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STATUS OF THE ATLANTIC SALMON (*Salmo salar* L.) STOCK OF HUMBER RIVER, NEWFOUNDLAND, 1998

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ABSTRACT

This is the ninth assessment of the Atlantic salmon stock of the Humber River. The results of the mark-recapture study in 1998 indicated that the population size of small salmon was less than in 1997 but that the proportion and number of large salmon were the highest recorded in the period of assessment, 1990-98. The percentage of the conservation requirement achieved in 1998 was 88% (95% CI = 60% - 135%) but could have been lower if not for the increase in the number of large salmon. Given the continued low returns of small salmon in 1998 compared to 1997, any anticipation of returns in 1999 should be made with caution. Recreational harvests in 1999 should be closely monitored to avoid overexploiting the stock if the run size is below conservation requirements. A reasonably accurate in-season prediction of the returns of small salmon (R^2=0.9094 p=0.0009) in 1998 was provided by captures of small salmon at one of the tagging traps operated in the estuary. Estimates of the number of small salmon retained on the Humber River in 1994-98 based on the voluntary licence stub return system were similar to estimates based on angler surveys at Big Falls.

RÉSUMÉ

Cette évaluation du stock de saumon de l'Atlantique de la rivière Humber est la neuvième du genre. L'étude par marquage et recapture de 1998 a montré que l'effectif de population des petits saumons était inférieur à celui de 1997, mais que la proportion et le nombre de grands saumons étaient les plus élevés notés au cours de la période d'évaluation, de 1990 à 1998. Les besoins de conservation ont été atteints à 88 % en 1998 (IC 95% = 60% - 135%), mais cette valeur aurait été plus faible en l'absence de l'accroissement du nombre de grands saumons. Étant donné les faibles remontées de petits saumons en 1998, par rapport à 1997, toute prévision des remontées en 1999 doit être faite avec prudence. La récolte de la pêche récréative de 1999 devrait être surveillée de près afin d'éviter toute surexploitation du stock si la remontée s'avérait inférieure aux besoins de conservation. Une prévision en cours de saison raisonnablement exacte de la remontée de petits saumons (R^2=0,9094, p=0,0009) en 1998 a été obtenue à partir des captures de petits saumons dans l'un des pièges de marquage situé dans l'estuaire. La valeur des estimations du nombre de petits saumons conservés sur la rivière Humber de 1994 à 1998, fondée sur le système de remise volontaire des talons de permis, était semblable à celle des estimations fondées sur les enquêtes auprès des pêcheurs récréatifs faites à Big Falls.

INTRODUCTION

This is the ninth assessment of the status of the Atlantic salmon (*Salmo salar* L.) stock of the Humber River since 1990. In 1990 and 1991, prior to the commercial moratorium, the stock achieved 60% and 27%, respectively of its conservation requirement (Chaput and Mullins MS 1991, 1992). With the exception of 1994, the stock has shown signs of improvement since the commercial moratorium was implemented in 1992 and with the implementation of effort controls in the recreational fishery. The low population size in 1994 could be attributed to extremely low spawning escapement in 1989 as suggested by retrospective analysis of angling data (Chaput and Mullins, MS 1992). Low marine survival and uncertainty in angling data used in the estimate of returns could be other factors. Commercial and recreational management measures implemented since 1978 in Newfoundland and Labrador that would have influenced the Humber stock are given in Table 1.

The Humber River is located at the northern limit of Salmon Fishing Area (SFA) 13 and flows into the Humber Arm of the Bay of Islands at latitude 48° 57' N and longitude 57° 53' W (Fig. 1). It is the second largest river system in Newfoundland and the largest on the western part of the island. Its drainage area of 7,679 km^2 represents 95% of the drainage area of the Bay of Islands and 57% of SFA 13. The total length of all tributaries in the system is 2,450 km. Complete obstructions to anadromous Atlantic salmon occur at Main Falls (Fig. 2) which is 112.6 km from the river mouth and at Junction Brook. Junction Brook once flowed into the Humber River at Deer Lake but was diverted for hydroelectric development in 1925, resulting in the loss of anadromous salmon habitat on the Grand Lake system (Porter et al., MS 1974) (see Fig. 2). No fish passage facility was provided for fish to bypass the diversion.

Recreational catches on the Humber River in 1992-96 were approximately 3,000 small and 200 large salmon based on catch and effort statistics collected by traditional methods employed by the Department of Fisheries and Ocean (Mullins and Claytor, MS 1989 and Mullins et al., MS 1989). However, angler creel surveys conducted at Big Falls in 1990-96 indicated that actual catches were often as much as twice as high as indicated by the available catch statistics (Mullins and Chaput, MS 1995; Mullins and Chaput, MS 1993; Chaput et al., MS 1992). New methods for collecting angling catch statistics based on voluntary licence stub returns now indicate that the Humber River produced average catches of 7,000 small and large salmon in 1994-97 (O'Connell et al. MS 1998). This is the highest catch of any river in Newfoundland and about 50% of the catch in SFA 13.

The present assessment provides an estimate of Atlantic salmon returns and spawning escapements in 1998 based on a mark-recapture study. The methodology used closely follows that of previous assessments (Chaput and Mullins, MS 1991; Chaput and Mullins, MS 1992; Mullins and Chaput, MS 1993; Mullins and Chaput, MS 1995; Mullins and Reddin, MS 1995; Mullins and Reddin, MS 1996; Mullins et al., MS 1997; Mullins and Caines, MS 1998).

MATERIALS AND METHODS

Recreational Fishery Harvest

a. Catch Statistics

Recreational catch statistics (effort and catches of small (<63 cm) and large (≥63 cm) salmon) collected for the Humber River in 1997 and 1998 were based on a voluntary licence stub return system. Methods used to estimate catches from licence stub returns are described by O'Connell et al., MS 1998.

Recreational catch statistics prior to 1997 were observed and estimated by DFO river guardians and fisheries officers according to methods described by Mullins and Claytor, MS 1989 and Mullins et al., MS 1989. These statistics were not collected in 1997-98. It is cautioned that the effort and catch actually observed, as opposed to estimated by this method, declined since 1992 (Mullins and Reddin, MS 1996). Hence, the most recent years were only indirectly comparable to those previous.

Estimates of total catches of small and large salmon in 1994-98 as determined from licence stub returns were compared with estimates determined from creel surveys.

b. *Big Falls Creel Survey*

Creel surveys were conducted at Big Falls (Fig. 2) in 1994 and 1996-97 (Mullins and Reddin, MS 1995; Mullins and Caines, MS 1998; Mullins et al. MS 1997) and in 1998 to collect detailed catch and effort information for that segment of the Humber River. Big Falls is the most popular angling location on the Humber River. Anglers leave the fishing area at Big Falls via two exit points making it possible to observe 100% of the catch with minimum manpower. Surveys covered the entire fishing area throughout the fishing season.

The two exit points were monitored 16 hours per day. The sampling day at each exit was divided into two eight-hour time periods: 0600-1400 hours and 1400-2200 hours. A survey clerk was assigned to each time period throughout the fishing season. Two methods were use by the survey clerks to record the number of hours fished and the number of salmon retained and released by each angler. Anglers were either interviewed as they exiting the fishing area and/or observed while in the fishing area. The latter method was usually used for anglers that were within sight of the clerks for the duration of their fishing activity. A portion of the retained catch was scale sampled, measured, sexed and examined for the presence of Carlin tags. However, this was secondary to the recording of catch and effort information.

The number of anglers interviewed was expressed in terms of rod days by subtracting the anglers that were interviewed more than once. The daily catches and effort were adjusted for the number of anglers and catch that remained on the river after the last survey period of the day and for the proportion of the total scheduled survey periods that were not surveyed. Some scheduled survey periods were not surveyed because of occasional illness of clerks. No adjustment was made for anglers that may have left the river before the start of the census day. However, based on the experience of the creel survey clerks, these numbers are believed to be minimal.

Daily catches and effort at Big Falls were summarized by standardized weeks.

Standardized Week	Time Period
22	May 28 – June 3
23	June 4 –10
24	June 11 – 17
25	June 18 – 24
26	June 25 – July 1
27	July 2 – 8
28	July 9 – 15
29	July 16 – 22
30	July 23 – 29
31	July 30 – August 5
32	August 6 – 12
33	August 13 – 19
34	August 20 to 26
35	August 27 – Sept. 2
36	Sept. 3 – 9

The total number of small salmon retained on the Humber River was estimated from the results of creel surveys according to the equation:

$$C_{sm\text{-}ret} = C_{sm\text{-}ret\text{-}bf} / Prop_{sm\text{-}ret\text{-}bf}$$

Where:
$C_{sm\text{-}ret}$ = Catch of small salmon retained on Humber River
$C_{sm\text{-}ret\text{-}bf}$ = Catch of small salmon retained at Big Falls (creel survey)
$Prop_{sm\text{-}ret\text{-}bf}$ = Proportion of Humber small salmon retained at Big Falls.
= # Tags Returned from Big Falls / # Tags Returned from Humber

The voluntary reporting rate of tags by anglers at Big Falls is considered to be the same as for the river as a whole as survey clerks were instructed not to prompt anglers to return tags. Only fish sampled for biological information were examined closely by the survey clerks for the presence of tags. Therefore, clerks would not have observed all tags recovered at Big Falls. In addition, many anglers reported that hey did not observe tags in retained salmon until later examination away from the river. Hence, the voluntary tag-reporting rate by anglers at Big Falls compared to other sections of the river was not biased by involvement in the survey.

The total numbers of small and large salmon released were estimated from the creel survey results according to the equations:

$$C_{sm\text{-}rel} = C_{sm\text{-}ret\text{-}bf} \times \text{Rel:Ret}$$
$$C_{lg\text{-}rel} = C_{lg\text{-}rel\text{-}bf} / 0.354$$

Where:
$C_{sm\text{-}rel}$ = Catch of small salmon released on Humber River
$C_{sm\text{-}ret\text{-}bf}$ = Catch of small salmon released at Big falls
Rel:Ret = Ratio of released to retained small salmon at Big Falls
$C_{lg\text{-}rel}$ = Catch of large salmon on Humber River
$C_{lg\text{-}rel\text{-}bf}$ = Catch of large salmon at Big Falls

The value of 0.354, is the proportion of the total number of Humber large released at Big Falls in 1992-96 (Mullins et al., MS 1997). This proportion was derived from DFO catch statistics collected over the entire angling season in these years.

Estimation of Angling Exploitation Rate, Total Returns, Spawning Escapements and Potential Egg Deposition

Equations used to calculate angling exploitation and total returns are summarized in Table 2. Confidence intervals around estimates of the voluntary tag reporting rate, tag retention rate, the ratio of large to small salmon in the population and the proportion of the total Humber River catch caught at Big Falls were derived by a simulation technique. Each parameter was recalculated 5000 times by resampling at random from a binomial probability distribution dictated by the available data. The values corresponding to the 2.5^{th} and 97.5^{th} percentiles in the bootstrapped frequency distribution for each parameter were used as the lower and upper confidence limits, respectively. The technique is described in detail by Diaconis and Efron (1983) and by Efron and Tibshirani (1986).

a. Angling Exploitation Rate

Salmon entering the Humber River were captured at four tagging traps operated in the estuary and marked with Carlin tags (Fig. 1). Tags were applied using a double stainless steel wire attachment directly under the anterior end of the dorsal fin. All salmon captured in the tagging traps were measured (fork length 0.1 cm), and scale sampled. Injured salmon were not tagged. Both small and large salmon were tagged. The **Lower** tagging trap (Fig. 1) trap has been fished in the same location at Wild Cove in the Humber River estuary, since 1990. The **Upper** tagging trap is located about 1.5 km farther in the estuary than the Lower trap. With the exception of 1994, when this trap was fished approximately 10 km farther upstream at Boom Siding, it has been operated the same location since 1993. The trap designs and installation were identical to those in previous assessments. Two additional tagging traps were operated in 1998 - one near the Lower and one near the Upper location. This was in an effort to increase the number of tags applied. It was expected that new restrictions in the recreational fishery in 1998 might result in fewer recaptures by anglers.

The angling exploitation rate (***er***) for retained small salmon was based on tag recaptures in the recreational fishery according to the formula:

$$er = R / M$$

Where:
R = Rv / rr
M = Ma x (1 – TL (0.009 x Median Days to Recapture))
rr = # Tags Returned from Big Falls / # Tags Observed at Big Falls
And where:
R = Total number of recaptures by anglers
Rv = Number of recaptures reported voluntarily by anglers
Ma = Number of tags applied to small salmon
M = Number of tags available to angling
TL = Tag loss rate due to tag shedding
rr = Voluntary tag reporting rate by anglers

The voluntary tag reporting rate by anglers (rr) is estimated annually based on the proportion of tags observed by creel survey clerks that were actually returned voluntarily by anglers. Survey clerks were instructed to observe only and not to prompt anglers to return tags. Note: the ratio *(tags/catch at Big Falls) : (tags/catch for the rest of the river)* does not give a valid estimate of the reporting rate

because it cannot be assumed that the creel clerks observed 100% of the tags recaptured at Big Falls. The reporting rate in 1994-97 was consistently around 60-65%.

The number of tagged small salmon available (M) to retention in the recreational fishery was estimated from the number of tags applied (Ma), adjusted for the proportion of tags retained (1 - Tag-Loss Rate), as in previous years. The tag-loss rate (TL) was estimated based on 0.009 (95% CI=0.006-0.011) tags shed per day at large which was derived for the Margaree River in 1992 (Chaput et al., MS 1993). The method of tag application in the Margaree tagging program was the same as for the Humber River. The median number of days at large for tagged fish was determined according to Sokal and Rohlf (1969). No adjustment was made to the number of tags available to account for tags removed from released small salmon because these tags would have also been available to the retention fishery for a period of time before being caught and released. For example, in the 1995 assessment (Mullins and Reddin, MS 1996), if the number of tags available to the retention fishery had been adjusted for tags removed from released fish, the exploitation rate calculation would have increased by less than 1.5%.

b. Total Returns

Returns of small salmon (N_{sm}) were determined based on adjusted marks and recaptures and the retained catch of small salmon according to the Petersen (Single Census uncorrected) method (Ricker, 1975):

$$N_{sm} = (C_{sm\text{-}ret} \times M) / R = C_{sm\text{-}ret} / er$$

Returns of large salmon (N_{lg}) were determined from returns of small salmon based on relative numbers of small and large salmon captured in the tagging traps:

$$N_{lg} = N_{sm} \times \text{Ratio Large : Small}$$

In the 1990 and 1991 assessments, the relative numbers of small and large salmon in the population were considered to be equivalent to that observed in the recreational fishery prior to 1984 when both small and large salmon could be retained (Chaput and Mullins, MS 1991, 1992). However, a commercial salmon fishery was also permitted in those years. The closure of the commercial fishery in 1992 created the potential for increased numbers of large relative to small salmon. Hence, in this and other assessments since 1992, the relative numbers in the population were taken as those observed in the tagging traps operated in the estuary rather than the recreational fishery.

The 95% confidence limits for the Petersen estimate of small salmon were calculated according to Ricker (1975). However, probability distribution of values within the 95% confidence limits was investigated by the application of a computer optimization technique described in White and Garott, 1990 (pers. comm. N. Arnason, University of Manitoba and C. Schwarz, SFU). The technique is based on the Petersen-Chapman maximum likelihood estimator, whereby, the maximum likelihood estimate of the population (N) is taken as the value that maximizes a probability density function. Log likelihood values were produced for values of N within the confidence limits by substitution. Log likelihood values were then plotted against their respective values of N to depict a relative probability distribution.

c. Spawning Escapements

Spawning escapements of small and large salmon were obtained by subtracting angling removals from the returns. Angling removals included retained small salmon and a mortality rate of 0.10 on released small and large salmon.

d. Potential Egg Depositions

Potential egg depositions were calculated for small and large salmon based on fecundity estimates for small and large female spawners. Fecundity was derived from biological characteristics (mean weight of females and percent female) collected annually and a relative fecundity estimate of 1,540 eggs/kg for small and large female spawners combined taken from (Porter and Chadwick, MS 1983). Small and large salmon can have different relative fecundity (Randall, 1989). However, the current estimate of the proportion of large salmon spawners in the Humber River stock is low on average (<10%) and age-specific fecundity estimates are lacking. he mean weight and percent female of small salmon were obtained from retained catches in the recreational fishery at Big Falls. The mean weight of female large salmon is from Porter and Chadwick (MS 1983) and the percentage female was based on commercial catches in the Bay of Islands in 1991 (Mullins and Chaput, MS 1992). These and other biological characteristics of Atlantic salmon on the Humber River are shown in Appendices 2-7 and summarized below.

	Small salmon				Large salmon			
Year	Whole Weight Females (kg)	Percent Female	Fecundity (eggs/kg)	Eggs per Spawner	Whole Weight Females (kg)	Percent Female	Fecundity (eggs/kg)	Eggs per Spawner
1990	1.70	53.0	1540	1388	3.7	90.0	1540	5128
1991	1.33	69.2	1540	1417	3.7	68.6	1540	3909
1992	1.96	54.2	1540	1636	3.7	69.2	1540	3943
1993	1.69	66.3	1540	1726	3.7	68.6	1540	3909
1994	1.70	50.9	1540	1332	3.7	68.6	1540	3909
1995	1.58	51.4	1540	1250	3.7	68.6	1540	3909
1996	1.80	59.9	1540	1660	3.7	68.6	1540	3909
1997	2.00	59.6	1540	1836	3.7	68.6	1540	3909
1998	1.80	50.0	1540	1386	3.7	68.6	1540	3909

Estimation of Conservation Requirement

The conservation requirement in terms of egg deposition, 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. The available fluvial habitat estimated for Humber River is 11, 530,700 m^2 (Porter and Chadwick, MS 1983) and the lacustrine habitat is 1,751 ha, excluding Deer Lake (Mullins and Chaput, MS 1995).

The conservation requirement of 28.3 million eggs expressed in terms of number of spawners is 15,749 small and 934 large salmon based on the mean proportions of small and large salmon in 1992-96 (Mullins et al., MS 1997).

Long Term Population Trends

Analysis to Detect Recruitment Over-fishing

Details of the analysis to detect recruitment over-fishing are described in O'Connell, et al. (1995). Spawning escapements that produced small and large salmon spawners on the Humber River in 1980-1997 were constructed by weighting previous spawning escapements by the smolt age distribution of 1SW salmon on the Humber River in 1993.

RESULTS

Recreational Fishery Harvest

a. Licence Stub Data

The recreational salmon fishery on the Humber River in 1998 opened on 6 June and closed on 7 September. As a precaution against continued low returns, similar to 1997, the retention bag limit was reduced to one small salmon before 5 July and three after 5 July. The catch was 1,285 small retained, 1,695 small released and 459 large released based on licence stub returns (Appendix 1). The catch of small retained was 47% lower than in 1997. The catch of small released was also lower than in 1997 but not as much as for retained fish - there was actually a small increase in the proportion of small salmon released in 1998. The catch of large salmon released decreased only slightly compared to 1997. Based on comments received from anglers, it appears that the reduction in the retention limit before 5 July would have resulted in lower overall fishing effort and might explain the lower catches in 1998. The retention limit of one small salmon before 5 July meant that anglers who wished to continue fishing were restricted to catch and release. This might explain the increase in the proportion of small salmon released in 1998. However, lower catches could also be explained by a lower population size. Without detailed information on angling effort it is impossible to separate the effects of changes in management measures from those of changes in the population size. Effort data was not available from licence stub information.

b. Big Falls Creel Survey Data

The creel survey was conducted at Big Falls from 6 June to 6 September 1998. The starting date of the survey was more than one week earlier than in most years in anticipation that the lower water conditions early in the season would be favourable for angling.

Year*	Survey Dates	Survey Type
1991	22 Jun.-30 Aug.	'Bus Route'
1992	16 Jun.-30 Aug.	'Bus Route'
1993	9 Jun.- 20 Aug.	'Bus Route'
1994	19 Jun.-5 Sept.	Total
1995	17 Jun.-5 Sept.	'Bus Route'
1996	18 Jun.-2 Sept.	Total
1997	24 Jun.-1 Sept.	Total
1998	6 Jun.-6 Sept.	Total

In spite of an earlier start date, catches and effort at Big Falls were quite low for the first two weeks of the survey ending 21 June (Table 3) and suggesting that few fish had reached this area. The peak of angling effort and retention of small salmon occurred during the week ending 5 July (Table 3).

The peak for released small salmon was one week earlier. This suggests that anglers may have chosen not to fill their one fish retention limit until the last week in order to continue to catch and release prior to 5 July. The number of released fish dropped off quickly after 5 July. The proportion of small salmon released at Big Falls in 1998 was the highest recorded in creel surveys since 1992 (Table 4).

The timing of catches in the recreational fishery at Big Falls was the earliest since 1992 for both small and large salmon (Figs. 3a-b). This was probably due to the earlier run timing to the river (Fig.4) as well as the lower water levels observed in 1998 (Fig. 5). Lower than normal water levels early in the season would mean better fishing conditions while temperatures were cool but anglers contend that salmon do not take the fly as well when the water temperature warms up later in the season.

There were 3,320 interviews and/or observations of anglers exiting the fishing area recorded in 1998 (Table 4). Anglers fished for an average of about four hours per trip, similar to 1997 and previous years. However, the time anglers spent to catch one fish was almost three hours more in 1998 than in 1997. This could have been related to the bag limit restrictions, low water levels in 1998 or a lower population size.

The creel survey clerks were successful in covering 99% of the survey schedule over the entire season in 1998. After adjustment for the proportion of periods monitored (Table 5), the total catch at Big Falls was 552 small salmon retained (Table 6), 593 small released (Table 7) and 35 large released (Table 8). The ratio of released to retained small salmon at Big Falls in 1998 was 1.074.

c. Comparison of Licence Stub and Creel Data

The Big Falls area of the Humber River has produced about 44% of the total catch of small salmon retained since 1992 based on tag return information (Table 9). This is comparable with the percentage based on DFO angling catch statistics but the decreased emphasis since 1992 on the collection of angling catch statistics by DFO may have affected this calculation. Applying an adjustment of 0.4387 to the catch at Big Falls in 1998 results in a total catch of 1,258 small salmon retained on the entire river. This is only 2% less than the estimate of small salmon retained based on the licence stub return system in 1998 (Table 10). The catch of small salmon retained based on creel surveys has been within 10% of estimates based on licence stub return system for the last three years. However, there has been more discrepancy between small salmon released catches based on these two methods than for retained. Small salmon released catches based on creel surveys were lower than estimates based on stub returns in every year. This may be because the proportion of small salmon retained at Big Falls is higher than in other parts of the system. Differences between estimates of catches of large salmon released based on the two methods may be due either to a change in the proportion of large salmon at Big Falls (0.354 in 1992-96 based on DFO catch statistics) or to more accurate catch statistics based on the licence stub returns. The increase in numbers and proportion of large salmon on the Humber River in recent years would have contributed to higher catches. The lower water levels and earlier run timing may also have resulted in increased catches in other segments of the river than Big Falls. The licence stub return data is not separated by river segment so it is impossible to verify if this is actually the case. However, anecdotal information from some anglers indicates that catches of large salmon have increased in some areas.

In past assessments, the total catch of small salmon on the Humber River was estimated based on on catches at Big Falls. This method was adopted because of an under-reporting of the catch in DFO statistics brought about by a reduction in the number of DFO River Guardians and changes in their duties. Fewer River Guardians in recent years would have resulted in fewer river patrols and more reliance on estimation of catches based more on historical patterns than on actual observations. Both run timing and angling patterns have changed in recent years on the Humber River, demanding more, not less data collection effort. The catch of large salmon was also likely under-reported in the DFO catch statistics especially for areas other than at Big Falls where there was less data collection effort. This

would explain the discrepancy with the stub return data and an over-estimation of the proportion of the large salmon catch at Big Falls.

Given the uncertainty associated with estimating the total catch for the river based on the catch from one segment, it is recommended that the licence stub data be adopted as the total catch for the river.

In-season Review

Catches of small salmon in the Lower tagging trap during the 1998 season were the lowest recorded (Table 11). This created the impression that the population size of small salmon was also low in 1998. Regressions of the population size since 1992 on cumulative catches in the Lower tagging trap to week ending dates in 1998 were significant for four out of six dates tested (Fig 6). The model that explained most of the annual variation was for cumulative catches to 28 June (R^2 = 0.7403, p=0.007). In five out of the six years tested, at least 50% of the run had entered the river by 28 June (Fig. 7). The exception was in 1993 when 50% of the catch was not reached until 5 July. The 1994 data point was the lowest in all cases suggesting that either the trap was more efficient than in other years or that the population estimate was not comparable with the other years. With the 1994 data point removed, the model explained 91% of the annual variation. This model predicted that the total population size of small salmon in 1998 was approximately 10,000 fish (Fig. 8).

Regressions of catch rates at Big Falls on total population size of small salmon in 1994-97 were not significant. The catch rates in 1994-98 to 28 June, typically the periods of peak angling activity, were more related to water levels than to the population size (Fig. 9).

Mark-Recapture

a. Tags Applied

The Lower tagging trap was operated from 2 June to 25 August and the Upper Trap was operated from 29 May to 29 August. Of the two additional traps operated, one operated from 11 June to 28 June and the other operated from 23 June to 15 August.

Year	Period of Marking	Period of Angling Recaptures
1990	9 June-2 Aug.	1 June-2 Sept.
1991	7 June-28 Aug.	1 June-8 Sept.
1992	7 June-1 Aug.	1 June-1 Aug.
1993	2 June-31 Aug.	6 June-6 Sept.
1994	6 June-1 Sept.	4 June-5 Sept.
1995	7 June-18 Sept.	3 June-4 Sept.
1996	24 May-3 Oct.	3 June-2 Sept.
1997	3 June-3 Sept.	1 June-1 Sept.
1998	29 May-29 Aug.	6 June-6 Sept.

A total of 214 small and 80 large bright salmon were captured in the four tagging traps (Table 12). The catch of small salmon was less than in the previous five years but the catch of large, with the exception of 1995, was similar to previous years since 1994. The proportion of large salmon was almost twice as high as in 1997 and three time higher than the 1992-96 mean.

A total of 203 small salmon were tagged and released in 1998 and 196 of these were considered to be available to the retention fishery on the Humber River (Table 13). The other seven were recovered from a counting fence on Hughes Brook (Fig. 1). Hughes Brook flows into the Humber Arm about 3.0 km north of the Humber River estuary. The median number of days at large for Hughes Brook fish was seven days (Min.=1; Max.=51) suggesting that tag loss would have been minimal based on 0.009 tags/day and no adjustment was necessary. Tagged small salmon were also recaptured in Hughes Brook in the past (2-12 in 1990-93 and three in 1997

b. Tagging Mortality

Tags were not applied at water temperatures above 15 C. Because of the relatively cool temperatures at the time of tagging, the experience of tagging personnel, the fact that fish were submerged in water while being tagged and that injured fish were not tagged, tagging mortality was believed to be negligible. The tag application process takes approximately 45 seconds.

c. Distribution of Tags in the Population

Similar distribution of small salmon in the two main tagging traps indicated that the tagging occurred over the entire run in 1998 (Figs. 10a-b). However, given that large salmon were caught in the Upper tagging trap in the first few days of operation, some large salmon may have entered the river prior to the installation of the traps. The run timing of small salmon at the Lower tagging trap was the earliest recorded in nine years of operation and the run timing of large salmon was about average (Figs. 4a-b).

The weekly distribution of tags applied was similar for the two main tagging traps (Fig. 11a). However, with the low number of tag recoveries, the recovery distributions were not similar (Fig. 11b). The distribution of tagged and untagged small salmon angled at Big Falls was also not similar (Fig. 11c). However, with only seven tags recovered in five weeks of a fishery that lasted 13 weeks, it is unlikely that recoveries would show the true distribution of tags in the population. In the past, the distributions of tagged and untagged salmon in the recreational fishery have been comparable indicating that both tagged and untagged salmon were evenly dispersed in the population and available to the fishery at the same time.

d. Tag Recoveries

A total of 16 Carlin tags were returned by anglers from retained and released small salmon in 1998 (Table 14). There were no reported recoveries of large salmon in 1998. Tag recoveries were distributed throughout major segments of the river with the largest number recovered at Big Falls (Table 15). Big Falls also produced the highest tag recoveries in previous years. A total of 14 tags were considered to be from retained small salmon including one that was not reported as retained or released. A total of seven tags were recovered from the area of the Big Falls segment covered by the creel survey. Tags applied early in the season were recovered earlier than those tagged later in the run (Table 16).

e. Tag Retention and Reporting Rate

The tag retention rate estimated in 1998 was 0.901 based on a median of 11 days at large for recaptured small salmon (Table 17). This was three days less than in 1997. It is noted that five Humber River small salmon tagged from 27-28 July 1995 and held in captivity until 23 November, had 0.0% tag loss at the time of release, 119 days after being tagged. Although this sample size is insufficient to

estimate tag loss in the wild, a higher tag retention rate than estimated in Table 10 would have resulted in an even lower angling exploitation rate.

The voluntary tag reporting rate of 0.50 in 1998 was based on four tags returned voluntarily by anglers out of a total of eight tags (retained and released) observed by the creel survey clerks at Big Falls (Table 18). This is less than the reporting rate of 0.60-0.65 estimated for previous years when sample sizes were larger. The estimate for 1998 may have been biased by the small sample size. Considering the similarity among reporting rates estimated in previous years when sample sizes were larger, the 1992-98 mean of 0.6264 was used as the 1998 value in order to reduce any potential bias caused by the low sample size. This value is supported in a study by Zale and Bain (1994) who reported that under simulated conditions 64-67% of anglers voluntarily returned tags for a reward.

f. Angling Exploitation Rate

After adjustment for tag loss and reporting rate, the angling exploitation rate on small salmon retained was 0.14 in 1998 (Table 19). This is the lowest exploitation rate estimated for the Humber River since 1990. The angled rate for Big Falls was 0.0621.

The low angling exploitation rate in the last three years, in particular, may have resulted from the early run timing of small salmon to the river (Fig. 4a) causing the fish to pass quickly through the system and be available to the fishery for a shorter period of time. This would explain the low angling exploitation rates in 1996-98 compared to previous years. It is also likely that the retention limit of one small salmon before 5 July 1998 would have resulted in fewer fish being caught and a lower angling exploitation rate in 1998. Catches of small salmon at Big Falls peaked before 5 July 1998. The highest angling exploitation rate recorded in the period of assessment was in 1994. The total angling effort was lower in 1994 than in 1996 and 1997 but the run timing was later and occurred over a much longer period of time. This may have resulted in the population being available to the fishery longer in 1994 than in 1996 and 1997 and, therefore, the exploitation rate was higher. The closure of the Tailrace portion of Deer Lake (Fig. 1) to angling in in 1996 would also have reduced angling exploitation.

Returns, Spawning Escapement and Percentage of the Conservation Egg Deposition Achieved

Returns to the Humber River in 1998, based on the mark-recapture results, were 9,476 (95% CI=6,749-14,150) small salmon and 3,542 (95% CI=2,523-5,289) large salmon (Table 20). The two calculation methods tested produced similar results: 1) based on total tag recoveries for the entire river and 2) based on treating tag recoveries at Big Falls and remainder of the river as two independent sighting occasions. Both estimates are highly probable and each is within the 95% confidence interval of the other (Table 20; Fig. 12). However, the assumption of independence in method 2 does not hold because the number of tags available for recapture at Big Falls would be affected by the number of tags recaptured in other parts of the river and vice versa. What is needed on the Humber River is a method of tag recoveries that is independent of the recreational fishery.

The spawning escapement of small salmon in 1998 was below the estimated spawner requirement for small, whereas the escapement of large salmon was above the spawner requirement for large (Figs. 13). These spawner requirements are management targets only and are based on the relative proportions of small and large salmon in the population in 1992-96 and may not represent the true proportions in a stable population.

Potential egg depositions from small and large spawners in 1998 were 82% (95% CI=46-161%) of the conservation egg deposition requirement (Table 21). These percentages would have been even lower if the proportion of large salmon had not increased.

Long term Population Trends

Since the closure of the commercial salmon fishery in 1992, with the exception of 1994 and 1997, the number of spawners on the Humber River has generally been above estimates of their cohorts derived by weighting previous spawners by the smolt-age distribution of their progeny (Fig. 14).

Spawners were above the replacement (diagonal) line (Fig. 15) in four out of seven years since 1992. In 1991, the number of spawners was well below the replacement line. Of the total of nine data points, three were below the replacement line (including 1998) indicating that the stock has been in an increasing trend in the time period examined. A healthy stock would have points distributed both above and below the replacement line.

DISCUSSION

The returns of small Atlantic salmon to the Humber River in 1998 were again low compared to 1995 and 1996. However, returns of large salmon were the highest recorded in nine years of assessment. This may have been due to the fact that large salmon are predominantly repeat spawning one sea winter (1SW) fish and may not be subject to the same marine conditions as either returning virgin 1SW salmon or smolts.

Returns of two sea winter (2SW) salmon in 1998 were expected to be low, given the low survival of 1SW salmon in 1997. However, if the low returns of small salmon in 1997 had been caused by a delay in age at maturity, these fish should have returned as 2SWs in 1998. In addition, the first 2SW recruits from the 1992 year-class were also expected to return to the river in 1998. If either of these conditions had occurred the percentage of 2SW salmon would be expected to increase. This was not the case. The percentage of 2SW salmon on the Humber River dropped to less than 20% in 1997 and 1998 compared to over 30% in 1992-96. This suggests that marine conditions have not improved.

In a stock with a healthy spawning population it is suggested that points in the spawner-recruit relationship should fall both above and below the line in a 50:50 distribution. The Humber River stock has been above the replacement line in five of the last seven years since 1992. This suggests a stock in a growth mode. Also, in a healthy population, the conservation requirement should be achieved each year. In the case of the Humber, this has also occurred in only four of the last seven years since 1992. It is concluded from this that the Humber River salmon stock, while below the conservation requirement in some years, is showing signs of improvement. However, growth of the spawning population in 1997 and 1998 was minimal compared to years before 1992. If the survival rate of year-classes contributing to returns to the river in 1999 is as low as for 1997 and 1998 returns, then a second consecutive year of low population growth could be experienced in 1999. Because of the potential for overexploiting the stock in 1999 if returns are again low, angling exploitation should be closely monitored.

The current assessment of the status of the Humber River Atlantic salmon stock is based on returns to the river in June to August. While these returns represent by far the majority of the stock size, there is evidence that a run of large salmon enters the river in the fall, presumably spawning in the lower part of the river. Mullins et al. (MS 1997) determined that the fall run consists of 2SW and 3SW salmon, as well as previous spawners and that the size of the run increased in 1994-96 compared to previous years. However, the population appeared to be low, probably less that 600 salmon, with the 3SW component probably less than 200 salmon. The 3SW component is unique to some southwest Newfoundland rivers and Humber River should be given special protection to minimize and to prevent any increase in fishing mortality.

In order to continue to improve the stock assessment technique on the Humber River, it is recommended that tag recovery techniques be developed that are independent of the recreational

fishery. This would eliminate the uncertainty associated with estimation of tag reporting by anglers and in estimating the catch in the recreational fishery. It is also recommended that tag retention be estimated for the Humber River by double tagging in 1999.

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Table 1. Recreational and commercial fishery management measures implemented in Newfoundland and Labrador since 1978 that would have influenced the Humber River salmon stock.

	Recreational Fishery									Commercial Fishery (SFA 13)	
		Small salmon									
			Season Quotas		Daily Bag Limit						
Year	Season Dates	Season Bag Limit	SFA 13	Adies Lake	Retained	Released	Large salmon	Closures	Fall Fishery (H&R)	Season Dates	Season Quotas
1978										1 Jun – 10 Jul	
1984							H&R			5 Jun – 10 Jul	
1987		15					H&R			5 Jun – 10 Jul	
1990		15					H&R			5 Jun – 10 Jul	35t
1991	1 Jun - 2 Sep	10					H&R			5 Jun – 10 Jul	25t reached 6 Jul
1992	6 Jun - 7 Sep	8	5000	100	2	4	H&R	SFA 13 quota reached 1 Aug. H&R 2 Aug - 7 Sep		Moratorium in Nfld.	
1993	6 Jun - 6 Sep	8	5200	100	1	4	H&R	Adies Lake closed 31 Jul - quota not reached		Moratorium in Nfld.	
1994	4 Jun - 5 Sep	3 before 31 Jul 3 after 31 Jul		100	2	4	H&R	Adies Lake closed 31 Jul - quota not reached		Moratorium in Nfld.	
1995	3 Jun - 4 Sep	3 before 31 Jul 3 after 31 Jul		100	2	4	H&R	Adies Lake closed 30 Jul - quota not reached.	.	Moratorium in Nfld.	
1996	3 Jun - 2 Sep	3 before 31 Jul 3 after 31 Jul		100	2	4	H&R	Adies Lake closed 30 Jul - quota not reached	3-30 Sep	Moratorium in Nfld.	
1997	6 Jun - 1 Sep	3 before 31 Jul 3 after 31 Jul		100	2	4	H&R	Retention 6 Jun – 27 Jul H&R 28 Jul - 1 Sep Adies Lake closed 30 Jul - quota not reached	2-30 Sep	Moratorium in Nfld. And Lab.	
1998	6 Jun - 7 Sep	1 before 5 Jul 3 after 5 Jul.		100	1	2	H&R		8-27 Sep	Moratorium in Nfld. And Lab.	

* Note: Daily bag limit of released fish is for small and large combined.

Table 2. Equations used in estimation of angling exploitation rate, total catch and total returns of Atlantic salmon to the Humber River, 1998. Parameters in bold type changed values with each iteration of the simulation procedure.

1. EXPLOITATION RATE (*er*) = $\frac{\text{Tags Recaptured (R)}}{\text{Tags Available (M)}}$

Where:

R = $\frac{\text{Tags Returned}}{\text{Reporting Rate (rr)}}$

rr = $\frac{\textbf{Tags Returned from Big Falls}}{\textbf{Tags Recaptured at Big Falls}}$ = $\frac{\textbf{57}}{\textbf{91}}$ = **0.6264** (95% CI=0.5275-0.7253)

M = Tags Applied x Proportion Tags Retained

Proportion Tags Retained = **1 - (Tag Loss Rate (TL))**
TL = (0.009 tags/day x Median Days to Recapture)
Range of Days to Recapture = 3 to 57 days; Median = 11

2. CATCH-Small Retained ($C_{sm\text{-}ret}$) = Estimated from Licence Stub Returns (O'Connell et al., MS 1998)

3. RETURNS-Small (N_{sm}) = $\frac{C_{sm\text{-}ret}}{er}$ or $\frac{M \times C_{sm\text{-}ret}}{R}$ (Petersen single census)

4. RETURNS-Large (N_{Lg}) = N_{Sm} x **Ratio Large:Small in Population**
(Ratio Large:Small = 80/214 = 0.3738 (95% CI=0.3084-0.4393))

Equations in bold type were solved 5000 times to generate the distribution from which confidence limits were determined.

Table 3. Weekly summary of catches, effort and CPUE at Big Falls, 1998.

Week Ending	Effort Rod Days	Small			Large Released	Total Catch	Weekly CPUE	Cumul. CPUE
		Retained	Released	Total				
7-Jun	0	0	0	0	0	0		
14-Jun	68	3	4	7	10	17	0.25	0.25
21-Jun	336	37	108	145	6	151	0.45	0.42
28-Jun	800	113	258	371	2	373	0.47	0.45
5-Jul	979	167	163	330	4	334	0.34	0.40
12-Jul	903	148	40	188	6	194	0.21	0.35
19-Jul	431	43	4	47	3	50	0.12	0.32
26-Jul	183	18	6	24	2	26	0.14	0.31
2-Aug	80	3	1	4	0	4	0.05	0.30
9-Aug	35	2	4	6	0	6	0.17	0.30
16-Aug	41	1	0	1	1	2	0.05	0.30
23-Aug	34	3	0	3	0	3	0.09	0.30
30-Aug	27	7	1	8	0	8	0.30	0.30
6-Sep	42	5	0	5	0	5	0.12	0.30
Total	3959	550	589	1139	34	1173	0.30	0.30

Table 4. Creel survey results at Big Falls 1992-98.

	INTERVI-EWS	#INTERV. ≥ 2	RODS ADJUSTED	# LEFT ON RIVER	TOTAL RODS	EFFORT HOURS	SMALL RETAINED	SMALL RELEASED	SMALL TOTAL	PROP. SMALL	LARGE RELEASED	TOTAL CATCH	CATCH/ ROD	HOURS/ INTERV.	HOURS/ FISH
YY															
92	0	0	0	0	0	2612	738	59	797	0.07	25	822	.	.	3.2
93	1613	0	1613	573	2186	6015	413	30	443	0.07	20	463	0.20	3.73	13.0
94	3839	0	3839	796	4635	14117	765	436	1201	0.36	63	1264	0.26	3.75	11.6
95	1244	0	1244	371	1615	4767	375	137	512	0.27	17	529	0.32	3.89	9.3
96	5331	353	4978	1474	6452	18867	1229	782	2011	0.39	73	2084	0.31	3.60	9.4
97	3599	311	3288	1267	4555	13553	1009	574	1583	0.36	42	1625	0.35	3.78	8.8
98	3320	351	2969	990	3959	12401	550	589	1139	0.52	34	1173	0.29	3.75	11.4

Table 5. Adjustment factors for unsampled creel survey periods.
Note: adjustments assume equal weighting of periods between days within weekly strata.

		Fishery										Total				
		Daily Limit of 1					Daily Limit of 2									
		PERIOD					PERIOD					PERIOD				
Location	Week	A	B	C	D	Total	A	B	C	D	Total	A	B	C	D	Total
Boat	23	1.00	1.00	1.00	1.00	1.00						1.00	1.00	1.00	1.00	1.00
	24	1.00	1.17	1.00	1.17	1.08						1.00	1.17	1.00	1.17	1.08
	25	1.00	1.00	1.00	1.00	1.00						1.00	1.00	1.00	1.00	1.00
	26	1.00	1.00	1.00	1.00	1.00						1.00	1.00	1.00	1.00	1.00
	27	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	28						1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	29						1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	30						1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	31						1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	32						1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	33						1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	34						1.17	1.17	1.00	1.00	1.08	1.17	1.17	1.00	1.00	1.08
	35						1.00	1.00	1.17	1.17	1.08	1.00	1.00	1.17	1.17	1.08
	36						1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Total	1.00	1.04	1.00	1.04	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1.02	1.01	1.02	1.02
Stair	23															
	24	2.00	1.00	1.33	1.00	1.23						2.00	1.00	1.33	1.00	1.23
	25	1.00	1.00	1.00	1.00	1.00						1.00	1.00	1.00	1.00	1.00
	26	1.00	1.00	1.00	1.00	1.00						1.00	1.00	1.00	1.00	1.00
	27	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	28						1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	29						1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	30						1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	31						1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	32						1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	33						1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	34						1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	35						1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	36						1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Total	1.11	1.00	1.05	1.00	1.04	1.00	1.00	1.00	1.00	1.00	1.02	1.00	1.01	1.00	1.01
Total	23	1.00	1.00	1.00	1.00	1.00						1.00	1.00	1.00	1.00	1.00
	24	1.22	1.10	1.10	1.10	1.13						1.22	1.10	1.10	1.10	1.13
	25	1.00	1.00	1.00	1.00	1.00						1.00	1.00	1.00	1.00	1.00
	26	1.00	1.00	1.00	1.00	1.00						1.00	1.00	1.00	1.00	1.00
	27	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	28						1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	29						1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	30						1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	31						1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	32						1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	33						1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	34						1.08	1.08	1.00	1.00	1.04	1.08	1.08	1.00	1.00	1.04
	35						1.00	1.00	1.08	1.08	1.04	1.00	1.00	1.08	1.08	1.04
	36						1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Total	1.04	1.02	1.02	1.02	1.03	1.01	1.01	1.01	1.01	1.01	1.02	1.01	1.01	1.01	1.01

Table 6. Adjusted retained catch of small salmon at two Creel survey locations at Big Falls.
Note: adjustments assume equal weighting of periods between days within weekly strata.

Small Retained

		Fishery										Total				
		Daily Limit of 1					Daily Limit of 2									
		PERIOD					PERIOD					PERIOD				
Location	Week	A	B	C	D	Total	A	B	C	D	Total	A	B	C	D	Total
Boat	23	0	0	0	0	0						0	0	0	0	0
	24	0	1	1	1	3						0	1	1	1	3
	25	6	13	3	23	45						6	13	3	23	45
	26	27	25	16	23	91						27	25	16	23	91
	27	10	4	3	2	19	46	48	8	18	120	56	52	11	20	139
	28						24	34	12	16	86	24	34	12	16	86
	29						6	1	0	4	11	6	1	0	4	11
	30						1	0	0	3	4	1	0	0	3	4
	31						0	0	0	1	1	0	0	0	1	1
	32						0	0	0	0	0	0	0	0	0	0
	33						0	1	0	1	2	0	1	0	1	2
	34						2	0	1	1	4	2	0	1	1	4
	35						1	0	1	7	9	1	0	1	7	9
	36						0	0	0	1	1	0	0	0	1	1
	Total	43	43	23	49	158	80	84	22	52	239	123	127	45	101	397
Stair	23											0	0	0	0	0
	24	8	2	1	2	13						8	2	1	2	13
	25	2	9	2	15	28						2	9	2	15	28
	26	6	9	5	13	33						6	9	5	13	33
	27	2	0	0	6	8	4	5	6	16	31	6	5	6	22	39
	28						5	9	5	6	25	5	9	5	6	25
	29						5	0	1	5	11	5	0	1	5	11
	30						1	3	0	3	7	1	3	0	3	7
	31						0	1	0	0	1	0	1	0	0	1
	32						1	0	0	0	1	1	0	0	0	1
	33						0	1	0	0	1	0	1	0	0	1
	34						0	0	0	0	0	0	0	0	0	0
	35						0	0	0	0	0	0	0	0	0	0
	36						0	0	0	0	0	0	0	0	0	0
	Total	18	20	8	36	82	16	19	12	30	77	34	39	20	66	159
Total	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	24	5	3	2	3	14	0	0	0	0	0	5	3	2	3	14
	25	8	22	5	38	73	0	0	0	0	0	8	22	5	38	73
	26	33	34	21	36	124	0	0	0	0	0	33	34	21	36	124
	27	12	4	3	8	27	50	53	14	34	151	62	57	17	42	178
	28	0	0	0	0	0	29	43	17	22	111	29	43	17	22	111
	29	0	0	0	0	0	11	1	1	9	22	11	1	1	9	22
	30	0	0	0	0	0	2	3	0	6	11	2	3	0	6	11
	31	0	0	0	0	0	0	1	0	1	2	0	1	0	1	2
	32	0	0	0	0	0	1	0	0	0	1	1	0	0	0	1
	33	0	0	0	0	0	0	2	0	1	3	0	2	0	1	3
	34	0	0	0	0	0	2	0	1	1	4	2	0	1	1	4
	35	0	0	0	0	0	1	0	1	6	8	1	0	1	6	9
	36	0	0	0	0	0	0	0	0	1	1	0	0	0	1	1
	Total	58	63	31	85	238	96	103	34	81	314	154	166	65	167	552

Table 7. Adjusted released catch of small salmon at two Creel survey locations at Big Falls.
Note: adjustments assume equal weighting of periods between days within weekly strata.

Small Released

		Fishery										Total				
		Daily Limit of 1					Daily Limit of 2									
		PERIOD					PERIOD					PERIOD				
Location	Week	A	B	C	D	Total	A	B	C	D	Total	A	B	C	D	Total
Boat	23	0	0	0	0	0						0	0	0	0	0
	24	2	1	0	4	7						2	1	0	4	7
	25	24	21	12	72	129						24	21	12	72	129
	26	52	52	20	64	188						52	52	20	64	188
	27	5	22	1	3	31	12	9	3	2	26	17	31	4	5	57
	28						1	1	1	0	3	1	1	1	0	3
	29						1	1	1	0	3	1	1	1	0	3
	30						0	0	0	0	0	0	0	0	0	0
	31						0	0	0	0	0	0	0	0	0	0
	32						0	0	0	0	0	0	0	0	0	0
	33						0	0	0	0	0	0	0	0	0	0
	34						0	0	0	1	1	0	0	0	1	1
	35						0	0	0	0	0	0	0	0	0	0
	36						0	0	0	0	0	0	0	0	0	0
	Total	83	96	33	143	355	14	11	5	3	33	97	107	38	146	388
Stair	23	0	0	0	0	0						0	0	0	0	0
	24	6	3	0	17	26						6	3	0	17	26
	25	5	18	3	41	67						5	18	3	41	67
	26	4	13	7	31	55						4	13	7	31	55
	27	3	1	0	3	7	8	7	3	15	33	11	8	3	18	40
	28						1	4	1	1	7	1	4	1	1	7
	29						1	0	0	2	3	1	0	0	2	3
	30						0	1	0	1	2	0	1	0	1	2
	31						0	0	1	0	1	0	0	1	0	1
	32						2	0	0	2	4	2	0	0	2	4
	33						0	0	0	0	0	0	0	0	0	0
	34						0	0	0	0	0	0	0	0	0	0
	35						0	0	0	0	0	0	0	0	0	0
	36						0	0	0	0	0	0	0	0	0	0
	Total	18	35	10	92	155	12	12	5	21	50	30	47	15	113	205
Total	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	24	8	4	0	21	33	0	0	0	0	0	8	4	0	21	33
	25	29	39	15	113	196	0	0	0	0	0	29	39	15	113	196
	26	56	65	27	95	243	0	0	0	0	0	56	65	27	95	243
	27	8	23	1	6	38	20	16	6	17	59	28	39	7	23	97
	28	0	0	0	0	0	2	5	2	1	10	2	5	2	1	10
	29	0	0	0	0	0	2	1	1	2	6	2	1	1	2	6
	30	0	0	0	0	0	0	1	0	1	2	0	1	0	1	2
	31	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1
	32	0	0	0	0	0	2	0	0	2	4	2	0	0	2	4
	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	34	0	0	0	0	0	0	0	0	1	1	0	0	0	1	1
	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	101	131	43	235	510	26	23	10	24	83	127	154	53	259	593

Table 8. Adjusted released catch of small salmon at two Creel survey locations at Big Falls.
Note: adjustments assume equal weighting of periods between days within weekly strata.

Large Released

		Fishery										Total				
		Daily Limit of 1					Daily Limit of 2									
		PERIOD					PERIOD					PERIOD				
Location	Week	A	B	C	D	Total	A	B	C	D	Total	A	B	C	D	Total
Boat	23	0	0	0	0	0						0	0	0	0	0
	24	2	2	1	2	8						2	2	1	2	8
	25	0	1	0	0	1						0	1	0	0	1
	26	0	1	0	0	1						0	1	0	0	1
	27	1	1	0	0	2	1	1	0	0	2	2	2	0	0	4
	28						3	2	0	0	5	3	2	0	0	5
	29						0	0	0	1	1	0	0	0	1	1
	30						0	0	0	1	1	0	0	0	1	1
	31						0	0	0	0	0	0	0	0	0	0
	32						0	0	0	0	0	0	0	0	0	0
	33						0	0	0	0	0	0	0	0	0	0
	34						0	0	0	0	0	0	0	0	0	0
	35						0	0	0	0	0	0	0	0	0	0
	36						0	0	0	0	0	0	0	0	0	0
	Total	3	5	1	2	12	4	3	0	2	9	7	8	1	4	21
Stair	23	0	0	0	0	0						0	0	0	0	0
	24	0	2	0	5	7						0	2	0	5	7
	25	0	0	0	3	3						0	0	0	3	3
	26	0	0	0	0	0						0	0	0	0	0
	27	0	0	0	0	0	0	0	1	1	2	0	0	1	1	2
	28						0	0	0	1	1	0	0	0	1	1
	29						0	0	0	0	0	0	0	0	0	0
	30						0	0	0	0	0	0	0	0	0	0
	31						0	0	0	0	0	0	0	0	0	0
	32						0	0	0	1	1	0	0	0	1	1
	33						0	0	0	0	0	0	0	0	0	0
	34						0	0	0	0	0	0	0	0	0	0
	35						0	0	0	0	0	0	0	0	0	0
	36						0	0	0	0	0	0	0	0	0	0
	Total	0	2	0	8	10	0	0	1	3	4	0	2	1	11	14
Total	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	24	2	4	1	7	15	0	0	0	0	0	2	4	1	7	15
	25	0	1	0	3	4	0	0	0	0	0	0	1	0	3	4
	26	0	1	0	0	1	0	0	0	0	0	0	1	0	0	1
	27	1	1	0	0	2	1	1	1	1	4	2	2	1	1	6
	28	0	0	0	0	0	3	2	0	1	6	3	2	0	1	6
	29	0	0	0	0	0	0	0	0	1	1	0	0	0	1	1
	30	0	0	0	0	0	0	0	0	1	1	0	0	0	1	1
	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	0	0	0	0	0	0	0	0	1	1	0	0	0	1	1
	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	3	7	1	10	22	4	3	1	5	13	7	10	2	15	35

Table 9. Proportion of small salmon retained at Big Falls based on DFO catch statistics and tag returns, 1992-98.

Year	DFO Catch statistics			Tag Returns		
	Humber	Big Falls	Prop.	Humber	Big Falls	Prop.
1992	2234	1497	0.6701	32	22	0.6875
1993	2206	882	0.3998	119	48	0.4034
1994	1550	651	0.4200	97	37	0.3814
1995	1825	549	0.3008	189	93	0.4921
1996	2448	1237	0.5053	79	25	0.3165
1997	.	.	.	33	15	0.4545
1998*	1285	552	0.4296	14	7	0.5000
Total (92-98)	11548	5368	0.4648	563	247	0.4387

* Catch statistics for Humber based on licence stub return system.

Table 10. Comparison of angling catch statistics on Humber River based on creel surveys and licence stub returns.

Year	Small Retained			Small Released			Total Samll			Large Released		
	Creel	Stub	% Diff	Creel	Stub	% Diff	Creel	Stub	% Diff	DFO/Creel*	Stub	% Diff
1994	2523	3069	21.6%	1438	2414	67.9%	3961	5483	38.4%	166	659	297.0%
1995	5150	3942	-23.5%	1881	3218	71.1%	7031	7160	1.8%	233	747	220.6%
1996	4740	4287	-9.6%	3016	3515	16.5%	7756	7802	0.6%	237	851	259.1%
1997	2447	2429	-0.7%	1433	2788	94.6%	3880	5217	34.5%	133	505	279.7%
1998	1258	1285	2.1%	1351	1695	25.5%	2609	2980	14.2%	99	459	363.6%
Mean	3224	3002	-6.9%	1824	2726	49.5%	5047	5728	13.5%	174	644	271.1%

* DFO data 1994-96.

Table 11. Total and cumulative weekly catches of small salmon in the Lower tagging trap 1990-98.

	Lower Trap			Estimated Returns			Count of Small Salmon in Lower Trap to Date						
Year	Small	Large	Total	Small	Large	Total	7-Jun	14-Jun	21-Jun	28-Jun	5-Jul	12-Jul	19-Jul
1989	2	5	7										
1990	257	22	279	12,216	855	13,071	0	18	52	66	77	153	187
1991	104	4	108	5,724	401	6,125	0	0	1	8	19	34	52
1992	181	29	210	17,571	2,945	20,516	4	70	112	120	154	160	169
1993	699	45	744	18,477	636	19,113	0	11	103	151	330	610	648
1994	438	79	517	7,995	1,030	9,025	1	26	164	224	293	359	399
1995	844	104	948	27,898	2,064	29,962	0	18	218	411	694	740	797
1996	516	63	579	30,445	2,679	33,124	11	84	351	458	468	474	482
1997	248	47	295	14,866	2,595	17,461	0	8	147	204	232	234	236
1998	65	19	84	10,000			0	7	34	43	45	52	54
Mean (92-96)	536	64	600	20477	1871	22348	3	42	190	273	388	469	499

Table 12. Captures of bright Atlantic salmon in Humber River tagging traps. 1989-98.

Year	Lower Trap			Upper Trap			Trap #3			Trap #4			Total			Prop. Small	Prop. Large	Ratio Large:Small
	Small	Large	Total	Small	Large	Total	Small	Large	Total	Small	Large	Total	Small	Large	Total			
1989	2	5	7	.	.	0	.	.	.	.	.	.	2	5	7	.	.	2.5000
1990	257	22	279	.	.	0	.	.	.	.	.	.	257	22	279	0.9211	0.0789	0.0856
1991	104	4	108	.	.	0	.	.	.	.	.	.	104	4	108	0.9630	0.0370	0.0385
1992	181	29	210	.	.	0	.	.	.	.	.	.	181	29	210	0.8619	0.1381	0.1602
1993	699	45	744	244	11	255	.	.	.	.	.	.	943	56	999	0.9439	0.0561	0.0594
1994*	438	79	517	187	3	190	.	.	.	.	.	.	625	82	707	0.8840	0.1160	0.1312
1995	844	104	948	1115	39	1154	.	.	.	.	.	.	1959	143	2102	0.9320	0.0680	0.0730
1996	516	63	579	461	23	484	.	.	.	.	.	.	977	86	1063	0.9191	0.0809	0.0880
1997	248	47	295	136	20	156	.	.	.	.	.	.	384	67	451	0.8514	0.1486	0.1745
1998	65	19	84	136	56	192	1	4	5	12	1	13	214	80	294	0.7279	0.2721	0.3738
Mean (92-96)	536	64	600	.	.	.	.	.	.	.	.	.	937	79	1016	0.9221	0.0918	0.1024

* Upper trap fished 10 km upstream.

Table 13. Condition of small and large salmon captured.

		LKelt		Large			SKelt			Small					
		Tagged	ALL	Injured	Tagged	ALL	Injured	Tagged	ALL	Brood	Hughes	Injured	Tagged	ALL	ALL
		N	N	N	N	N	N	N	N	N	N	N	N	N	N
RELLOC	WK														
Estuary	22	2	2	.	8	8	1	30	31	.	.	.	.	.	41
	23	3	3	1	37	38	.	13	13	.	.	.	16	16	70
	24	.	.	4	25	29	.	2	2	.	.	2	129	131	162
	25	.	.	.	.	.	.	.	.	.	.	2	12	14	14
	26	.	.	.	1	1	.	.	.	.	1	.	10	11	12
	27	.	.	.	1	1	.	.	.	.	2	2	18	22	23
	28	.	.	.	1	1	.	.	.	3	.	.	4	7	8
	29	.	.	.	.	.	.	.	.	1	1	.	1	3	3
	30	.	.	.	1	1	.	.	.	.	1	1	1	3	4
	32	.	.	1	.	1	.	.	.	.	1	.	4	5	6
	34	.	.	.	.	.	.	.	.	.	1	.	1	2	2
	ALL	5	5	6	74	80	1	45	46	4	7	7	196	214	345
River	WK														
	27	.	.	.	8	8	.	.	.	.	.	1	59	60	68
	28	1	1	12	1	13	.	.	.	.	.	9	130	139	153
	29	.	.	.	.	.	.	.	.	.	.	2	16	18	18
	30	.	.	1	.	1	.	.	.	.	.	.	22	22	23
	ALL	1	1	13	9	22	.	.	.	.	.	12	227	239	262

Table 14. Recapture weeks of small salmon in angling on Humber River, 1998.

		RECGR			ALL
		Retained	Released wo Tag	Unknown	ALL
		N	N	N	N
AREA	RECAPTURE WEEK				
1	26	.	1	.	1
	28	.	1	.	1
	ALL	.	2	.	2
2	RECAPTURE WEEK				
	25	3	.	1	4
	26	2	.	.	2
	27	1	.	.	1
	28	2	.	.	2
	30	1	.	.	1
	31	1	.	.	1
	ALL	10	.	1	11
4	RECAPTURE WEEK				
	29	1	.	.	1
	34	1	.	.	1
	35	1	.	.	1
	ALL	3	.	.	3
ALL	RECAPTURE WEEK				
	25	3	.	1	4
	26	2	1	.	3
	27	1	.	.	1
	28	2	1	.	3
	29	1	.	.	1
	30	1	.	.	1
	31	1	.	.	1
	34	1	.	.	1
	35	1	.	.	1
	ALL	13	2	1	16

Table 15. Recapture location of small salmon angling on Humber River, 1998.

			RECAPTURE LOCATION								
			Adies Stream	Big Falls	Cache Rapids	Dancing Point	Deer Lake	Harrimans	Little Falls	Mistaken Point	ALL
			N	N	N	N	N	N	N	N	N
RELLOC	RECGR	RECWK									
Estuary	Retained	25	.	1	1	.	.	1	.	.	3
		26	.	.	.	.	1	.	.	1	2
		27	.	1	.	.	.	.	.	.	1
		28	.	2	.	.	.	.	.	.	2
		29	.	1	.	.	.	.	.	.	1
		30	.	.	.	.	1	.	.	.	1
		31	.	.	.	1	.	.	.	.	1
		34	1	.	.	.	.	.	.	.	1
		35	.	1	.	.	.	.	.	.	1
		ALL	1	6	1	1	2	1	.	1	13
	Released wo Tag	RECWK									
		26	.	.	.	.	.	.	1	.	1
		28	.	.	1	.	.	.	.	.	1
		ALL	.	.	1	.	.	.	1	.	2
	Unknown	RECWK									
		25	.	1	.	.	.	.	.	.	1
		ALL	.	1	.	.	.	.	.	.	1
	ALL	RECWK									
		25	.	2	1	.	.	1	.	.	4
		26	.	.	.	.	1	.	1	1	3
		27	.	1	.	.	.	.	.	.	1
		28	.	2	1	.	.	.	.	.	3
		29	.	1	.	.	.	.	.	.	1
		30	.	.	.	.	1	.	.	.	1
		31	.	.	.	1	.	.	.	.	1
		34	1	.	.	.	.	.	.	.	1
		35	.	1	.	.	.	.	.	.	1
		ALL	1	7	2	1	2	1	1	1	16

Table 16. Recapture weeks of small salmon in angling on Humber River, 1998.

			RECAPTURE WEEK								
			25	26	27	28	29	30	31	34	35	ALL
			N	N	N	N	N	N	N	N	N	N
RELLOC	RECGR	RELWK										
Estuary	Retained	23	.	1	.	.	.	.	.	.	.	1
		24	3	1	1	.	.	1	1	.	.	7
		26	.	.	.	1	.	.	.	.	.	1
		27	.	.	.	1	1	.	.	1	1	4
		ALL	3	2	1	2	1	1	1	1	1	13
	Released	RELWK										
	wo Tag	24	.	1	.	.	.	.	.	.	.	1
		25	.	.	.	1	.	.	.	.	.	1
		ALL	.	1	.	1	.	.	.	.	.	2
	Unknown	RELWK										
		24	1	.	.	.	.	.	.	.	.	1
		ALL	1	.	.	.	.	.	.	.	.	1
	ALL	RELWK										
		23	.	1	.	.	.	.	.	.	.	1
		24	4	2	1	.	.	1	1	.	.	9
		25	.	.	.	1	.	.	.	.	.	1
		26	.	.	.	1	.	.	.	.	.	1
		27	.	.	.	1	1	.	.	1	1	4
		ALL	4	3	1	3	1	1	1	1	1	16

Table 17. Tag retention rate estimated for angled small salmon on Humber River, 1990-98.

Year	No. Tags	Days at Large			Tag Retention Rate
		Minimum	Maximum	Median	
1990	27	3	52	13.0	0.883
1991	9	3	42	5.0	0.955
1992	27	4	47	12.0	0.892
1993	119	0	80	15.0	0.8650
1994	92	2	77	16.6	0.8506
1995	189	0	71	13.4	0.8794
1996	79	3	72	12.0	0.8920
1997	33	2	40	16.0	0.8560
1998	13	3	57	11.0	0.9010
Total	588	0	80	13.0	0.8830

Table 18. Tag reporting rate by anglers from retained and released small salmon at Big Falls.

Year	Tags Observed	Tags Returned	Tag Reporting Rate
1990*	.	.	0.698
1991*	.	.	0.698
1992	5	4	0.8000
1993**	2	2	0.75
1994	14	9	0.6429
1995	23	14	0.6087
1996	28	17	0.6071
1997	11	7	0.6364
1998	8	4	0.5000
Total (92-98)	91	57	0.6264 (95% CI=0.5275-0.7253)

* Based on ratio of marked to unmarked at North brook fence and in angling.

** Assumed default value.

Table 19. Angling exploitation on small salmon retained on the Humber River, 1990-98.

	Marks		Angling Recaptures		Exploitation Rate	
Year	unadj	adj	unadj	adj	unadj	adj
1990	202	156	27	39	0.13	0.25
1991	55	42	9	13	0.16	0.25
1992	152	117	27	39	0.18	0.25
1993	818	708	119	159	0.15	0.23
1994	596	507	92	143	0.15	0.28
1995	1912	1682	189	310	0.10	0.18
1996	936	835	79	130	0.08	0.16
1997	369	316	33	52	0.09	0.16
1998	196	177	15	24	0.08	0.14

Table 20. Population estimate of small and large salmon on Humber River, 1998.

	Small Salmon							Large Salmon				
	Mark-Recapture Parameters			Pop.	95% CI			Ratio	Pop.	95% CI		
Method	M	C	R	Small	LCL	UCL	UCL-LCL	Large:Small	Large	LCL	UCL	UCL-LCL
1. Total	177	1285	24	9476	6749	14150	7401	0.3738	3542	2523	5289	2766
2a. Big Falls	177	552	13									
2b. Total minus Big Falls	177	733	11	9498	6660	14357	7697	0.3738	3550	2490	5367	2877

Table 21. Atlantic salmon returns, spawning escapements and percentage of the conservation requirement achieved on the Humber River in 1990-98. Catches of small salmon in 1990-97 are based on creel surveys catches in 1998 are based license stub returns.

Conservation egg deposition requirement: 28.3 million eggs

	Estimated Returns			Angling Catch			Spawning Escapement*			% Egg Requirement	95% CI		
				Small		Large							
Year	Small	Large	Total	Retained	Released	Released	Small	Large	Total	Achieved**	LCL	UCL	CL-LCL
1990	12,216	855	13,071	3,054	.	75	9,162	848	10,010	60			
1991	5,724	401	6,125	1,431	53	11	4,288	400	4,687	27			
1992	17,571	2,945	20,516	4,349	317	177	13,191	2,927	16,118	117			
1993	18,477	636	19,113	4,161	303	125	14,286	624	14,909	96			
1994	7,995	1,030	9,025	2,523	1,438	166	5,328	1,013	6,342	40			
1995	27,898	2,064	29,963	5,150	1,881	233	22,560	2,041	24,601	128			
1996	30,445	2,679	33,125	4,740	3,016	237	25,404	2,655	28,059	186			
1997	14,866	2,595	17,461	2,447	1,433	133	12,276	2,582	14,857	115	91	169	78
1998	9,476	3,542	13,018	1,285	1,695	459	8,022	3,496	11,518	88	60	135	75
Mean (92-96)	20,477	1,871	22,348	4,185	1,391	188	16,154	1,852	18,006	113			

* Spawning escapements are adjusted for 10% mortality on released fish.

** Percentage egg requirement achieved in 1990 is based on biological characteristics from Porter and Chadwick, 1983.

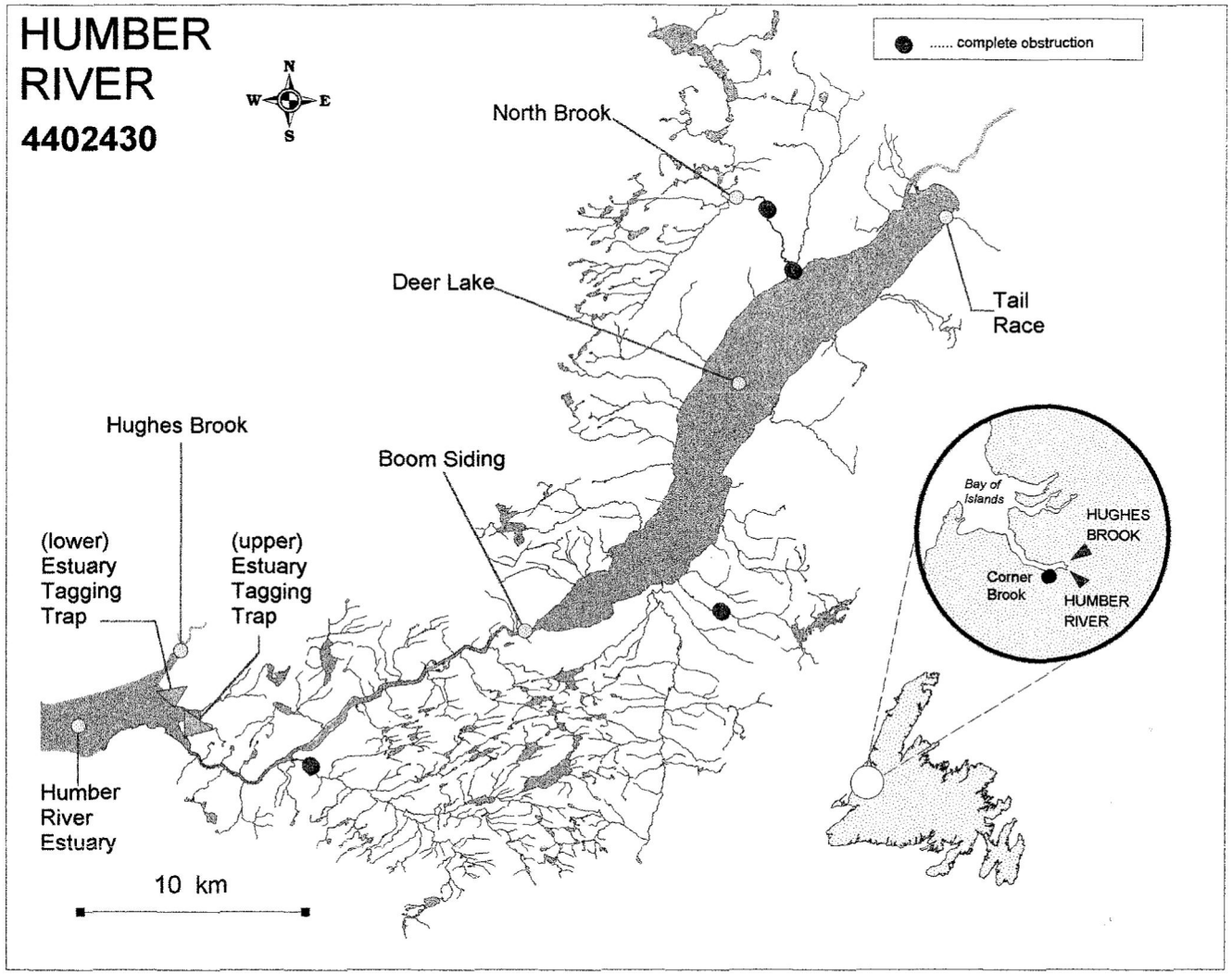


Figure 1. Location of major features of the lower portion of the Humber River, Newfoundland.

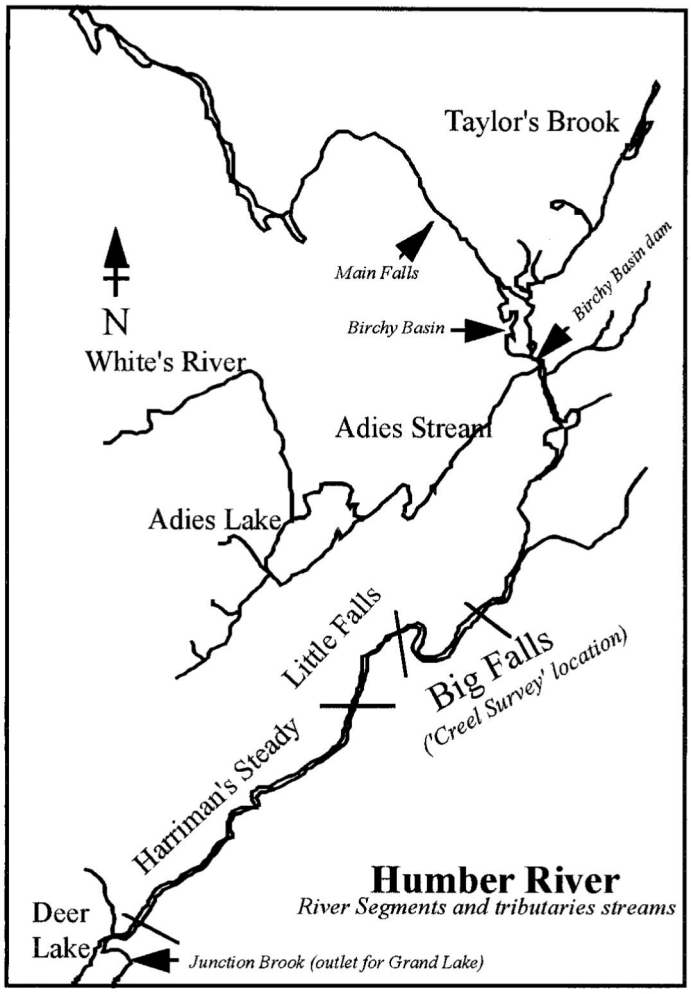


Figure 2. River segments of the Humber River, upstream of Deer Lake and showing the Big Falls Creel Survey location.

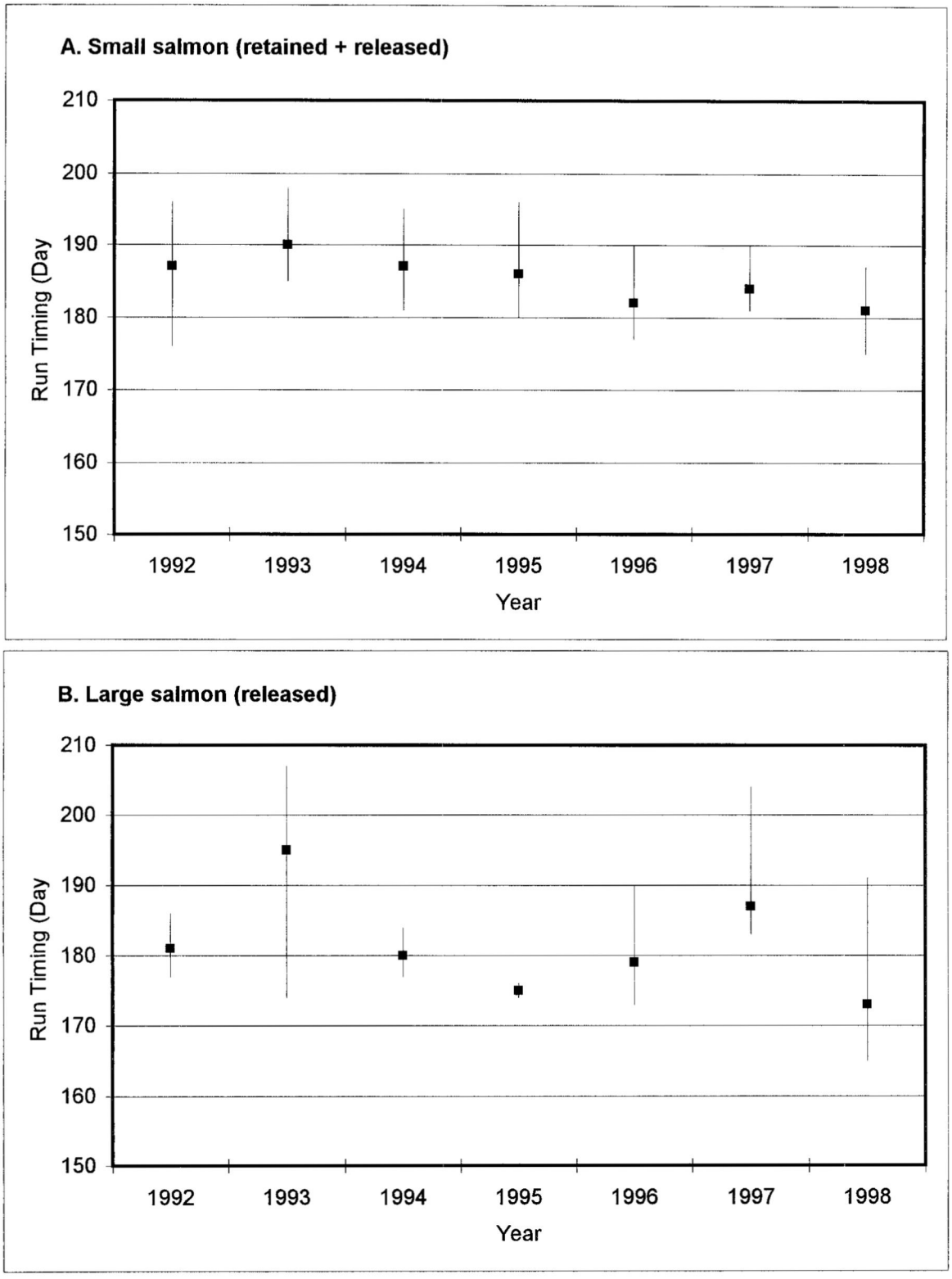
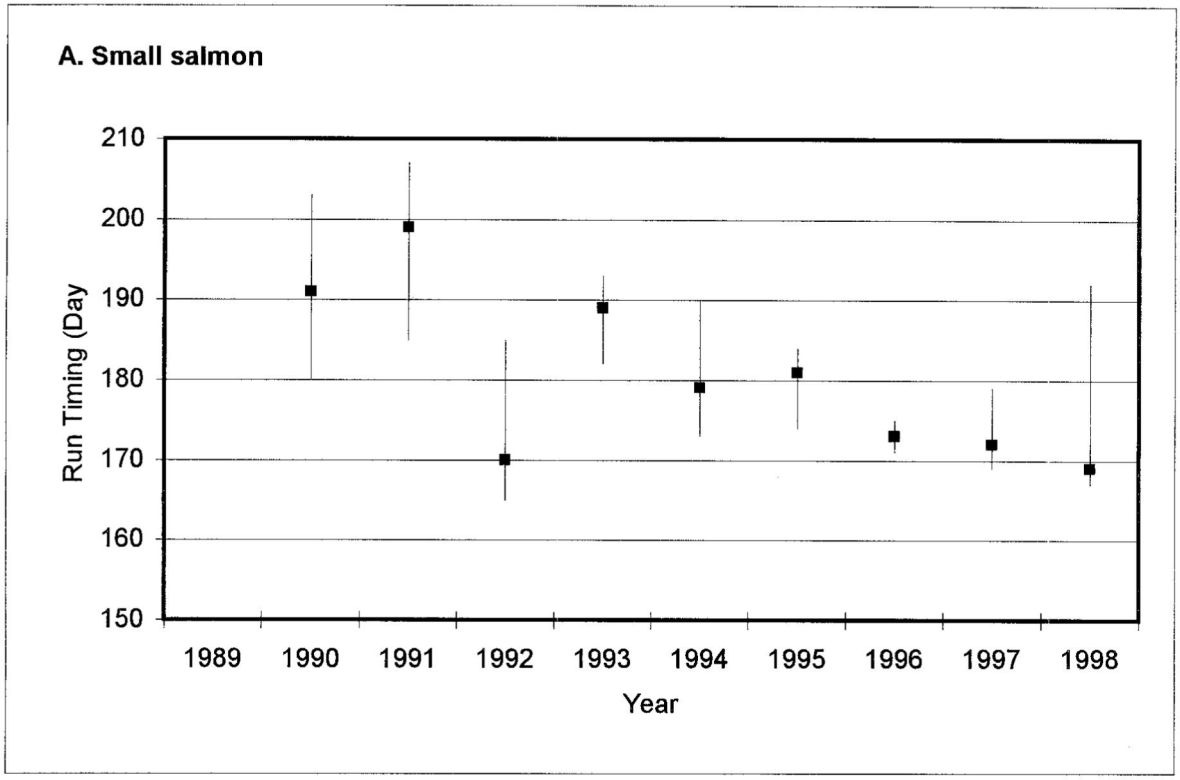


Figure 3. Run timing of small and large salmon in the recreational fishery at Big Falls on the Humber River, 1992-98.



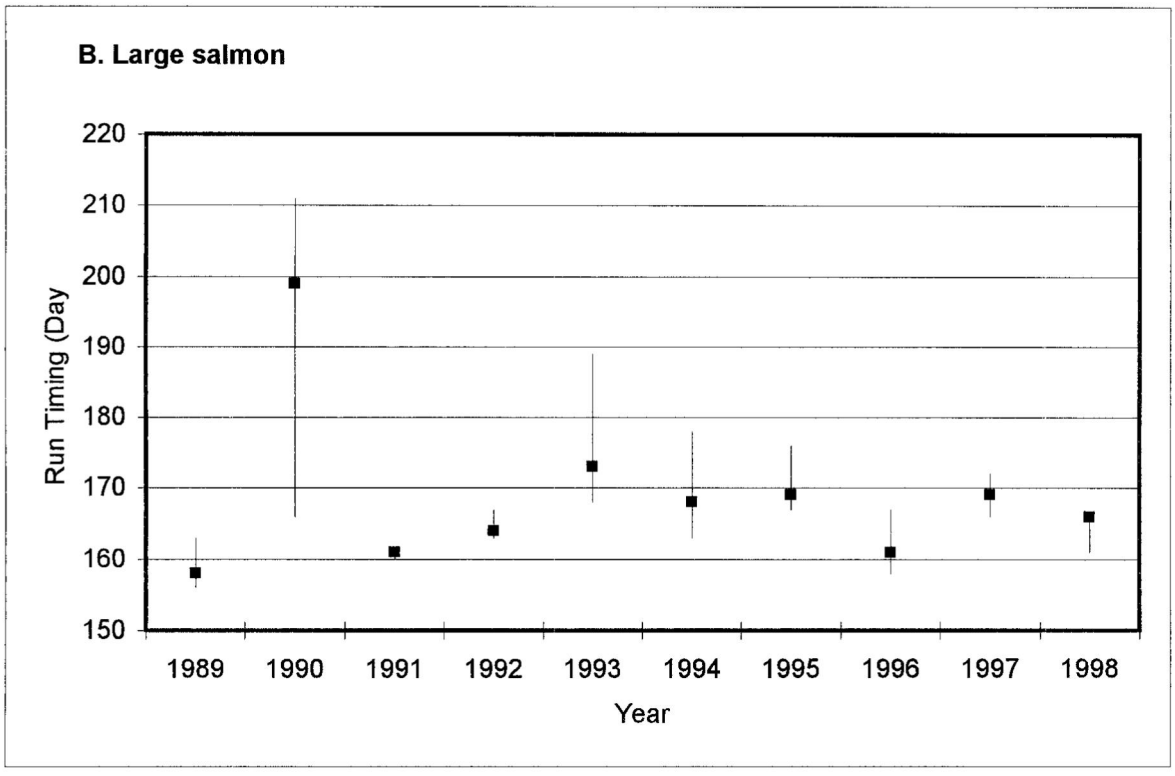


Figure 4. Run timing of small and large salmon in the lower tagging trap operated in the estuary of the Humber River, 1992-98.

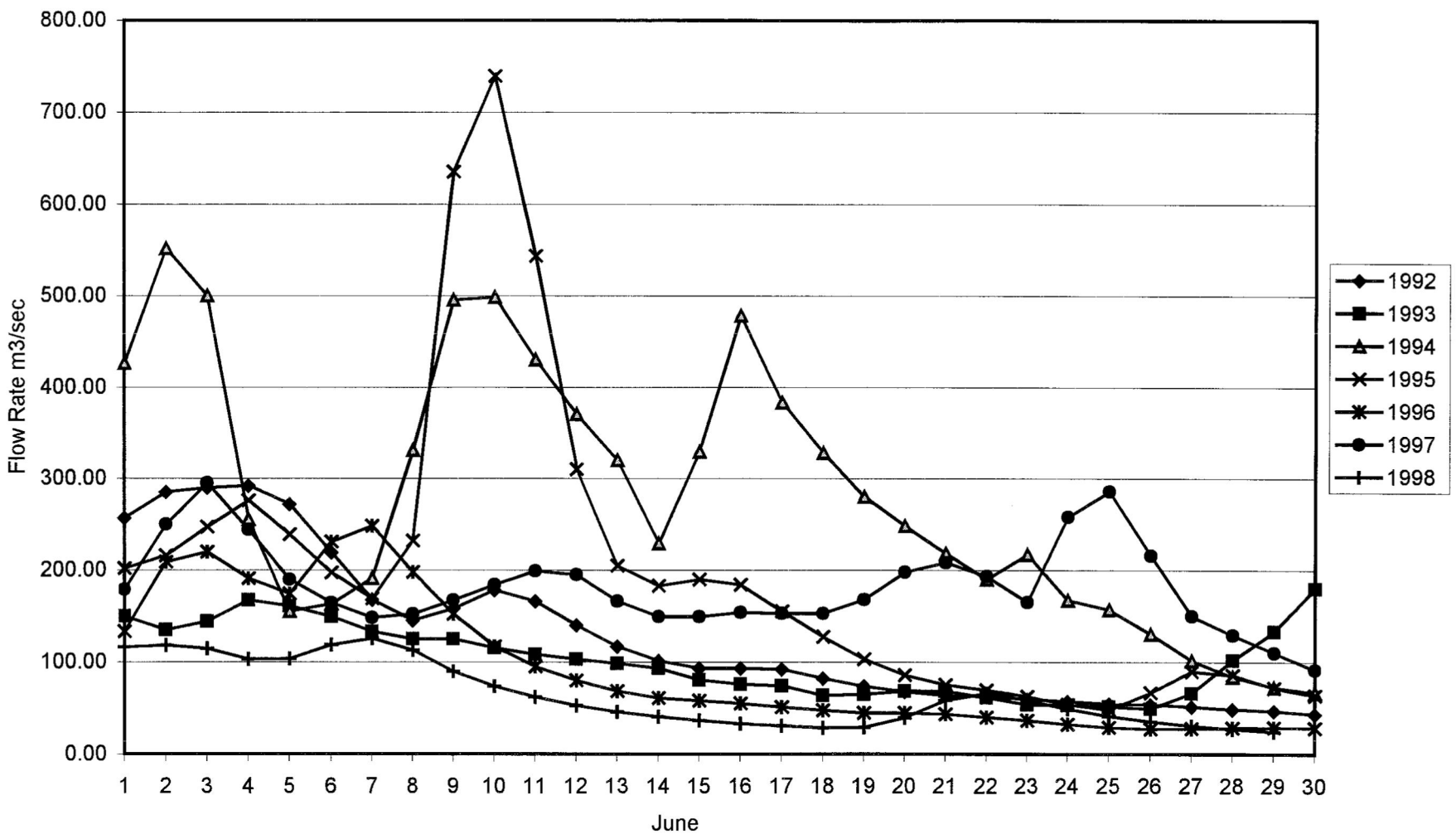


Figure 5. Water discharge rate on upper Humber River, 1992-98.

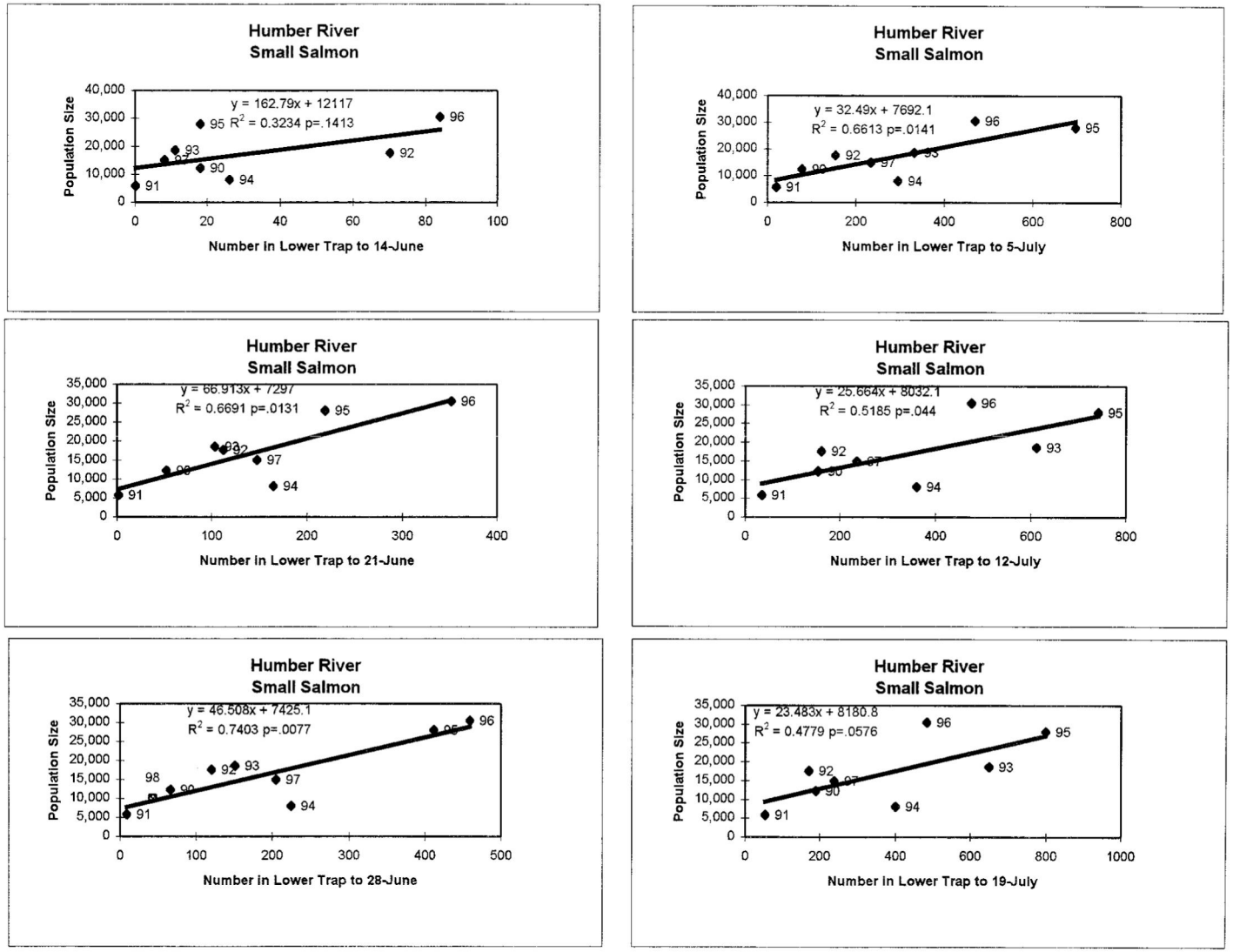


Figure 6. Results of regression analysis of the population size of small salmon and cumulative weekly counts in the lower tagging trap.

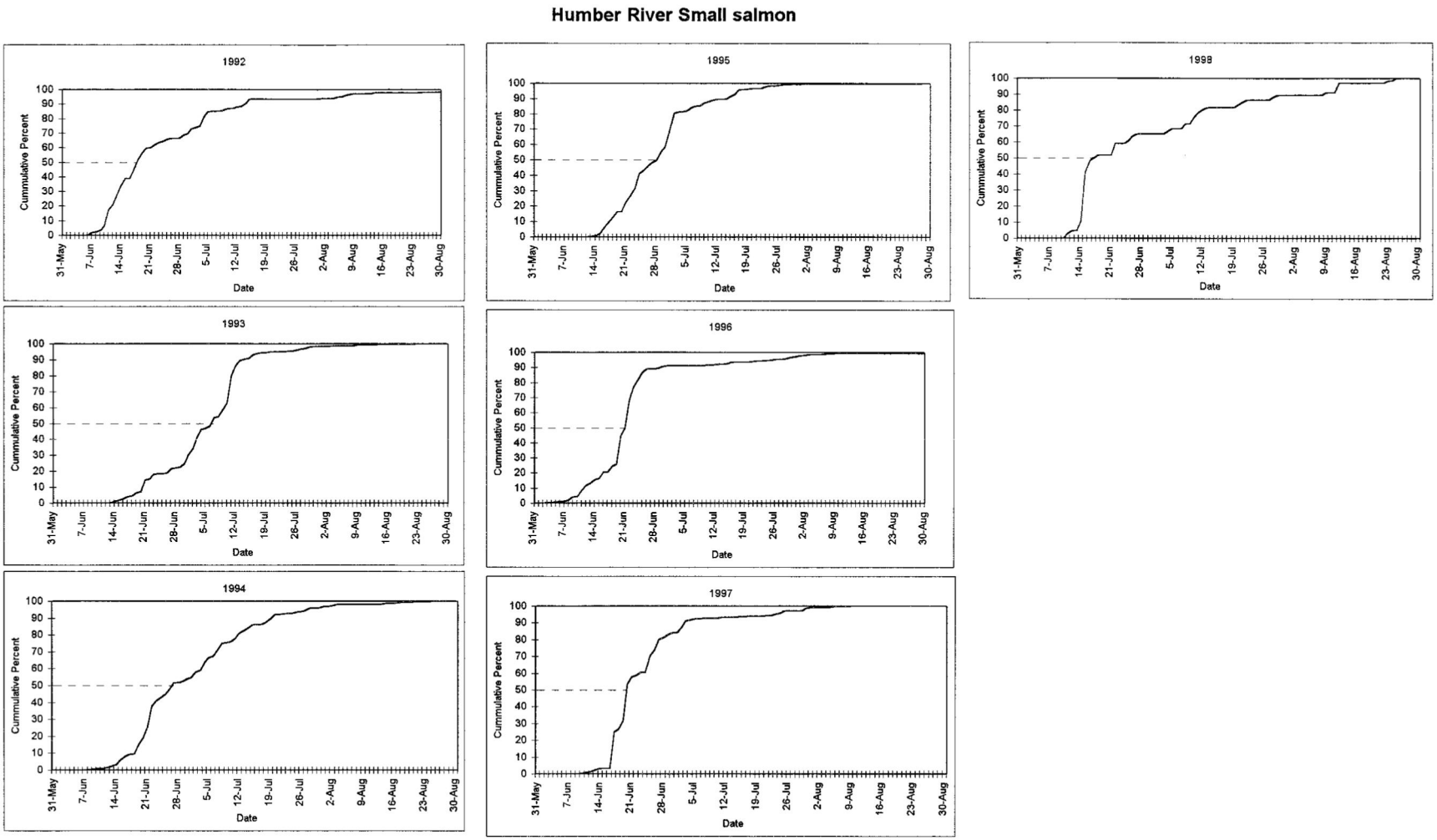


Figure 7. Cumulative daily percentage of small salmon caught in the lower tagging trap operated in the estuary of the Humber River, 1992-98. Horizontal line represents 50% of the total cumulative catch.

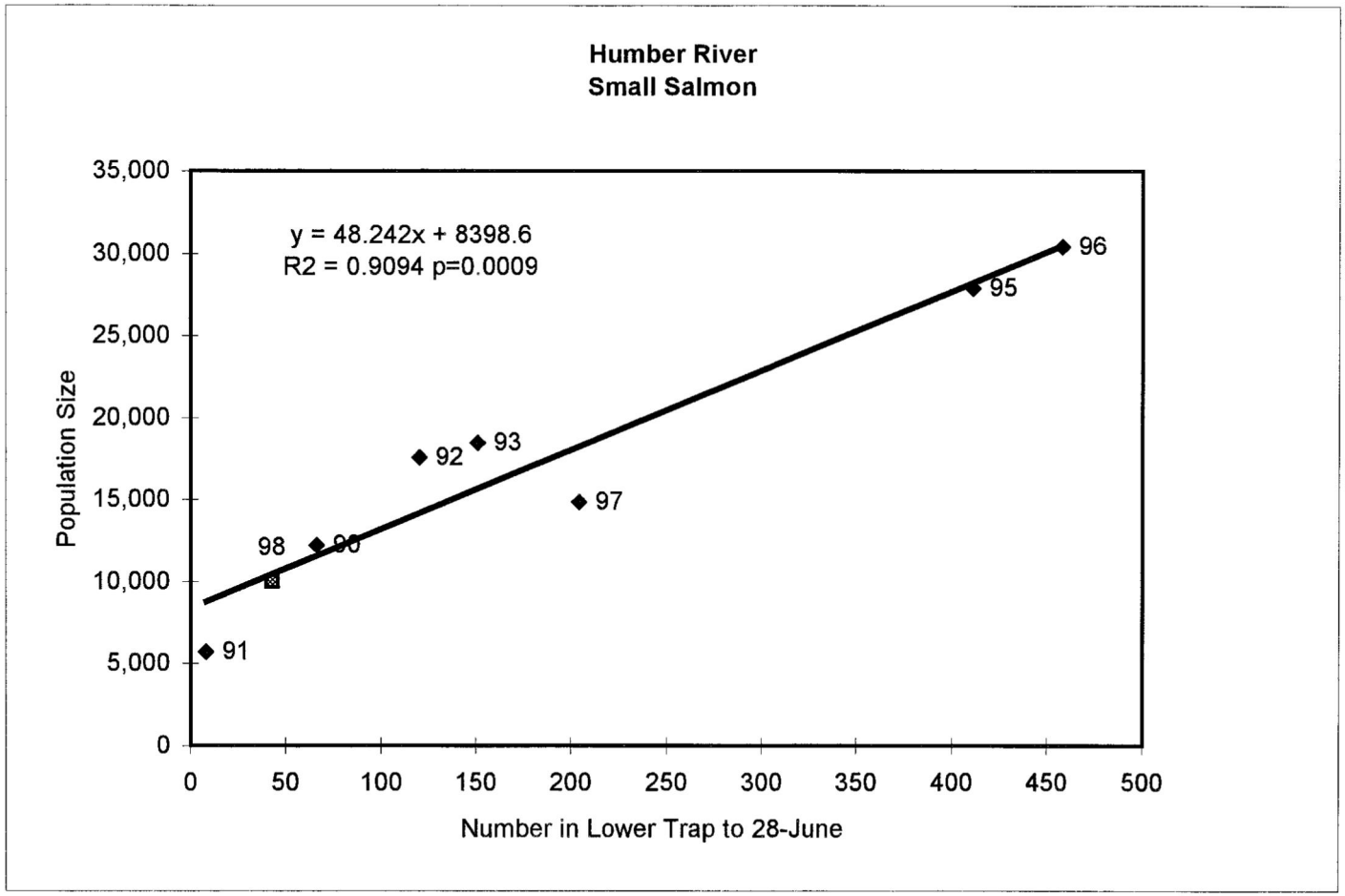
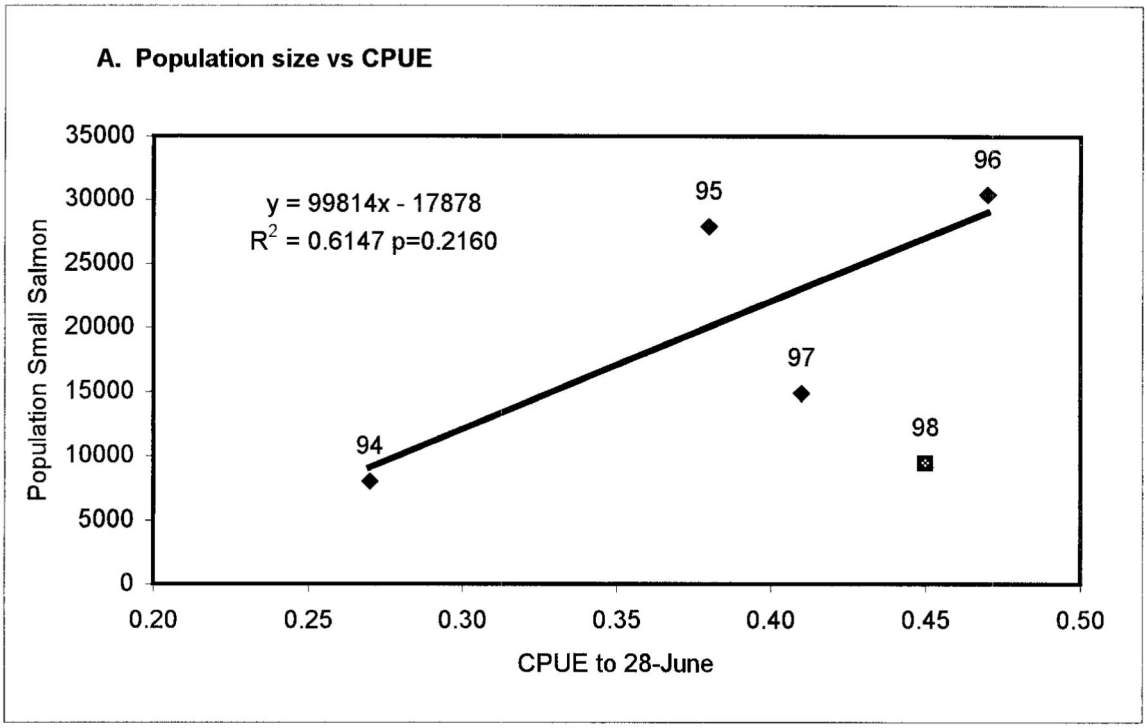


Figure 8. Relationship between the total population size of small salmon and cumulative catch of small salmon to 28 June in the lower tagging trap operated in the estuary of the Humber River, 1992-97. The 1998 data point was not included in the regression.



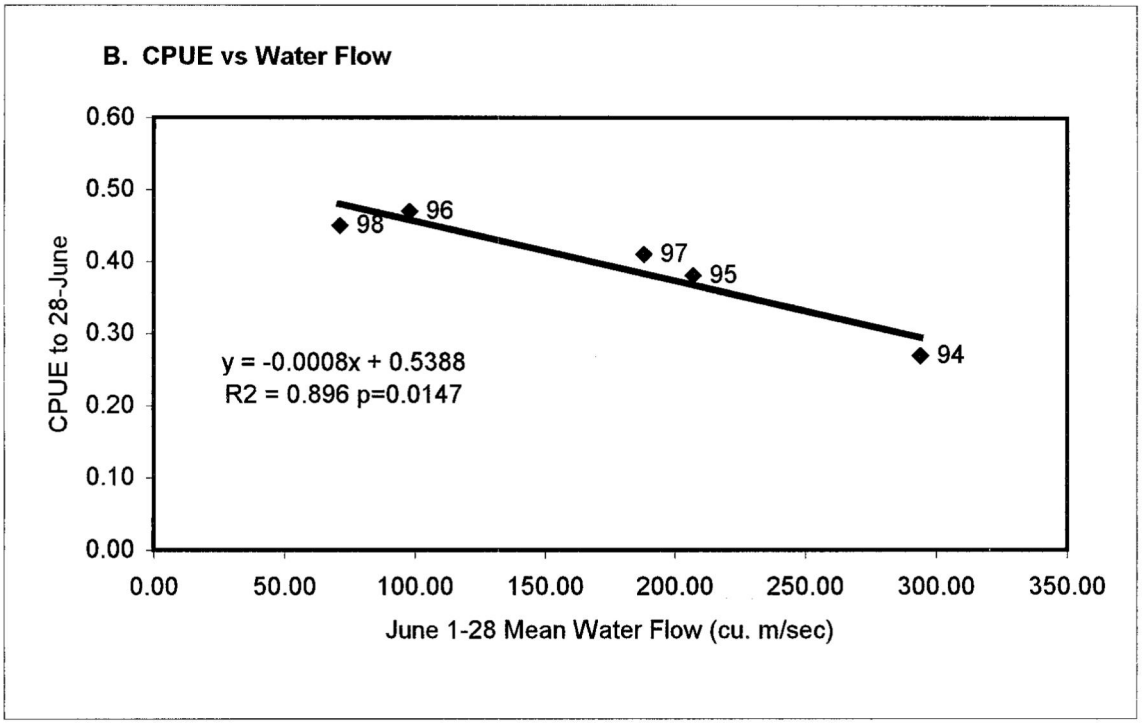


Figure 9. Relationship between the total population size of small salmon and catch per unit of effort (CPUE) on small salmon to 28 June at Big Falls and between CPUE to 28 June and water flow rate on the Humber River, 1994-97. Notes: the 1998 data point was not included in the regression of total population size on CPUE; angling effort is measured in rod days; and water flow data was provided by Environment Canada from guaging station located on the upper Humber River near the community of Reidville.

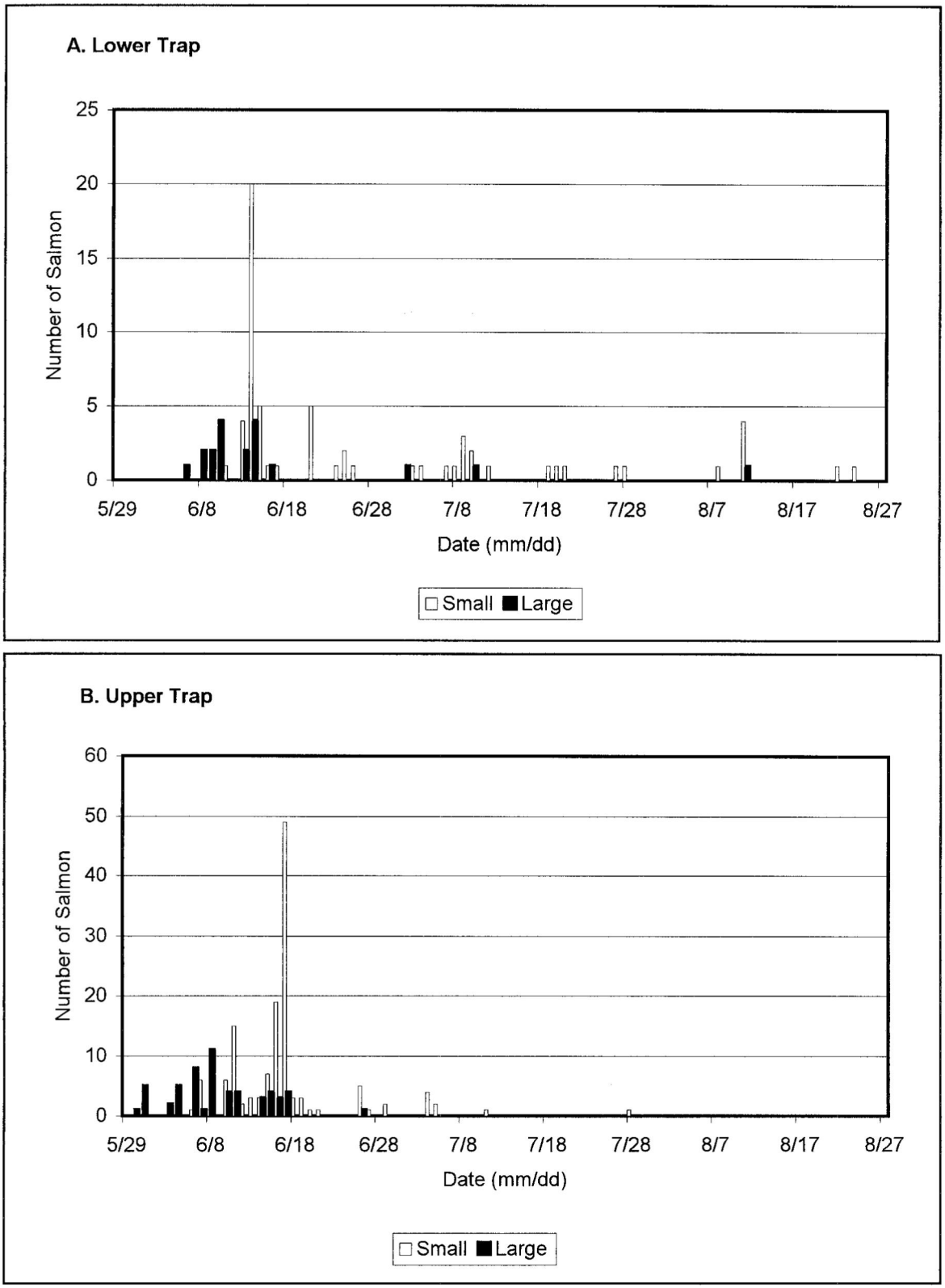
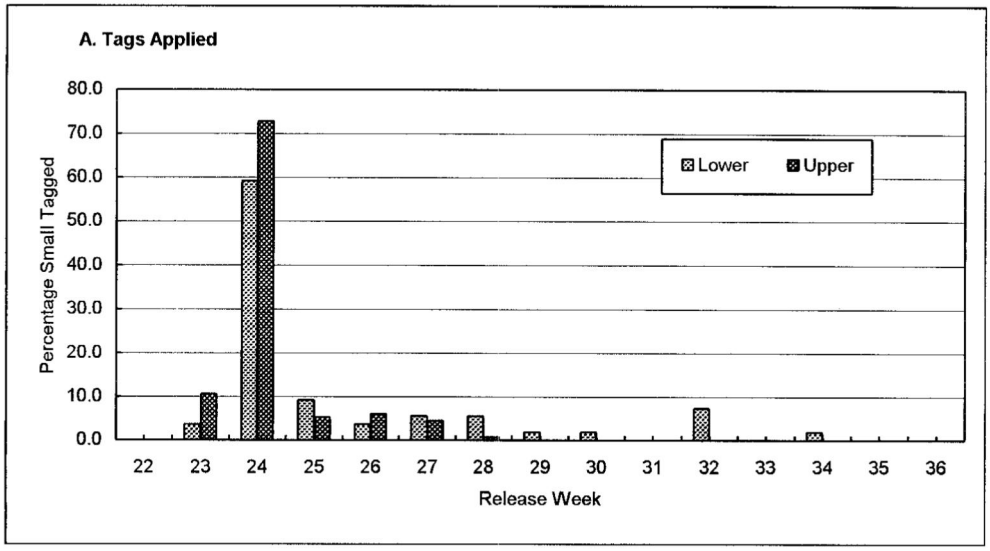
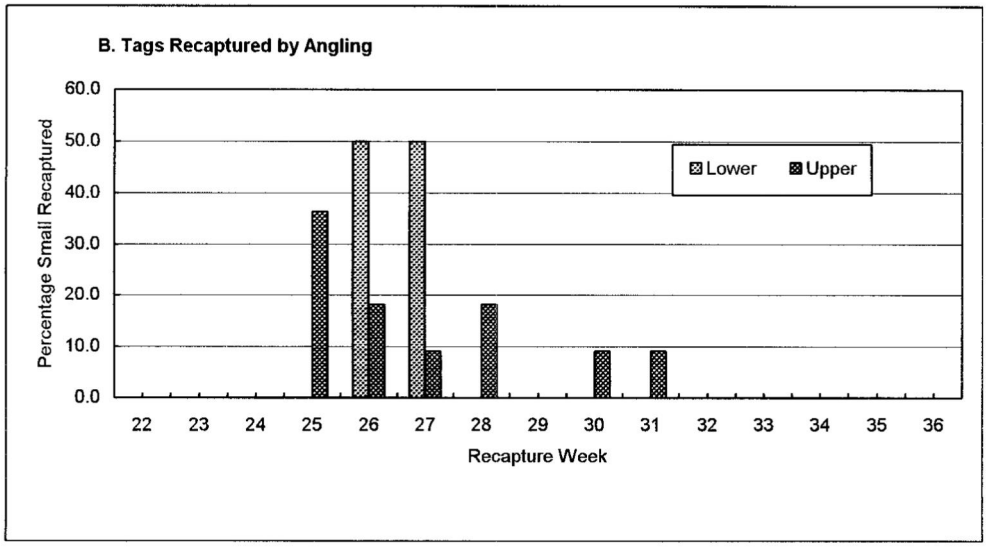


Figure 10. Daily catches of small and large salmon at two tagging traps operated in the estuary of the Humber River, 1998.





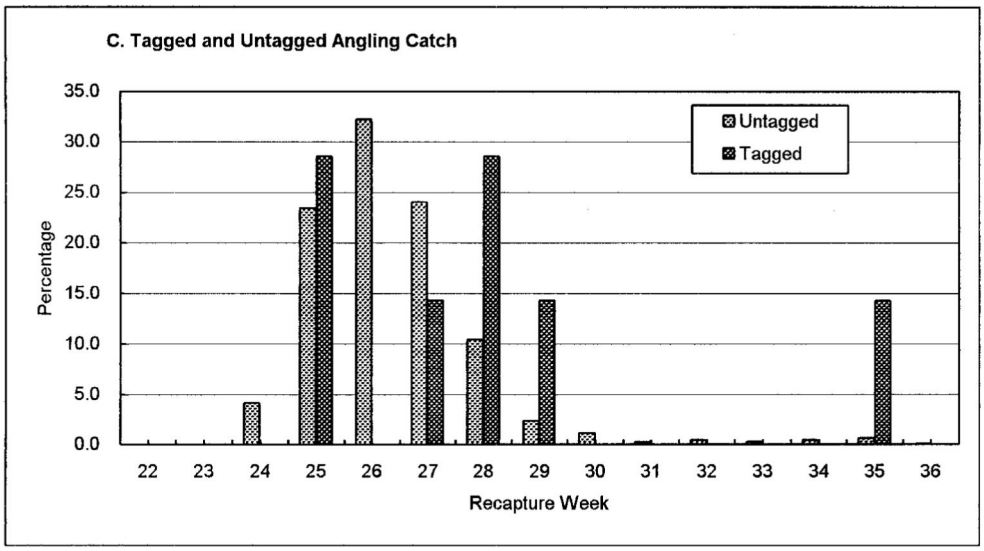


Figure 11. Weekly distribution of tag applications and tag recaptures by angling of both tagged and untagged retained small salmon on the Humber River, 1998.

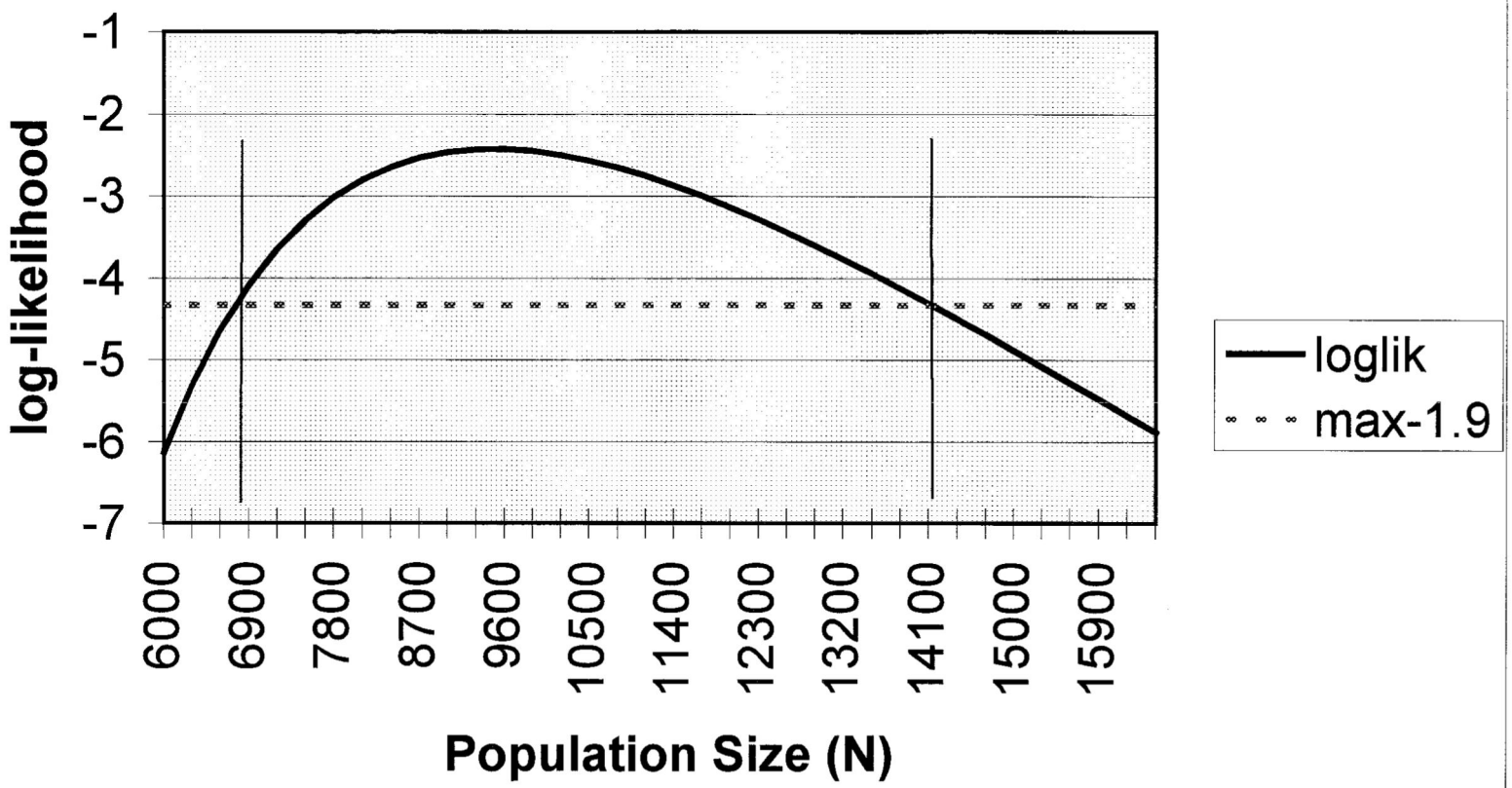
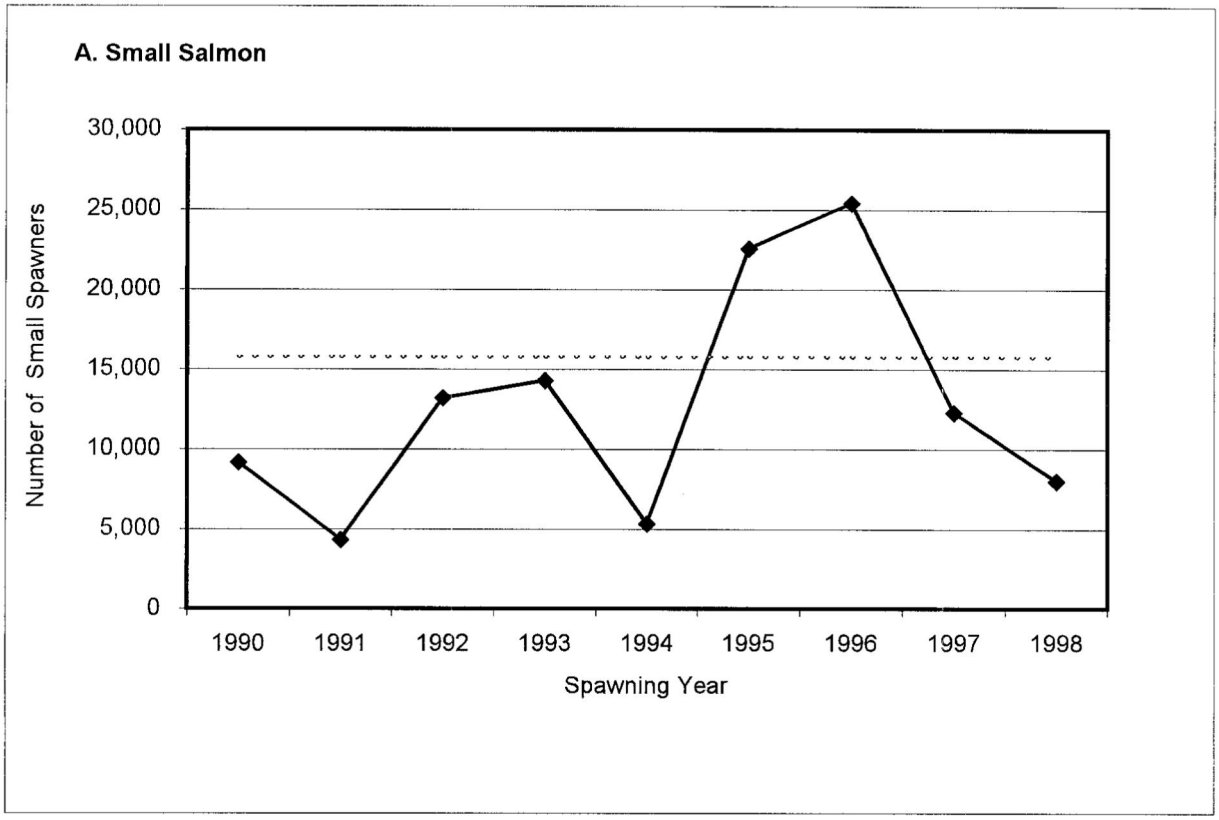


Figure 12. Peterson-Chapman log-likelihood distribution for Humber River data, 1998. Horizontal line represents the 95% confidence level. Vertical lines represent the lower and upper confidence limits.



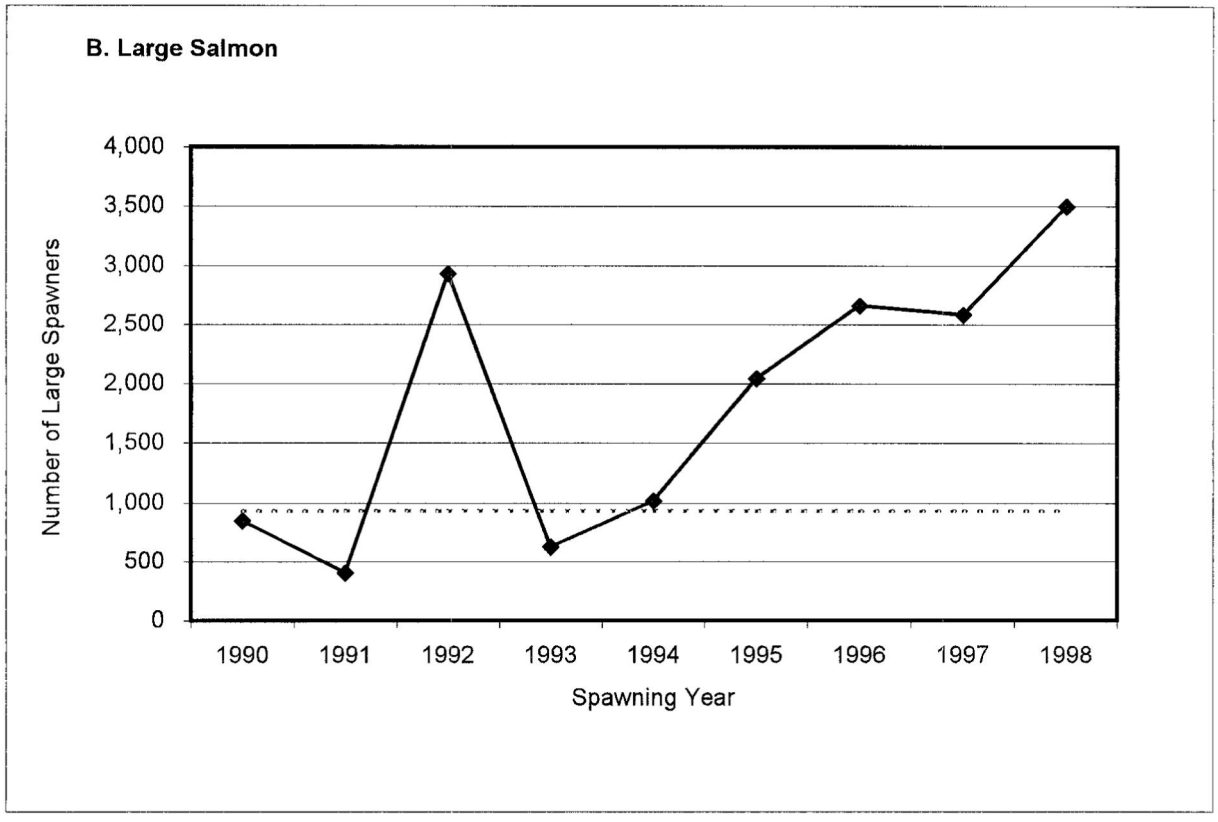


Figure 13. Small and large salmon spawners on the Humber River, 1990-98. Horizontal dashed lines represent conservation requirements in terms of spawners.

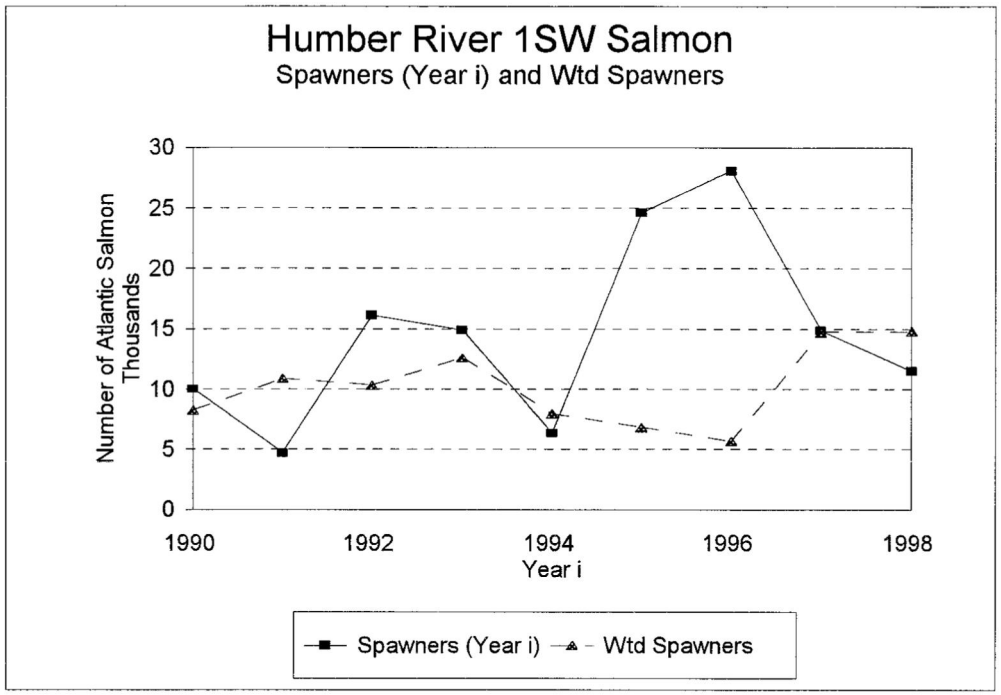


Figure 14. Relationship between total spawners in Year i and spawner recruits adjusted for yearclass (wtd spawners).

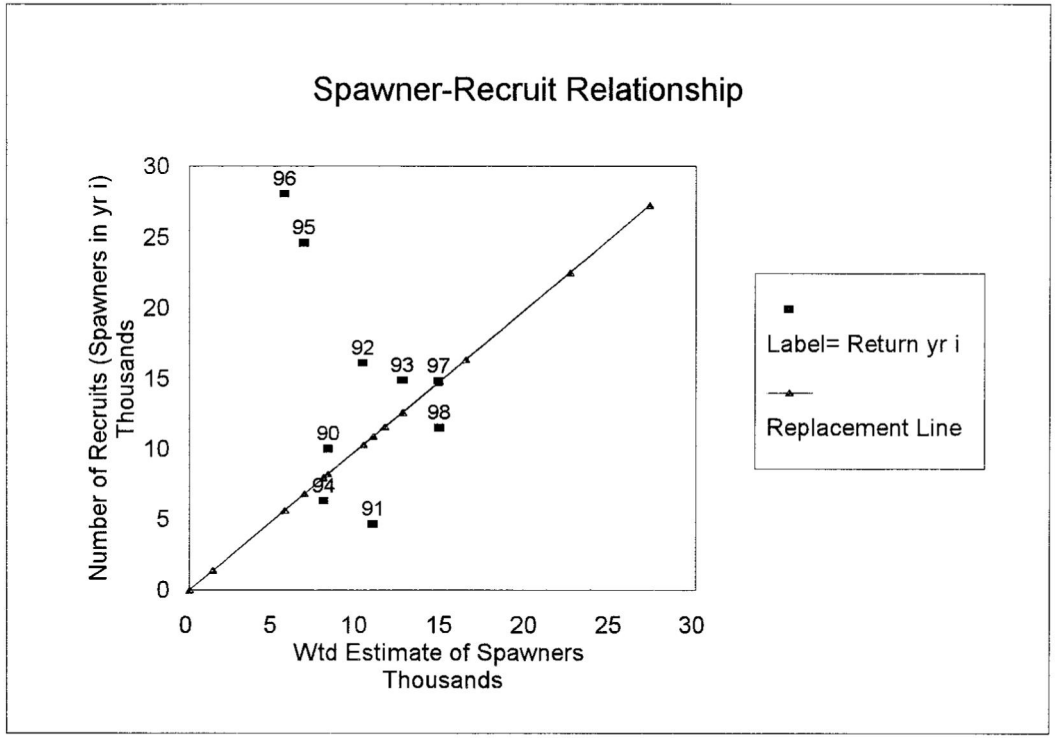


Figure 15. Relationship between 1SW salmon spawners and recruits on the Humber River.

Appendix 1. Recreational effort and catch on the Humber River 1974-1998.

	Effort	Small (<63cm)			Large (>=63cm)			Total (Small+Large)			
Year	(Rod days)	Retained	Released	Total	Retained	Released	Total	Retained	Released	Total	CPUE
1974	8976	2742	.	2742	107	.	107	2849		2849	0.32
1975	9611	6147	.	6147	114	.	114	6261		6261	0.65
1976	10489	5102	.	5102	61	.	61	5163		5163	0.49
1977	6127	2158	.	2158	45	.	45	2203		2203	0.36
1978	7633	2722	.	2722	187	.	187	2909		2909	0.38
1979	7961	3343	.	3343	27	.	27	3370		3370	0.42
1980	8292	3512	.	3512	303	.	303	3815		3815	0.46
1981	8701	4132	.	4132	153	.	153	4285		4285	0.49
1982	8737	4287	.	4287	95	.	95	4382		4382	0.50
1983	7746	3110	.	3110	47	.	47	3157		3157	0.41
1984	7189	2872	.	2872	40	.	40	2912		2912	0.41
1985	7211	2430	.	2430	*	11	11	2430	11	2441	0.34
1986	8635	3456	.	3456	*	232	232	3456	232	3688	0.43
1987	7250	3074	.	3074	*	113	113	3074	113	3187	0.44
1988	8521	4042	.	4042	*	144	144	4042	144	4186	0.49
1989	6279	1217	.	1217	*	10	10	1217	10	1227	0.20
1990	6918	3021	.	3021	*	75	75	3054	75	3096	0.45
1991	5770	1431	.	1431	*	11	11	1431	11	1442	0.25
1992	6072	2234	194	2428	*	177	177	2234	371	2605	0.43
1993	7023	2206	601	2807	*	125	125	2206	726	2932	0.42
1994	5687	1548	463	2011	*	166	166	1548	629	2177	0.38
1995	6855	1825	705	2530	*	233	233	1825	938	2763	0.40
1996	8978	2448	1350	3798	*	237	237	2448	1587	4035	0.45
1997**		2429	2788	5217	*	505	505	2429	3293	5722	
1998**		1285	1695	2980	*	459	459	1285	2154	3439	
Mean 84-8	7514.2	2848.5	.	2848.5	.	102.0	91.7	2855.2	102.0	2940.2	0.38
95%CL	946.2	1015.7	.	1015.7	.	117.0	92.4	1016.0	117.0	1086.4	0.10
N	6	6	.	6	0	6	6	6	5	6	6
Mean 86-9	7228.8	2706.8		2706.8	.	97.5	97.5	2712.3	97.5	2804.3	0.38
95%CL	1221.7	1189.8	.	1189.8	.	89.2	89.2	1189.8	89.2	1265.2	0.12
N	6	6	.	6	.	6	6	6	6	6	6
Mean 92-9	6923.0	2052.2	662.6	2714.8	.	187.6	187.6	2052.2	850.2	2902.4	0.42
95%CL	1851.3	447.3	533.1	831.3	.	58.9	58.9	447.3	570.5	859.6	0.03
N	5	5	5	5	.	5	5	5	5	5	5

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

AND CPUE IS BASED ON RETAINED+RELEASED FISH FOR 1985-1996 AND ON RETAINED FISH ONLY PRIOR TO 1985.

*NOT ALLOWED TO RETAIN LARGE SALMON IN INSULAR NEWFOUNDLAND

**DATA OBTAINED FROM THE LICENSE STUB RETURN.

Appendix 2. Mean fork length, weight and sex composition of small and large female Atlantic salmon caught by angling on the Humber River, 1988-98.
Sex was determined from internal examination.

Angling

		FORK LENGTH (cm)					WHOLE WEIGHT FEMALES (kg)					NO.	PERCENT FEMALE	
		N	MEAN	MIN	MAX	STD	N	MEAN	MIN	MAX	STD	SEXED	N	%
Large	YY													
	88	1	63.2	63.2	63.2	.	0	.	.	.	.	0	0	.
	90	1	63.5	63.5	63.5	.	0	.	.	.	.	1	1	100.0
	92	3	63.0	63.0	63.0	0.0	1	2.7	2.7	2.7	.	2	1	50.0
	93	1	63.0	63.0	63.0	.	1	2.4	2.4	2.4	.	1	1	100.0
	94	3	63.0	63.0	63.0	0.0	0	.	.	.	.	0	0	.
	96	6	69.7	63.0	93.5	12.2	2	2.2	2.0	2.3	0.2	5	3	60.0
	97	4	63.3	63.0	64.0	0.5	0	.	.	.	.	2	0	.
	98	2	63.0	63.0	63.0	0.0	0	.	.	.	.	0	0	.
	1984-91	2	63.4	63.2	63.5	0.2	0	.	.	.	.	1	1	100.0
	1992-98	19	65.2	63.0	93.5	7.2	4	2.4	2.0	2.7	0.3	10	5	50.0
	Total	21	65.0	63.0	93.5	6.8	4	2.4	2.0	2.7	0.3	11	6	54.5
Small	YY													
	88	72	55.7	48.0	62.0	3.0	0	.	.	.	.	0	0	.
	89	149	54.3	43.3	62.0	3.0	9	1.4	1.0	1.8	0.3	86	37	43.0
	90	54	56.4	49.0	62.5	3.3	0	.	.	.	.	27	19	70.4
	91	164	54.3	45.7	62.0	2.7	65	1.6	1.2	2.5	0.2	130	66	50.8
	92	357	56.1	48.5	62.5	2.6	57	1.9	1.5	2.5	0.3	254	138	54.3
	93	127	55.6	48.0	62.5	2.9	49	1.7	1.0	2.4	0.3	83	56	67.5
	94	372	55.6	48.0	62.8	2.9	21	1.7	1.3	2.4	0.3	112	57	50.9
	95	119	55.5	48.0	62.0	2.7	18	1.6	1.2	1.9	0.2	73	37	50.7
	96	294	55.6	47.0	62.5	2.7	109	1.8	1.1	2.8	0.3	187	112	59.9
	97	173	56.8	47.0	62.5	2.8	34	2.0	1.1	3.0	0.4	114	68	59.6
	98	177	55.5	47.5	62.0	2.8	21	1.8	0.8	2.5	0.4	78	39	50.0
	1984-91	439	54.8	43.3	62.5	3.0	74	1.6	1.0	2.5	0.2	243	122	50.2
	1992-98	1619	55.8	47.0	62.8	2.8	309	1.8	0.8	3.0	0.3	901	507	56.3
	Total	2058	55.6	43.3	62.8	2.9	383	1.8	0.8	3.0	0.3	1144	629	55.0

Appendix 3. Mean fork length, weight and sex composition of small and large female Atlantic salmon captured in tagging traps operated in the estuary of the Humber River, 1988-98. Sex was determined from internal examination.

Estuary Traps

		FORK LENGTH (cm)					WHOLE WEIGHT FEMALES (kg)					NO.	PERCENT FEMALE	
		N	MEAN	MIN	MAX	STD	N	MEAN	MIN	MAX	STD	SEXED	N	%
Large	YY													
	89	5	75.6	71.5	77.5	2.4	0	.	.	.	.	5	5	100.0
	90	22	72.6	63.0	92.0	8.3	0	.	.	.	.	0	0	.
	91	4	77.5	75.5	80.0	2.1	0	.	.	.	.	0	0	.
	92	29	75.2	63.6	91.0	5.2	0	.	.	.	.	0	0	.
	93	56	72.6	63.2	90.6	6.0	1	5.0	5.0	5.0	.	1	1	100.0
	94	82	74.1	63.0	88.5	5.8	0	.	.	.	.	0	0	.
	95	143	75.8	63.1	115.0	5.9	0	.	.	.	.	0	0	.
	96	86	75.8	63.5	93.1	6.3	0	.	.	.	.	0	0	.
	97	73	75.5	63.5	89.2	5.3	0	.	.	.	.	0	0	.
	98	80	77.6	65.3	93.4	5.6	0	.	.	.	.	0	0	.
	1984-91	31	73.7	63.0	92.0	7.3	0	.	.	.	.	5	5	100.0
	1992-98	549	75.4	63.0	115.0	5.9	1	5.0	5.0	5.0	.	1	1	100.0
	Total	580	75.3	63.0	115.0	6.0	1	5.0	5.0	5.0	.	6	6	100.0
Small	YY													
	89	2	52.5	51.4	53.5	1.5	0	.	.	.	.	0	0	.
	90	255	54.7	43.9	62.8	3.7	0	.	.	.	.	29	21	72.4
	91	102	52.3	37.3	61.3	3.5	24	1.3	0.9	1.9	0.2	39	27	69.2
	92	181	53.7	34.7	62.0	3.3	14	1.8	1.0	2.8	0.5	22	17	77.3
	93	937	53.4	38.3	62.6	2.9	37	1.4	1.0	2.6	0.3	59	40	67.8
	94	624	53.2	44.0	62.8	2.8	4	2.0	1.5	2.3	0.4	9	4	44.4
	95	1958	52.9	39.4	62.9	2.6	0	.	.	.	.	5	3	60.0
	96	977	53.4	40.0	62.8	2.8	3	2.2	1.8	2.7	0.5	5	3	60.0
	97	404	54.5	45.7	62.7	2.8	0	.	.	.	.	0	0	.
	98	225	54.4	46.2	62.9	2.8	0	.	.	.	.	0	0	.
	1984-91	359	54.0	37.3	62.8	3.8	24	1.3	0.9	1.9	0.2	68	48	70.6
	1992-98	5306	53.3	34.7	62.9	2.8	58	1.6	1.0	2.8	0.4	100	67	67.0
	Total	5665	53.4	34.7	62.9	2.9	82	1.5	0.9	2.8	0.4	168	115	68.5

Appendix 4. Smolt-age distribution of small and large Atlantic salmon caught by angling on the Humber River, 1988-98. Virgin spawners only.

Angling

		SMOLT-AGE												Total		
		2			3			4			5					
		N	%	MEAN	N	%	MEAN	N	%	MEAN	N	%	MEAN	N	%	MEAN
Large	YY															
	88	.	.	.	1	100.0	3.0	.	.	.	.	.	.	1	100.0	3.0
	90	.	.	.	1	100.0	3.0	.	.	.	.	.	.	1	100.0	3.0
	92	.	.	.	2	66.7	3.0	1	33.3	4.0	.	.	.	3	100.0	3.3
	94	.	.	.	2	66.7	3.0	1	33.3	4.0	.	.	.	3	100.0	3.3
	96	.	.	.	3	100.0	3.0	.	.	.	.	.	.	3	100.0	3.0
	97	.	.	.	1	33.3	3.0	2	66.7	4.0	.	.	.	3	100.0	3.7
	1984-91	.	.	.	2	100.0	3.0	.	.	.	.	.	.	2	100.0	3.0
	1992-98	.	.	.	8	66.7	3.0	4	33.3	4.0	.	.	.	12	100.0	3.3
	Total	.	.	.	10	71.4	3.0	4	28.6	4.0	.	.	.	14	100.0	3.3
Small	YY															
	88	2	2.6	2.0	48	62.3	3.0	27	35.1	4.0	.	.	.	77	100.0	3.3
	89	7	5.6	2.0	95	75.4	3.0	23	18.3	4.0	1	0.8	5.0	126	100.0	3.1
	90	2	3.6	2.0	32	58.2	3.0	21	38.2	4.0	.	.	.	55	100.0	3.3
	91	10	6.0	2.0	132	78.6	3.0	26	15.5	4.0	.	.	.	168	100.0	3.1
	92	9	2.6	2.0	282	82.7	3.0	50	14.7	4.0	.	.	.	341	100.0	3.1
	93	2	1.6	2.0	97	75.2	3.0	30	23.3	4.0	.	.	.	129	100.0	3.2
	94	4	1.2	2.0	183	55.6	3.0	141	42.9	4.0	1	0.3	5.0	329	100.0	3.4
	95	.	.	.	60	54.5	3.0	50	45.5	4.0	.	.	.	110	100.0	3.5
	96	.	.	.	145	50.7	3.0	133	46.5	4.0	8	2.8	5.0	286	100.0	3.5
	97	2	1.2	2.0	124	74.3	3.0	38	22.8	4.0	3	1.8	5.0	167	100.0	3.3
	98	.	.	.	106	60.9	3.0	68	39.1	4.0	.	.	.	174	100.0	3.4
	1984-91	21	4.9	2.0	307	72.1	3.0	97	22.8	4.0	1	0.2	5.0	426	100.0	3.2
	1992-98	17	1.1	2.0	997	64.9	3.0	510	33.2	4.0	12	0.8	5.0	1536	100.0	3.3
	Total	38	1.9	2.0	1304	66.5	3.0	607	30.9	4.0	13	0.7	5.0	1962	100.0	3.3

Appendix 5. Smolt-age distribution of small and large Atlantic salmon captured in tagging traps operated in the estuary of the Humber River, 1989-98. Virgin spawners only.

Estuary Traps

		SMOLT-AGE															Total		
		2			3			4			5			6					
		N	%	MEAN	N	%	MEAN	N	%	MEAN	N	%	MEAN	N	%	MEAN	N	%	MEAN
Large	YY																		
	89	.	.	.	2	100.0	3.0	.	.	.	.	.	.	.	.	.	2	100.0	3.0
	90	1	7.7	2.0	9	69.2	3.0	3	23.1	4.0	.	.	.	.	.	.	13	100.0	3.2
	92	2	9.1	2.0	19	86.4	3.0	1	4.5	4.0	.	.	.	.	.	.	22	100.0	3.0
	93	4	13.8	2.0	22	75.9	3.0	3	10.3	4.0	.	.	.	.	.	.	29	100.0	3.0
	94	.	.	.	16	55.2	3.0	13	44.8	4.0	.	.	.	.	.	.	29	100.0	3.4
	95	.	.	.	29	47.5	3.0	32	52.5	4.0	.	.	.	.	.	.	61	100.0	3.5
	96	.	.	.	22	61.1	3.0	14	38.9	4.0	.	.	.	.	.	.	36	100.0	3.4
	97	1	7.1	2.0	6	42.9	3.0	7	50.0	4.0	.	.	.	.	.	.	14	100.0	3.4
	98	.	.	.	11	84.6	3.0	2	15.4	4.0	.	.	.	.	.	.	13	100.0	3.2
	1984-91	1	6.7	2.0	11	73.3	3.0	3	20.0	4.0	.	.	.	.	.	.	15	100.0	3.1
	1992-98	7	3.4	2.0	125	61.3	3.0	72	35.3	4.0	.	.	.	.	.	.	204	100.0	3.3
	Total	8	3.7	2.0	136	62.1	3.0	75	34.2	4.0	.	.	.	.	.	.	219	100.0	3.3
Small	YY																		
	90	8	3.3	2.0	210	86.8	3.0	24	9.9	4.0	.	.	.	.	.	.	242	100.0	3.1
	91	2	2.1	2.0	89	93.7	3.0	4	4.2	4.0	.	.	.	.	.	.	95	100.0	3.0
	92	6	3.4	2.0	130	74.7	3.0	38	21.8	4.0	.	.	.	.	.	.	174	100.0	3.2
	93	28	3.1	2.0	752	84.3	3.0	112	12.6	4.0	.	.	.	.	.	.	892	100.0	3.1
	94	5	0.8	2.0	341	56.4	3.0	257	42.5	4.0	2	0.3	5.0	.	.	.	605	100.0	3.4
	95	1	0.1	2.0	519	39.2	3.0	766	57.8	4.0	37	2.8	5.0	2	0.2	6.0	1325	100.0	3.6
	96	1	0.1	2.0	475	50.6	3.0	448	47.8	4.0	14	1.5	5.0	.	.	.	938	100.0	3.5
	97	.	.	.	267	71.4	3.0	107	28.6	4.0	.	.	.	.	.	.	374	100.0	3.3
	98	1	0.5	2.0	125	60.4	3.0	81	39.1	4.0	.	.	.	.	.	.	207	100.0	3.4
	1984-91	10	3.0	2.0	299	88.7	3.0	28	8.3	4.0	.	.	.	.	.	.	337	100.0	3.1
	1992-98	42	0.9	2.0	2609	57.8	3.0	1809	40.1	4.0	53	1.2	5.0	2	0.0	6.0	4515	100.0	3.4
	Total	52	1.1	2.0	2908	59.9	3.0	1837	37.9	4.0	53	1.1	5.0	2	0.0	6.0	4852	100.0	3.4

Appendix 6. Sea-age distribution of small and large Atlantic salmon caught by angling on the Humber River, 1988-98.

Angling

		SEA-AGE				Total	
		1SW		1SW RS			
		N	%	N	%	N	%
SIZE:	YY						
Large	88	1	100.0	.	.	1	100.0
	90	1	100.0	.	.	1	100.0
	92	3	100.0	.	.	3	100.0
	93	.	.	1	100.0	1	100.0
	94	3	100.0	.	.	3	100.0
	96	3	50.0	3	50.0	6	100.0
	97	3	75.0	1	25.0	4	100.0
	98	.	.	2	100.0	2	100.0
	1984-91	2	100.0	.	.	2	100.0
	1992-98	12	63.2	7	36.8	19	100.0
	Total	14	66.7	7	33.3	21	100.0
Small	YY						
	88	77	100.0	.	.	77	100.0
	89	126	100.0	.	.	126	100.0
	90	55	98.2	1	1.8	56	100.0
	91	170	98.8	2	1.2	172	100.0
	92	342	99.7	1	0.3	343	100.0
	93	130	98.5	2	1.5	132	100.0
	94	331	99.1	3	0.9	334	100.0
	95	110	99.1	1	0.9	111	100.0
	96	289	99.0	3	1.0	292	100.0
	97	168	100.0	.	.	168	100.0
	98	178	100.0	.	.	178	100.0
	1984-91	428	99.3	3	0.7	431	100.0
	1992-98	1548	99.4	10	0.6	1558	100.0
	Total	1976	99.3	13	0.7	1989	100.0

Appendix 7. Sea-age distribution of small and large Atlantic salmon captured in tagging traps operated in the estuary of the Humber River, 1989-98.

Estuary Traps

		SEA-AGE								Total	
		1SW		2SW		1SW RS		2SW RS			
		N	%	N	%	N	%	N	%	N	%
SIZE:	YY										
Large	89	.	.	2	40.0	3	60.0	.	.	5	100.0
	90	6	28.6	7	33.3	7	33.3	1	4.8	21	100.0
	91	.	.	.	.	4	100.0	.	.	4	100.0
	92	1	3.6	21	75.0	6	21.4	.	.	28	100.0
	93	1	1.8	28	50.0	10	17.9	17	30.4	56	100.0
	94	7	8.6	23	28.4	50	61.7	1	1.2	81	100.0
	95	4	2.9	57	40.7	77	55.0	2	1.4	140	100.0
	96	1	1.2	35	41.2	45	52.9	4	4.7	85	100.0
	97	.	.	14	19.7	54	76.1	3	4.2	71	100.0
	98	.	.	13	16.3	66	82.5	1	1.3	80	100.0
	1984-91	6	20.0	9	30.0	14	46.7	1	3.3	30	100.0
	1992-98	14	2.6	191	35.3	308	56.9	28	5.2	541	100.0
	Total	20	3.5	200	35.0	322	56.4	29	5.1	571	100.0
Small	YY										
	90	242	95.3	.	.	12	4.7	.	.	254	100.0
	91	95	92.2	.	.	8	7.8	.	.	103	100.0
	92	175	96.7	.	.	6	3.3	.	.	181	100.0
	93	904	96.4	1	0.1	33	3.5	.	.	938	100.0
	94	608	97.9	.	.	13	2.1	.	.	621	100.0
	95	1327	99.5	.	.	7	0.5	.	.	1334	100.0
	96	942	97.8	.	.	21	2.2	.	.	963	100.0
	97	375	92.8	.	.	29	7.2	.	.	404	100.0
	98	209	93.3	.	.	15	6.7	.	.	224	100.0
	1984-91	337	94.4	.	.	20	5.6	.	.	357	100.0
	1992-98	4540	97.3	1	0.0	124	2.7	.	.	4665	100.0
	Total	4877	97.1	1	0.0	144	2.9	.	.	5022	100.0