeded the conservation requirement.

POTENTIAL SOURCES OF MORTALITY

a. Environmental Conditions

Mean water discharge rate on Harry's River from mid-May to mid-August in 1998 and 1999 was the lowest recorded in thirty years (Fig. 10). The mean water temperature recorded at the counting fence for mid-June to mid-August was the highest since 1994 (Fig. 11). Low water levels and high water temperatures can cause increased stress on adult salmon resulting in possible higher mortality from predators and the hook and release fishery.

Anglers at public consultation meetings in 1997 suggested that the high water levels early in the 1997 season resulted in lower numbers of anglers on the rivers and may have resulted in the higher spawning escapements on all Bay St. George rivers in 1997.

Increasing juvenile densities at three sites in recent years suggest improved juvenile abundance and the potential for long-term improvement in returns of adult salmon to the river (Mullins et al., MS 1999). However, low water levels and high temperatures such as occurred in 1998 and 1999 create

continued uncertainty for juvenile survival and subsequent smolt production. This is especially a concern in the smaller headwater tributaries. The most extreme (low) relative condition factors observed in juvenile salmon in 1987, a very dry year, were confined to headwater streams (FitzGerald et al., MS 1998).

b. Illegal Removals

Poaching activity on Harry's River has been classed as high by both anglers and DFO river guardians. There were 17 known salmon fishery violations in which charges were laid on Harry's River since 1995 (Table 4). There were also seven other violations involving nets for which no charges could be laid. The extent to which this type of activity has contributed to low spawning escapements is unknown. It has been suggested that removals by poaching may be as high as 50% of the run. If this is true, then it is a severe problem that needs to be addressed.

Incidence of net marks on salmon captured at the counting fence decreased in 1999 compared to 1998 (Table 5). These net marks are likely the result of encounters with both legal and illegal nets set either in freshwater or marine. The impact of this activity on returns to the river and spawning escapements is unknown but the lower incidence of net marks in 1999 could just as likely be the result of a higher netting efficiency as it could a lower incidence of poaching. The low waters levels in the river in 1999 would certainly have presented increased opportunities for netting.

c. Forest Spraying

There is some indication recently that the Harry's River salmon stock may have been adversely affected by forest spraying of the insecticide Matacil 1.8D in the 1970s and 1980s (Fairchild et al., 1999). The long-term effects of this and other more recent forest spray programs are unknown.

DISCUSSION

The results of the analysis of uncertainties in the estimation of egg depositions on Harry’s River indicated a greater than 50% probability that the egg deposition in 1999 was less than 50% of the conservation requirement. This is alarming considering that there was no retention fishery on the river in the last four years and that the commercial salmon fishery was closed in 1992. Therefore, it is recommended that the recreational salmon fishery on Harry’s River continue to be managed in such a way that the spawning stock is maximised.

If Harry’s River had been closed to all angling in 1999, the percentage of the conservation requirement achieved would have been only 1% higher.

Salmon mortality below conservation requirements is usually not advisable. However, catch and release angling is considered by many to be an effective means of maximising spawning escapements because the presence of anglers is a deterrent to poaching. Poaching has been a long-standing problem on this river and may be an important factor in its slow recovery. The stock achieved only 49% of the conservation requirement in 1998 and 1999 and has been at most 52% of the conservation requirement in the last eight years. This was in spite of increased numbers and proportion of large salmon in recent years.

The main stem of Harry's River is highly accessible because of the many logging roads but there are also many headwater tributaries that are less accessible. Spawning surveys indicate that most of the salmon spawn in the headwater tributaries. Therefore, these smaller headwater streams should continue to be preserved as sanctuaries for spawning salmon until the stock improves. The headwater tributaries above Home Pool are currently closed to angling. The resulting loss of angling opportunities is considered to be minimal. Angling activity on Pinchgut Brook and other headwater tributaries represented only a small percentage (7.2%) of the total angling on Harry's River in 1984-89.

Salmon returns to the Pinchgut Brook tributary relative to Harry's River, as a whole, can only be fully understood through knowledge of the total number of salmon entering the system. This could be achieved by installing a counting fence near the mouth of the river supplemented by tagging. The tagging would provide a means of verifying the proportion of salmon spawning on Pinchgut Brook, thus eliminating some of the uncertainty.

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Table 1. Counts and proportion of small and large Atlantic salmon at the Pinchgut Brook counting fence, 1992-99.

Year	Fence Counts			Proportion	
	Small	Large	Total	Small	Large
1992	222	5	227	0.978	0.022
1993	576	43	619	0.931	0.069
1994	563	47	610	0.923	0.077
1995	752	28	780	0.964	0.036
1996	601	38	639	0.941	0.059
1997	613	68	681	0.900	0.100
1998	593	63	656	0.904	0.096
1999	608	63	671	0.906	0.094
Mean (92-98)	560	42	602	0.931	0.069

Table 2. Atlantic salmon spawning escapement, potential egg deposition and percentage conservation requirement achieved on Harry's River, 1992-1999.

Harrys River, 1992-1999

Year	Spawning Escapement				Potential Egg Deposition (x 10^6)			Percent Conservation Egg Deposition*
	Pinchgut	Harrys						
	Total	Small	Large	Total	Small	Large	Total	
1967								
1992	217	517	12	529	0.83	0.08	0.91	12
1993	591	1,342	99	1,441	2.25	0.67	2.92	37
1994	592	1,333	111	1,444	2.88	0.75	3.63	46
1995	777	1,827	68	1,895	3.30	0.46	3.76	48
1996	639	1,820	116	1,936	3.28	0.79	4.07	52
1997	681	1,657	184	1,841	2.65	1.24	3.90	50
1998	656	1,596	177	1,773	2.61	1.20	3.81	49
1999	671	1,643	171	1,814	2.68	1.16	3.84	49
Min. 1999	671	1,483	154	1,637	2.43	1.04	3.47	44
Max. 1999	671	1,842	191	2,033	3.01	1.29	4.31	55
Mean (92-98)	593	1442	110	1551	2.54	0.74	3.29	42

* The percentage achieved in 1992-95 may have decreased slightly from the values reported in Mullins et al., (MS 1996) due to updated habitat information.

Table 3. Total returns, spawning escapement, and potential egg deposition of Atlantic salmon on Pinchgut Brook, 1992-99.

Pinchgut Brook, 1992-1999

Year	Total Returns to Pinchgut Fence			Angling Catch				Spawning Escapement			Potential Egg Deposition (x 10^6)			Percent Conservation Egg Deposition
				Retained		Released								
	Small	Large	Total	Small	Large	Small	Large	Small	Large	Total	Small	Large	Total	
1992	222	5	227	10	0	0	1	212	5	217	0.34	0.03	0.37	36
1993	576	43	619	28	0	1	0	548	43	591	0.92	0.29	1.21	117
1994	563	47	610	18	0	10	0	544	47	591	1.18	0.32	1.49	145
1995	752	28	780	3	0	2	0	749	28	777	1.35	0.19	1.54	150
1996	601	38	639	0	0	0	0	601	38	639	1.08	0.26	1.34	130
1997	613	68	681	0	0	0	0	613	68	681	0.98	0.46	1.44	140
1998	593	63	656	0	0	0	0	593	63	656	0.97	0.43	1.40	136
1999	608	63	671	0	0	0	0	608	63	671	0.99	0.43	1.42	138
Mean (92-98)	560	42	602	8	0	2	0	551	42	593	0.97	0.28	1.26	122

Table 4. Record of salmon fisheries violations on Harrys River, 1995 to Oct. 1999.				
ACTION	**ACT/REG**	**SECT/PAR**	**DESCRIPTION**	**NUMBER**
CHARGES LAID	FA	33	Possess fish caught contrary to the act or regulations	4
CHARGES LAID	FA	62	Obstruction	1
CHARGES LAID	NFLDFR	12	Possession of a net near inland waters	2
CHARGES LAID	NFLDFR	13.1(1)(A)	Catch and retain by angling more than daily quotas	1
CHARGES LAID	NFLDFR	13.3(1)	Catch and retain by angling inland waters salmon 63 cm or more in length	1
CHARGES LAID	NWR	6(4)	Possession of improperly tagged salmon	7
CHARGES LAID	NWR	6(2)	Validation of licence by holding at least one unused tag	1
			TOTAL CHARGES	**17**
SEIZURE PERSONS UNKNOWN	NFLDFR	10(2)	Net fish inland waters	**3**
OTHER NETTING VIOLATIONS (1996-1998)				**4**
(C.B. Office)				

Table 5. Incidence of net marks and other evidence of potential sources of mortality at Pinchgut Brook, 1992-1999.

Year	Type	NUMBER			PERCENTAGE		
		SMALL	LARGE	TOTAL	SMALL	LARGE	TOTAL
1996	net marks						0.6
1997	net marks						9.3
1998	net marks						1.8
1999	net marks	1	0	1	1.6	0.0	0.2
	scars	0	0	0	0.0	0.0	0.0
	fungus	0	0	0	0.0	0.0	0.0
	tot injuries	1	0	1	1.6	0.0	0.2
	unmarked	607	63	670	99.8	100.0	100.0
	total	608	63	670	100.0	100.0	100.0

Note: some fish may have had more than one type of mark.

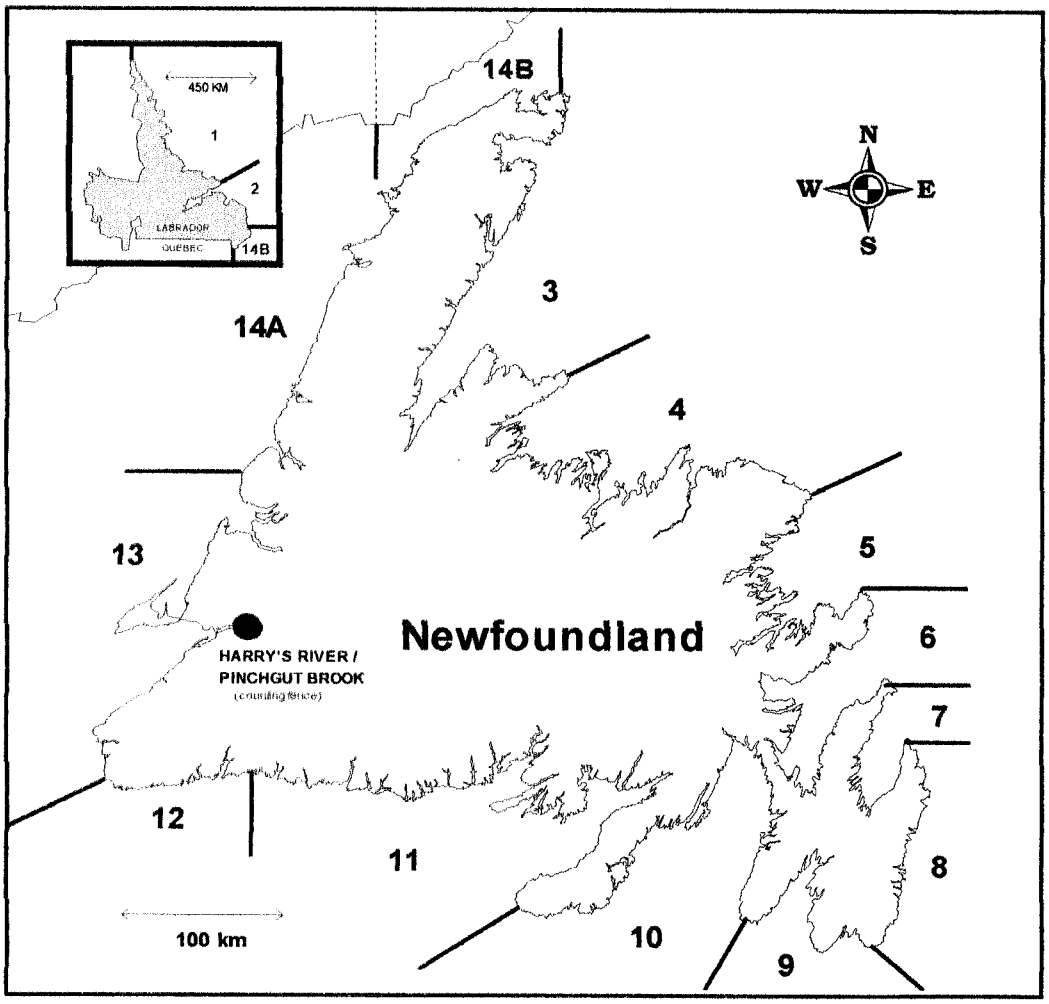


Figure 1. Salmon Fishing Areas (SFAs) of Newfoundland and Labrador.

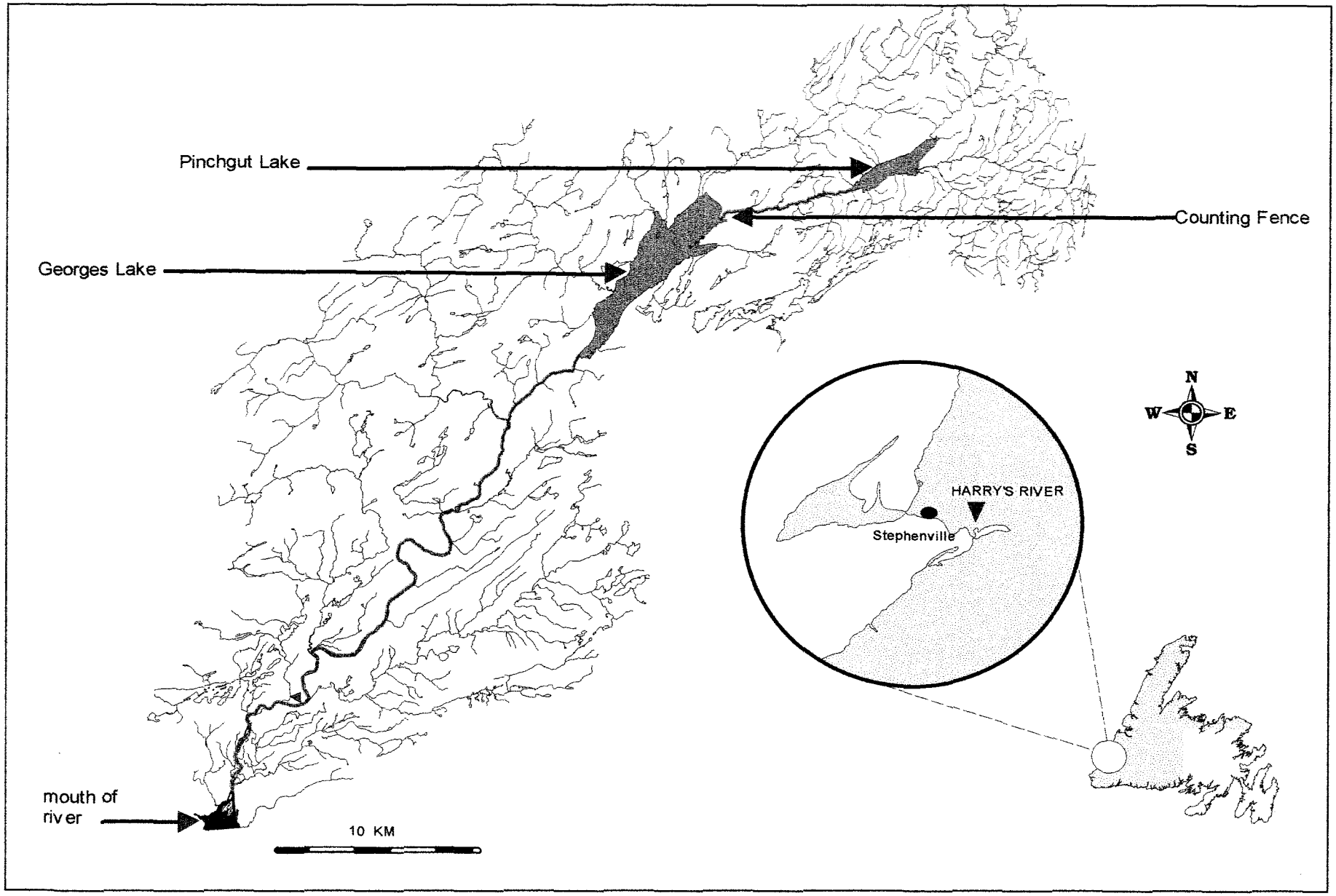
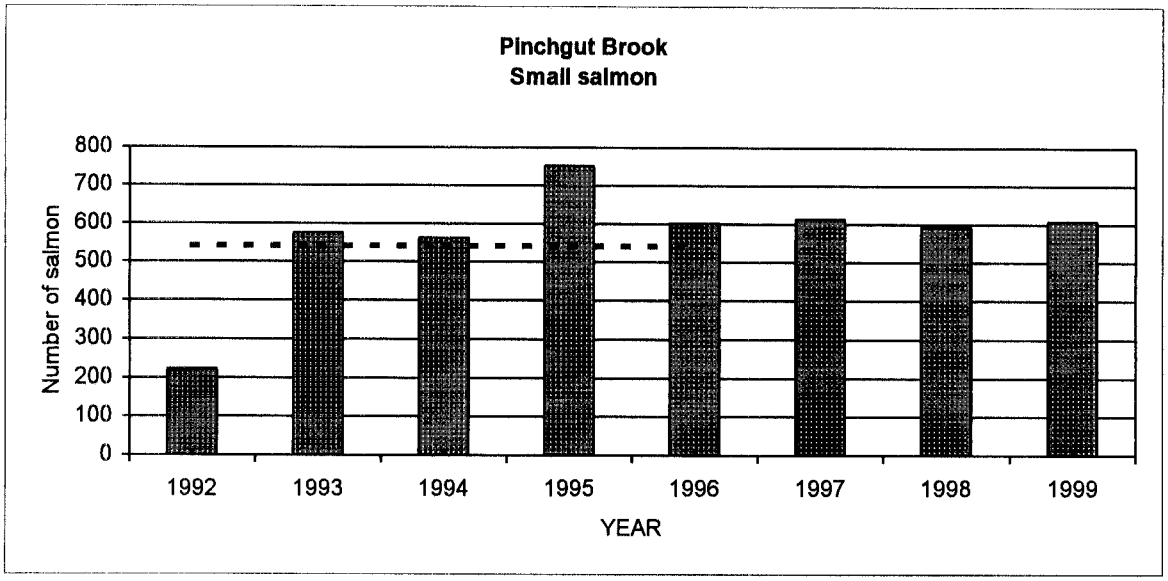


Figure 2. Location of selected features of the Harry's River system.



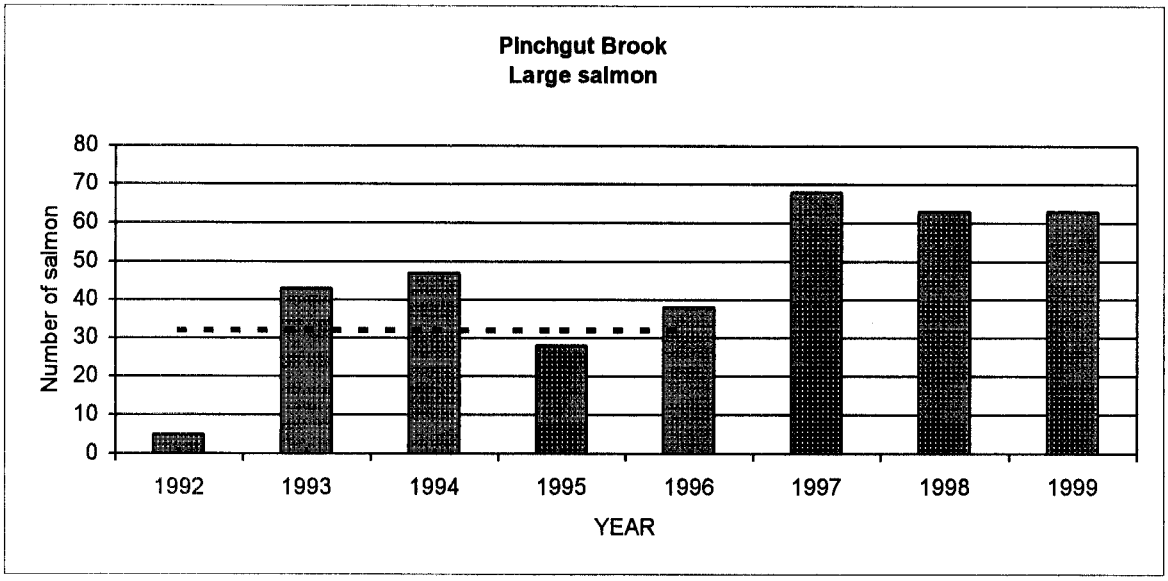


Figure 3. Counts of small and large salmon at the Pinchgut Brook counting fence, 1992-1999.

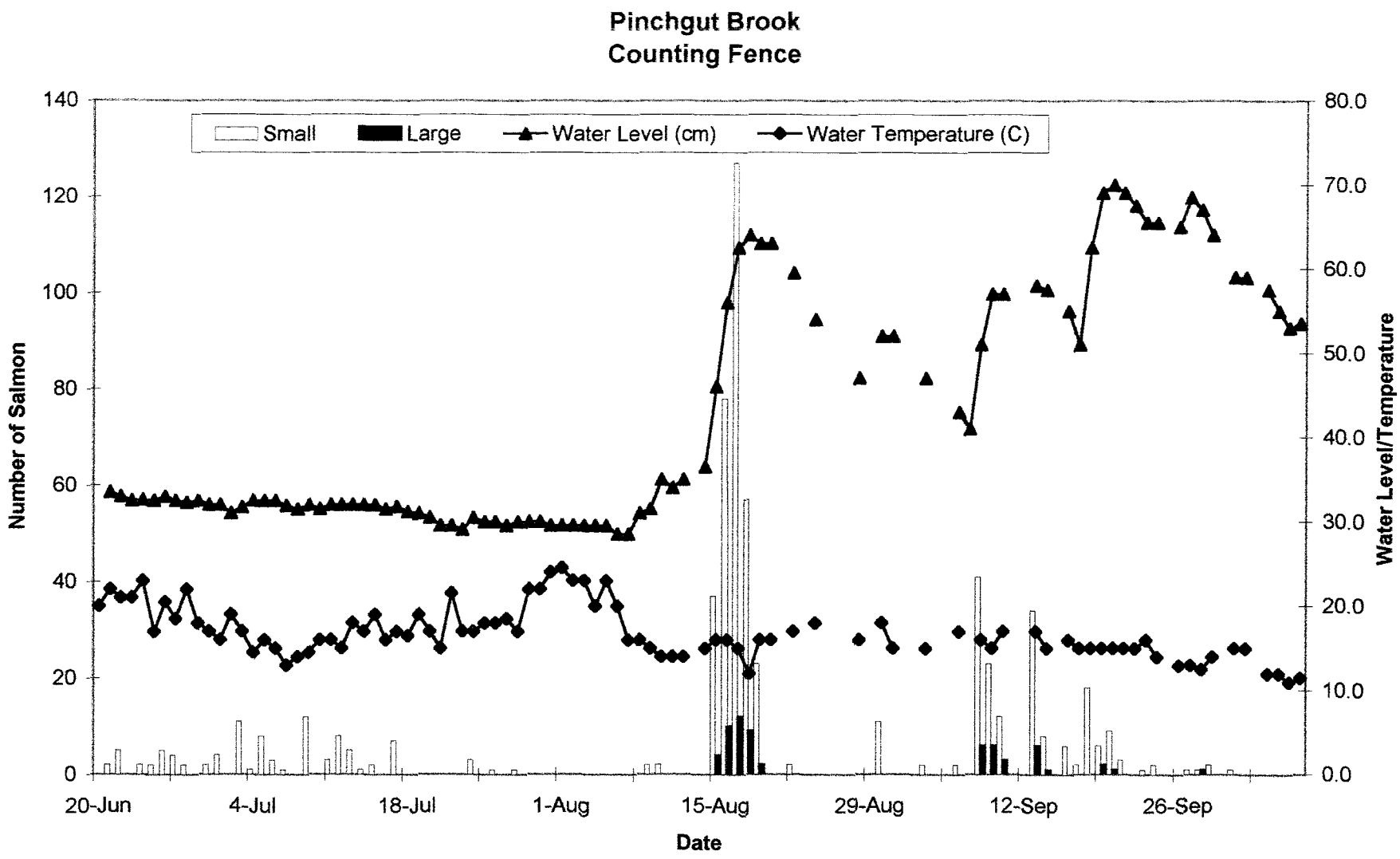
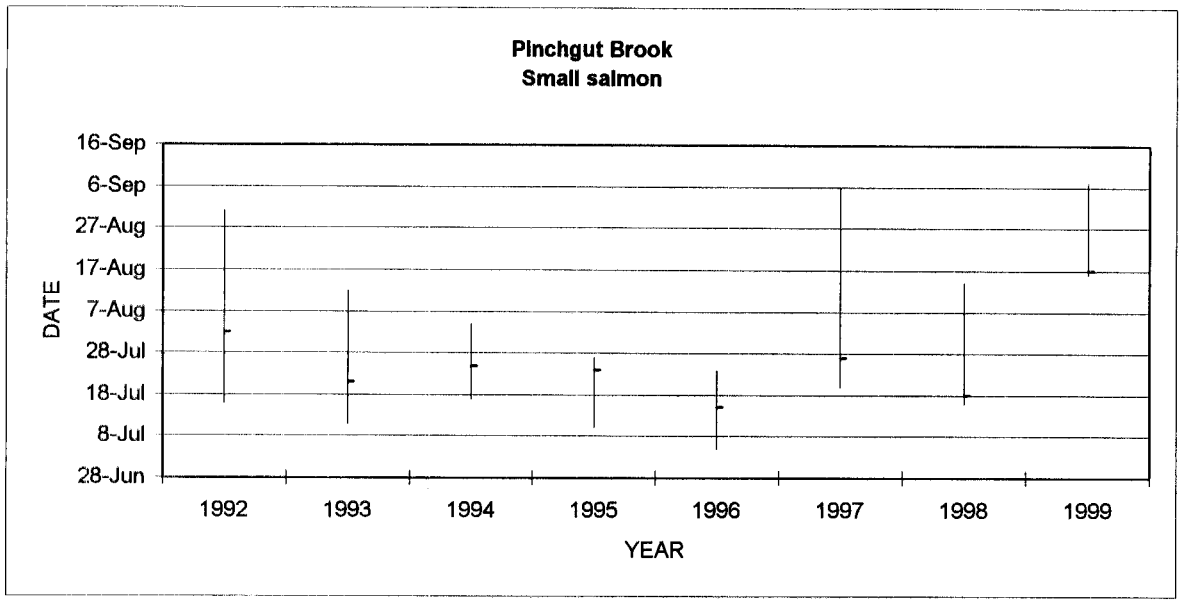


Figure 4. Daily counts of small and large salmon, mean water temperatures and mean water level at the counting fence on Pinchgut Brook, 1999.



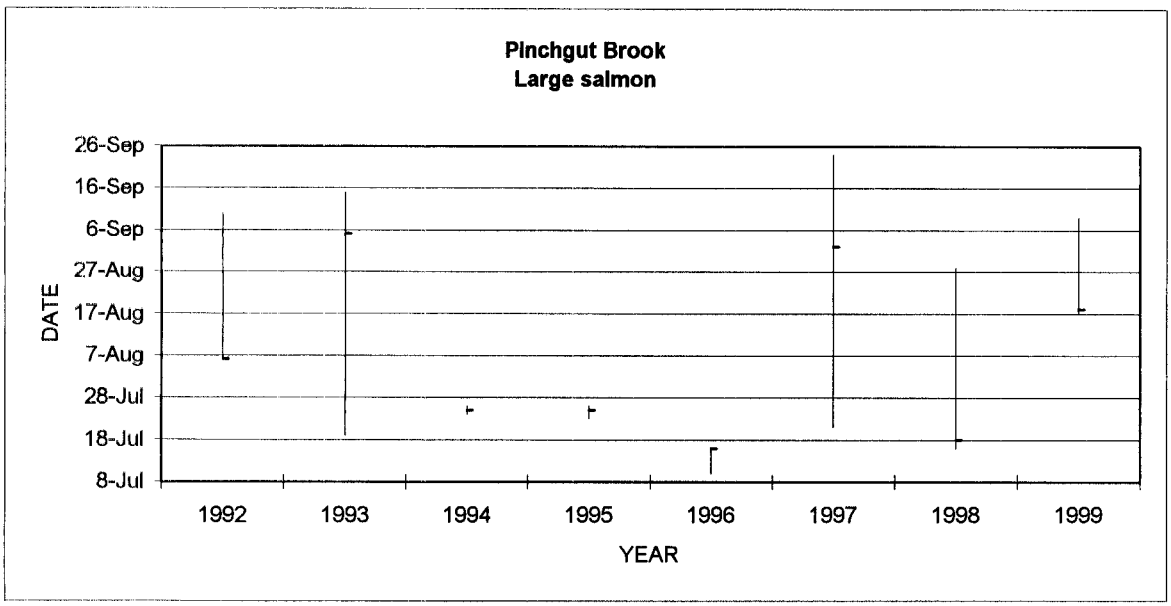


Figure 5. Run timing of small and large Atlantic salmon at the counting fence on Pinchgut Brook, 1992-1999. Vertical bars represent 25% to 75% of the run entering the river. Symbols represent 50% of the run.

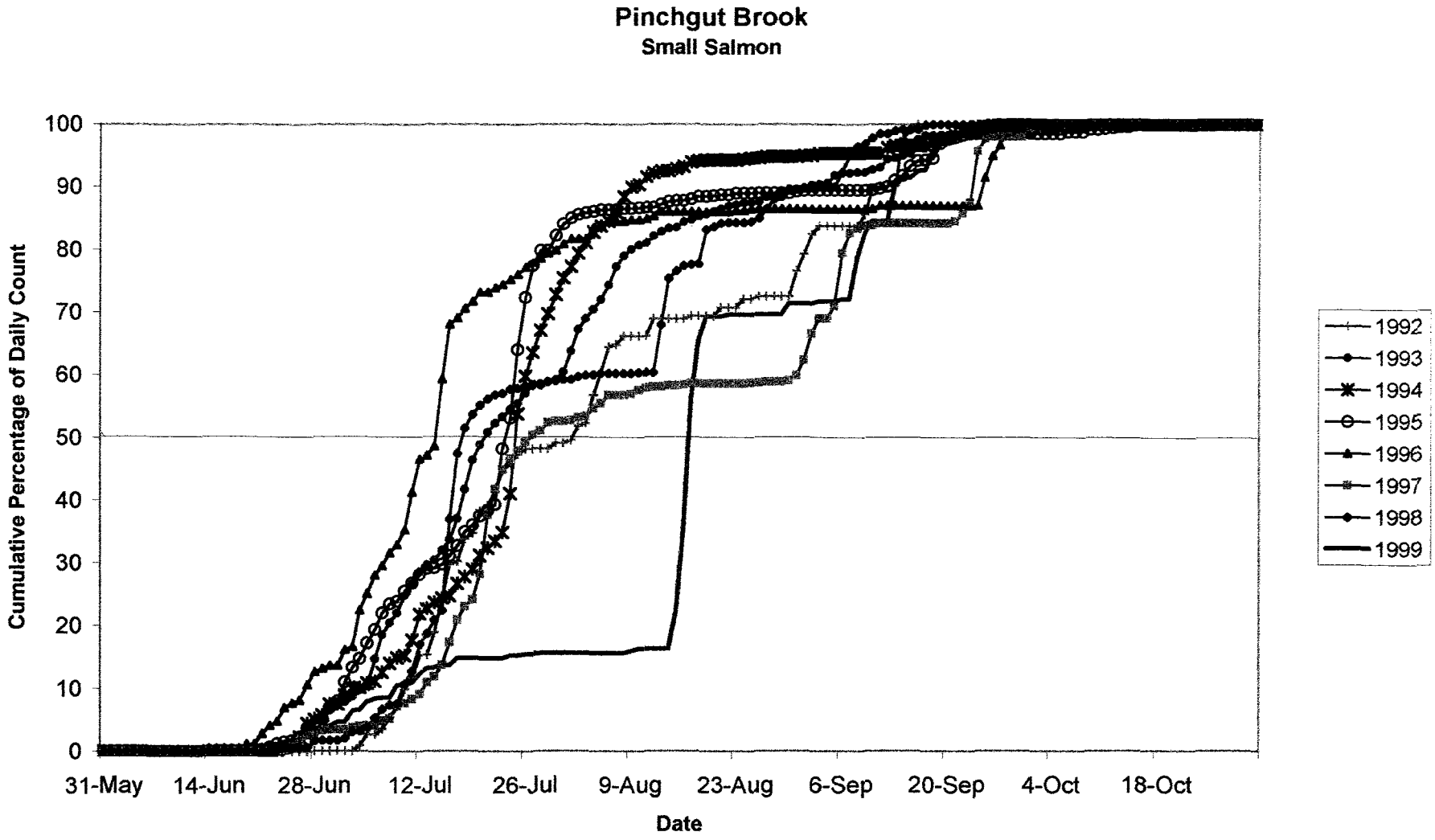
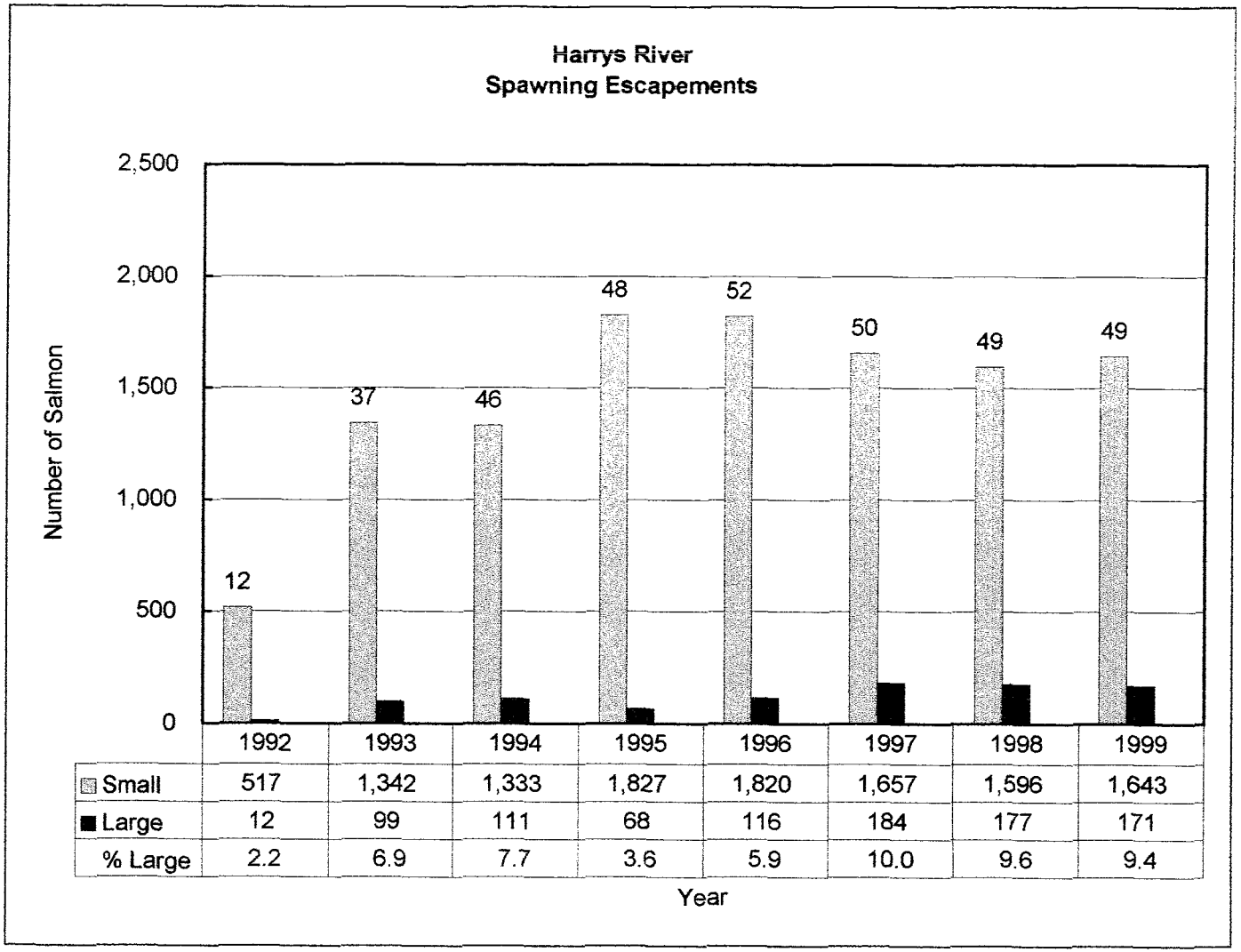


Figure 6. Cumulative daily counts of small salmon at the counting fence on Pinchgut Brook, 1992-1999.



	1992	1993	1994	1995	1996	1997	1998	1999
Small	517	1,342	1,333	1,827	1,820	1,657	1,596	1,643
Large	12	99	111	68	116	184	177	171
% Large	2.2	6.9	7.7	3.6	5.9	10.0	9.6	9.4

Figure 7. Spawning escapement of small and large salmon on Harrys River, 1992-1999. Numbers above bars represent the percentage of the conservation requirement achieved.

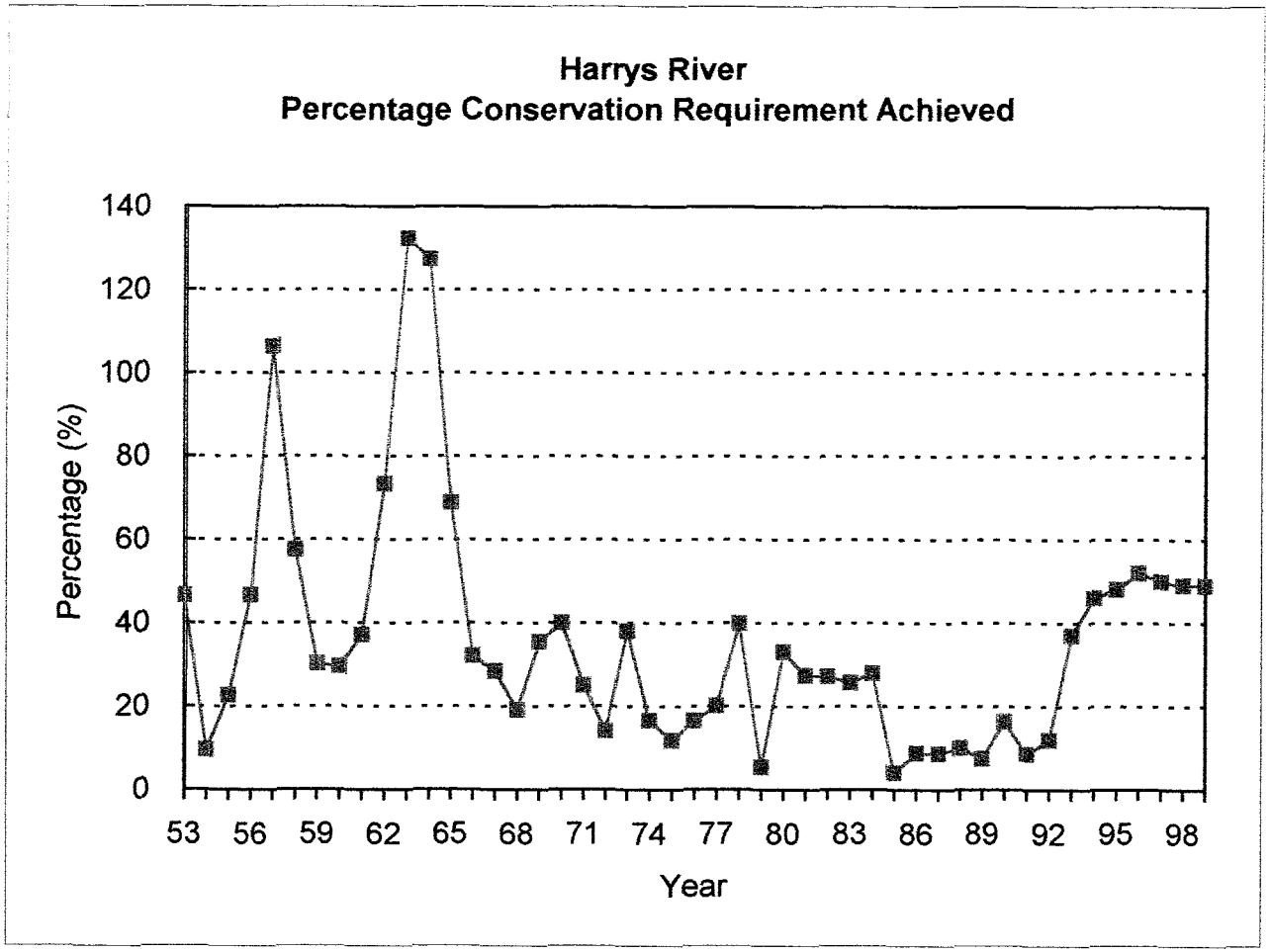


Figure 8. Percentage of the conservation egg deposition requirement achieved on Harry's River, 1953-99. Results for 1953-91 are based on angling catch statistics (Reddin and Mullins, MS 1996) and those for 1992-99 are based on the counting fence at Pinchgut Brook.

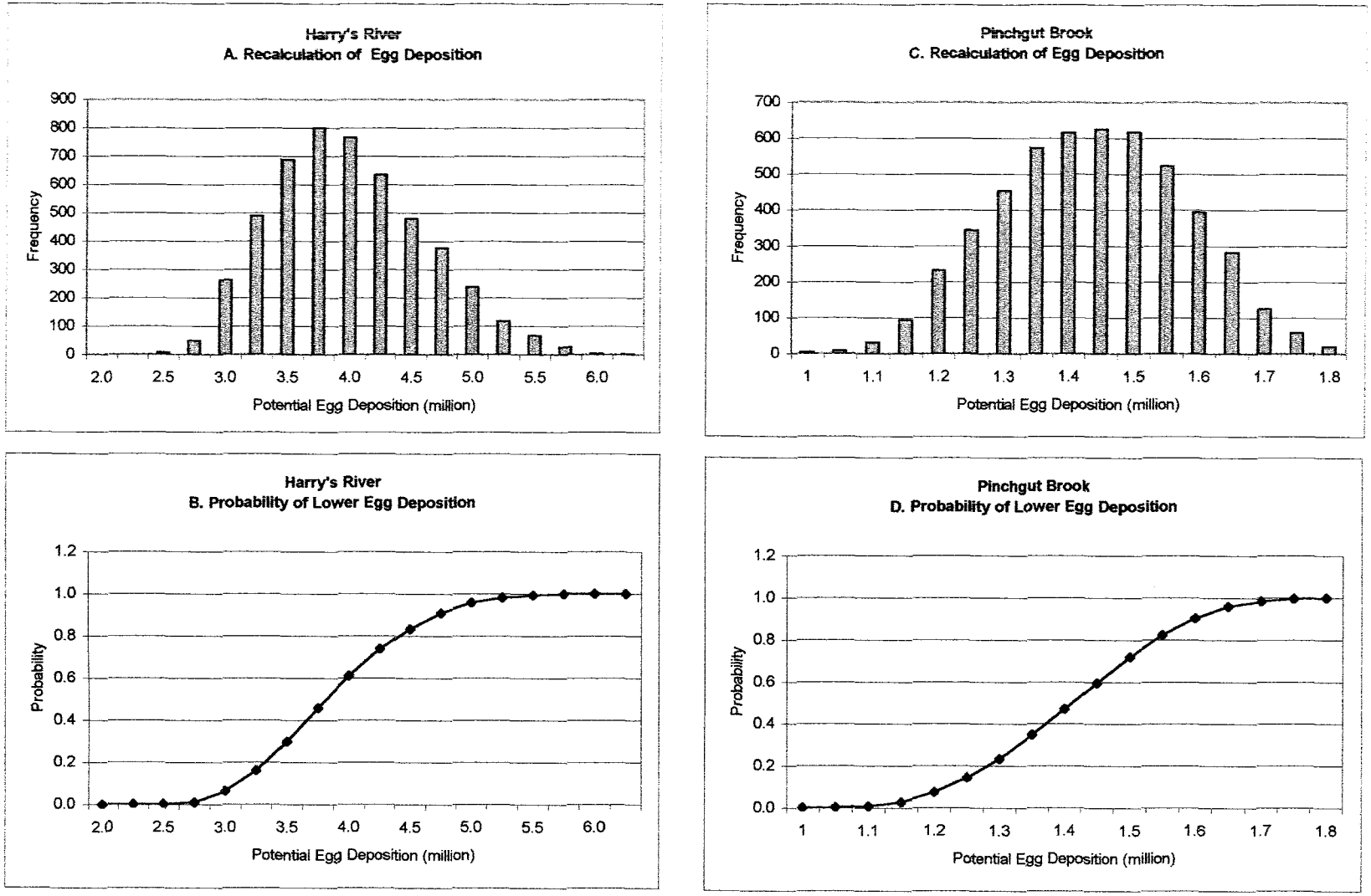


Figure 9. Results of simulation of uncertainty in the calculation of potential egg depositions by Atlantic salmon on Harry's River and Pinchgut Brook, 1999. The proportion of small and large salmon was allowed to vary according to observations at the counting fence in 1999 and the proportion of spawning on Pinchgut and fecundity of small and large salmon were allowed to vary within a 20% coefficient of variation.

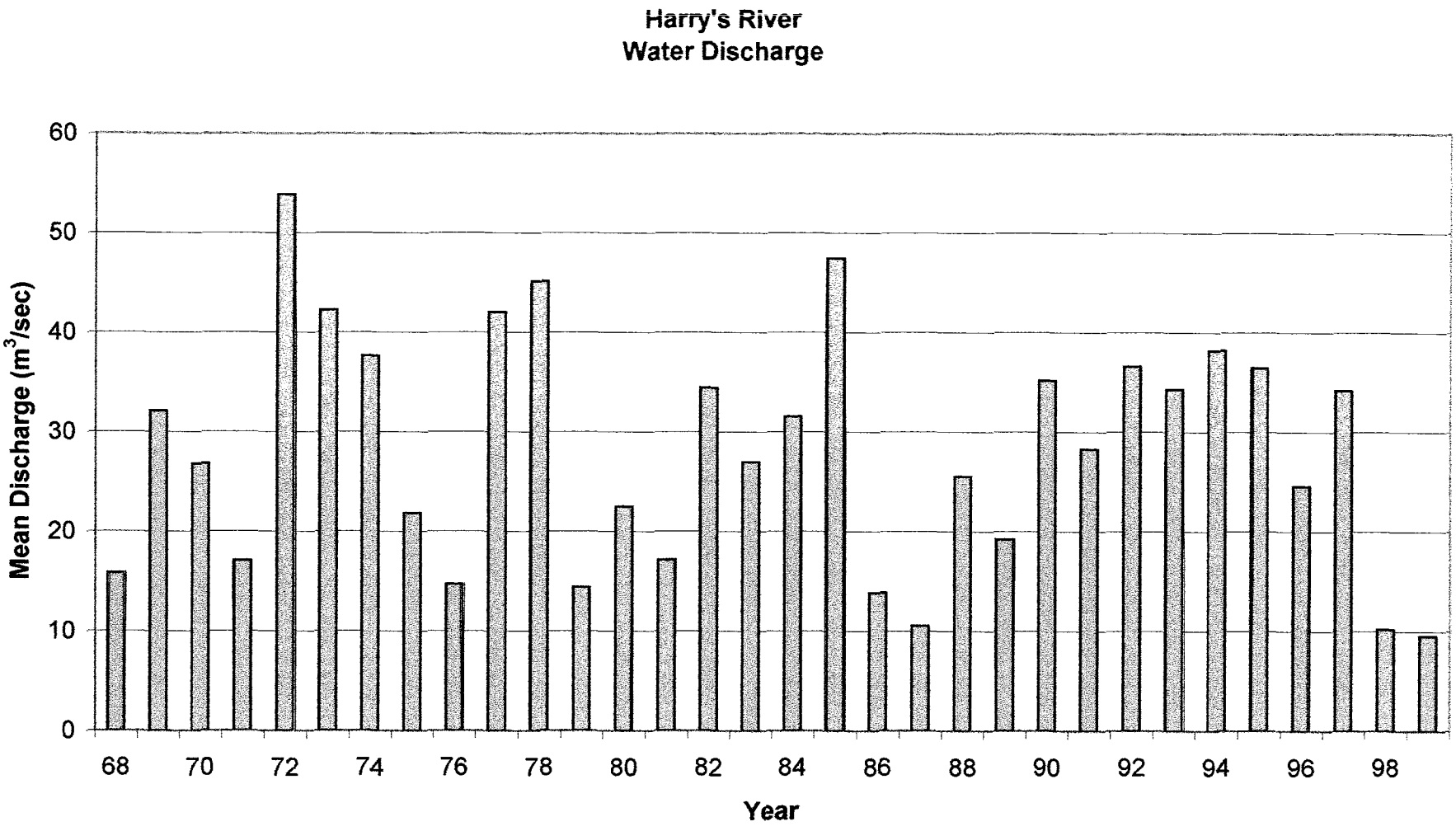


Figure 10. Mean water discharge rate (m3/sec) from mid-May to mid-August on Harry's River, 1968-1999. Data supplied by Environment Canada, the Newfoundland Department of Environment and Labour and the Deer Lake Power Company.

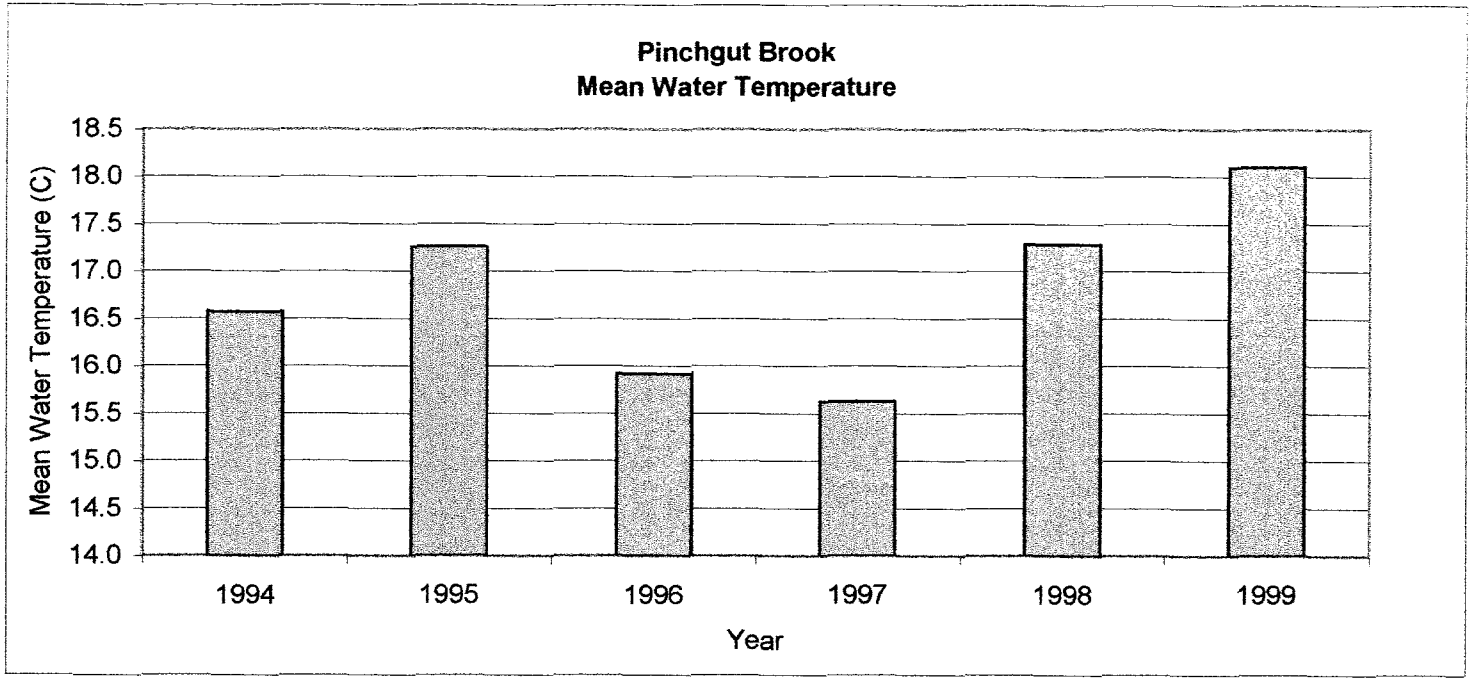


Figure 11. Mean water temperature for mid-June to mid-August recorded at the counting fence on Pincgut Brook, 1994-99.

Appendix 1. Recreational salmon fishery catches and effort on the Harry's River, 1974-1999.

Code: 4101200

	Effort	Small (<63 cm)			Large (>=63 cm)			Total (Small + Large)			
Year	Rod Days	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	CPUE
1974	4218	941	.	941	34	.	34	975	.	975	0.23
1975	2180	704	.	704	16	.	16	720	.	720	0.33
1976	2893	902	.	902	40	.	40	942	.	942	0.33
1977	3853	1008	.	1008	68	.	68	1076	.	1076	0.28
1978	3142	713	.	713	65	.	65	778	.	778	0.25
1979	755	148	.	148	1	.	1	149	.	149	0.20
1980	1602	518	.	518	65	.	65	583	.	583	0.36
1981	2082	659	.	659	18	.	18	677	.	677	0.33
1982	2141	570	.	570	31	.	31	601	.	601	0.28
1983	2439	533	.	533	30	.	30	563	.	563	0.23
1984	2543	720	.	720	11	.	11	731	.	731	0.29
1985	1686	173	.	173	*	0	0	173	0	173	0.10
1986	2628	382	.	382	*	8	8	382	8	390	0.15
1987	1643	378	.	378	*	8	8	378	8	386	0.23
1988	2077	434	.	434	*	11	11	434	11	445	0.21
1989	1961	324	.	324	*	3	3	324	3	327	0.17
1990	2182	706	.	706	*	22	22	706	22	728	0.33
1991	1456	370	.	370	*	4	4	370	4	374	0.26
1992	2094	311	35	346	*	28	28	311	63	374	0.18
1993	1870	319	23	342	*	50	50	319	73	392	0.21
1994	1518	153	84	237	*	50	50	153	134	287	0.19
1995	1252	149	60	209	*	44	44	149	104	253	0.20
1996**		34	1196	1230	*	206	206	34	1402	1436	
1997**		2	591	593	*	139	139	2	730	732	
1998**		0	288	288	*	95	95	0	383	383	
1999**		0	116	116	*	42	42	0	158	158	
84-89 $\bar{X}$	2089.7	401.8	.	401.8	.	6.0	6.8	403.7	6.0	408.7	0.20
95% CL	439.0	188.7	.	188.7	.	5.5	4.7	192.8	5.5	192.6	0.07
N	6	6	0	6	0	5	6	6	5	6	6
86-91 $\bar{X}$	1991.2	432.3	.	432.3	.	9.3	9.3	432.3	9.3	441.7	0.22
95% CL	434.8	145.4	.	145.4	.	7.2	7.2	145.4	7.2	152.5	0.08
N	6	6	0	6	0	6	6	6	6	6	6
92-95 $\bar{X}$	1683.5	233.0	50.5	283.5	.	43.0	43.0	233.0	93.5	326.5	0.19
95% CL	593.1	150.8	43.2	112.7	.	16.5	16.5	150.8	51.2	106.8	0.02
N	4	4	4	4	0	4	4	4	4	4	4

IN THE ABOVE TABLE A PERIOD INDICATES NO DATA FOR THAT YEAR.

CPUE IS BASED ON RETAINED + RELEASED FISH FOR 1985-1995 AND ON RETAINED FISH ONLY PRIOR TO 1985.

* NOT ALLOWED TO RETAIN LARGE SALMON IN INSULAR NEWFOUNDLAND.

**DATA OBTAINED FROM THE LICENSE STUB RETURN; 1999 DATA ARE PRELIMINARY