Department of Fisheries and Oceans
Canadian Stock Assessment Secretariat
Research Document 97/37

Not to be cited without
permission of the authors[1]

Ministère des pêches et océans
Secrétariat canadien pour l'évaluation des stocks
Document de recherche 97/37

Ne pas citer sans
autorisation des auteurs[1]

Status of Atlantic Salmon (*Salmo salar* L.) Stock of Humber River, Newfoundland, 1996

by

C. C. Mullins, T.R. Porter and J.B. Dempson
Science Branch
Department of Fisheries and Oceans
1 Regent Square
Corner Brook, NF A2H 7K6

Abstract

This is the seventh assessment of the Atlantic salmon stock of the Humber River. Indices of abundance are mark and recapture estimates of run size, angling catch and effort data and public consultations. Returns of small salmon in 1996 were the highest and large salmon were the second highest in seven years of assessment which included two pre-moratorium years (1990 and 1991). The conservation egg deposition requirement was exceeded on the Humber River in 1996. Assuming that freshwater and marine survival to the adult stage remains the same and recreational fishing mortality does not increase, it is anticipated that total returns to the river and spawning escapements in 1997 will be higher than in 1996. Approximately 50% of small salmon returns in 1997 will be produced from spawners in the first year of the commercial salmon moratorium in 1992.

Estimates of the total population size of salmon in pre-moratorium years, based on an assumed commercial exploitation rate, indicate a significant decline in the Humber River stock since 1979. With the exception of 1995 and 1996, the total population size during moratorium years was among the lowest recorded. Spawners on the Humber River replaced themselves in four out of five moratorium years compared to only four out of 12 pre-moratorium years since 1980.

The experience of anglers in 1996 was that salmon were abundant on the river in comparison to previous years. The angling catch of small salmon was greater than the 1992-95 and pre-moratorium means. Catches in moratorium years have been relatively stable compared to pre-moratorium years as a result of fisheries management restrictions.

The run of large salmon to the Lower Humber River consists of 2SW and 3SW salmon, and previous spawners. The assessment suggests that there was an overall increase in average population size of large salmon to the Lower Humber River in 1994-96 compared to previous years. However, the population of large salmon in the Lower Humber River appears to be low, probably less that 600 salmon, the 3SW component would probably be less than 200 salmon. The 3SW component is unique to Newfoundland and should be given special protection to minimize and to prevent any increase in fishing mortality.

Résumé

Il s'agit de la septième évaluation du stock de saumon atlantique de la rivière Humber. Les indices d'abondance utilisés sont les estimations par marquage-recapture de l'importance de la remontée, les données des captures et de l'effort de la pêche récréative et les résultats des consultations auprès du public. Les remontées de petits saumons de 1996 ont été les plus élevées et celles de grands saumons les deuxièmes plus élevées notées au cours de la période d'évaluation de sept ans qui comprend deux années d'avant le moratoire (1990 et 1991). La ponte nécessaire aux besoins de conservation a été dépassée en 1996 dans la rivière Humber. Si l'on suppose que la survie jusqu'à l'âge adulte en eau douce et en mer demeure la même et que la mortalité par pêche récréative n'augmente pas, la remontée totale de la rivière et les échappées de géniteurs seront plus importantes en 1997 qu'en 1996. Environ 50 % des remontées de petits saumons de 1997 proviendront de géniteurs nés la première année du moratoire imposé à la pêche commerciale du saumon, en 1992.

L'effectif total estimé de la population de saumons d'avant le moratoire, fondé sur un taux d'exploitation commerciale estimé, indique une baisse appréciable du stock de la rivière Humber depuis 1979. À l'exception de 1995 et de 1996, l'effectif total de la population pendant les années du moratoire compte parmi les plus faibles jamais notés. Les géniteurs de la rivière Humber ont remplacé leurs effectifs au cours de quatre des cinq années du moratoire tandis qu'ils ne l'avaient fait qu'au cours de quatre des 12 années précédant le moratoire, soit à partir de 1980.

Les pêcheurs à la ligne ont noté que les saumons étaient abondants dans la rivière en 1996, comparativement aux années antérieures. Les captures à la ligne de petits saumons ont été supérieures aux valeurs moyennes de la période 1992-1995 et à celles des années d'avant le moratoire. À cause d'une

gestion restrictive, les captures faites pendant le moratoire ont été relativement stables comparativement à celles d'avant le moratoire.

La remontée de grands saumons du cours inférieur de la Humber est surtout constituée de poissons dibermarins et tribermarins et de géniteurs ayant déjà frayé. L'évaluation porte à croire à une augmentation générale de l'effectif moyen de la population de grands saumons dans le cours inférieur de la Humber pendant la période 1994-1996. La population de grands saumons de cette partie de la rivière semble faible, probablement inférieure à 600 saumons, et la composante de saumons tribermarins compte probablement moins de 200 individus. Cette composante est unique à Terre-Neuve et devrait faire l'objet d'une protection particulière afin de minimiser la mortalité par pêche et d'en prévenir toute augmentation.

INTRODUCTION

This is the seventh assessment of the status of the Humber River salmon stock since 1990. Prior to the closure of the commercial salmon fishery in1990 and 1991, the stock achieved 60% and 27%, respectively, of the conservation egg deposition requirement for the river (Chaput and Mullins MS 1991, 1992). After the closure of the commercial fishery and the implementation of effort controls in the recreational fishery in 1992, the stock has shown signs of improvement. In 1992-1995, the stock achieved 117%, 96%, 40% and 129%, respectively, of the conservation requirement. The low percentage achieved in 1994, compared to 1992 and 1993, was attributed to an extremely low spawning escapement in 1989 which would have produced most of the recruitment in 1994.

The Humber River is the largest river flowing into the Bay of Islands, situated in western Newfoundland at the northern limit of Salmon Fishing Area (SFA) 13 (Fig. 1). The Humber River flows into Humber Arm at latitude 48/ 57' N and longitude 57/ 53' W and comprises 95% of the total drainage area of the Bay of Islands (8,124 km^2) which is 57% of the total drainage area of SFA 13. The total length of all tributaries in the Humber River is 2,450 km. Complete obstructions to migrations of anadromous Atlantic salmon within the river system occur at Main Falls (Fig. 2) which is 112.6 km from the river mouth and at Junction Brook which was diverted for hydroelectric development in 1925. The diversion of Junction Brook which flowed into the Humber River at Deer Lake resulted in the loss to the Humber River system of the anadromous salmon production potential of the Grand Lake system (Porter et al., MS 1974) (see Fig. 2). No fish passage facility was provided during the diversion to maintain upstream migration of fish stocks.

Commercial and recreational salmon fisheries management measures implemented in Newfoundland and Labrador since 1978 that would have impacted on the Humber salmon stock are:

1. 1978 - commercial season shortened to 1 June - 10 July from 15 May - 31 December.
2. 1984 - mandatory release of large salmon ($\geq$63 cm fork length) in recreational fishery.
3. 1987 - recreational season bag limit of 15 small salmon ($<$63 cm fork length).
4. 1990 - 35 t commercial quota in SFA 13 commercial fishery.
5. 1991 - 25 t commercial quota in SFA 13; recreational season bag limit of 10 small salmon.
6. 1992 - five year commercial moratorium; recreational quota of 5,000 small salmon in SFA 13 reached on 1 August; Adies Lake (Fig. 2) quota of 100 small salmon not reached; a catch and released fishery was permitted from 2 August to 7 September after the quota was reached; recreational season bag limit of eight small salmon.
7. 1993 - recreational quota of 5,200 small salmon in SFA 13 (4,160 for 5 June to 31 July and 1,040 for 1 August to 6 September) not reached; Adies Lake closed 31 July - quota of 100 small salmon not reached; daily bag limit of one fish; Cook's Brook was closed for the season.
8. 1994 - recreational season bag limit of three small salmon before 31 July and three after 31 July; Adies Lake closed 31 July - quota of 100 small salmon not reached; daily bag limit of two fish; daily catch and release limit of four fish.
9. 1995 - recreational season bag limit of three small salmon before 31 July and three after 31 July; Adies Lake closed 30 July - quota of 100 small salmon not reached; daily bag limit of two fish; daily catch and release limit of four fish.
10. 1996 - recreational season bag limit of three small salmon before 31 July and three after 31 July; Adies Lake closed 30 July - quota of 100 small salmon not reached; daily bag limit of two fish; daily catch and release limit of four fish; catch and release fall fishery permitted for the first time from 3-30 September.

The present assessment provides estimated returns and spawning escapements for 1996 and anticipated returns and spawning escapements for 1997 following the methodology presented for 1990-95 (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). The following topics are addressed:

1) estimation, by mark-recapture methods, of total returns, spawning escapement and the percentage of the conservation egg deposition requirement achieved in 1996

2) examination of the effects of the commercial salmon moratorium
3) examination of total recruitment and spawning escapement in 1974-96 and anticipated values for 1997.
4) estimation of the late summer/fall run

MATERIALS AND METHODS

Recreational Fishery Statistics

Except for Big Falls (Fig. 2), the recreational effort and catch of retained and released small (<63 cm) and large (≥63 cm) salmon in 1996 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. This was similar to previous years but the proportion of the effort and catches actually observed, as opposed to estimated, has declined in recent years (Mullins and Reddin, MS 1996). Daily catches and effort were summarized by standardized weeks for each river segment (Fig. 1-2).

Standardized weeks used for summarizing catch and effort data.

Week	Time Period
22	May 28 to June 3
23	June 4 to 10
24	June 11 to 17
25	June 18 to 24
26	June 25 to July 1
27	July 2 to 8
28	July 9 to 15
29	July 16 to 22
30	July 23 to 29
31	July 30 to August 5
32	August 6 to 12
33	August 13 to 19
34	August 20 to 26
35	August 27 to Sept. 2
36	Sept. 3 to 9
37	Sept. 10 to 16
38	Sept. 17 to 23
39	Sept. 24 to 30
40	Oct. 1 to 7

For Big Falls, the recreational fishery statistics were compiled from the results of a creel survey as well as from reports by DFO river guardians. The results of the creel survey included actual observations for the entire season, whereas, the reports by river guardians included estimated as well as observed values. The number of anglers interviewed in the creel survey was expressed in terms of rod days by subtracting the anglers that were interviewed more than once.

The total effort and catch for the Humber River, as collected above, may be slightly biased in comparison to previous years because of the inclusion of the more accurate creel survey information at Big Falls. Therefore, some caution should be used in comparing the 1996 data to previous years as the actual

observed catches recorded in the creel survey have typically been higher than those estimated and observed by the river guardians (Mullins and Reddin, MS 1996). Statistics were not collected for the fall catch and release fishery in 1996.

Estimation of Total Recreational Harvest (Creel Survey at Big Falls)

In order to improve the accuracy of the annual stock assessment, as in previous years, the total catch of retained small salmon on the Humber River was derived from the results of the creel survey at Big Falls according to the equation:

$$AC = AC_{bf} / TR_{propbf}$$

where

AC = estimated total angling catch of retained small salmon on the Humber River
AC_{bf} = angling catch of retained small salmon at Big Falls
TR_{propbf} = proportion of tags returned from Big Falls

The creel survey that was conducted at Big Falls during the 1994 fishing season revealed that the catch of retained small salmon was underestimated in the DFO catch statistics (Mullins and Reddin, MS 1995).

The 1996 creel survey was conducted from 18 June to 2 September. As in 1994 (Mullins and Reddin, MS 1995), the 1996 survey was based on full coverage throughout the fishing season. Big Falls was again selected as the survey site because, based on DFO angling catch statistics and tag returns in 1992-95, it produces almost 50% of the total catch on the Humber River (Table 1). Anglers also access and exit the Big Falls area via only two points which makes it possible to observe 100% of the catch with minimal effort.

Each of the two exit points was monitored 16 hours per day in 1996. 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 1996 season (Appendix 1). The survey clerks interviewed anglers as they exited the fishing area and recorded the number of hours fished, the number of salmon retained and released, and the number of Carlin tagged salmon recaptured.

In order to determine the amount of angling activity that may have been missed by the survey clerks before and after the normal sampling day, two additional time periods (0400-0600 and 2200-2300 hours) were sampled one day per week.

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

Equations used to calculate the estimates of returns are summarized in Table 2. Confidence limits around various estimated parameters were determined by simulation techniques.

a. Angling Exploitation Rate

Carlin tags were applied to salmon captured at two estuarial tagging traps (Fig. 1) The Lower Trap has been fished in the same location at Wild Cove, Humber Arm, since 1990. The Upper Trap was fished about 1.5 km upstream from the Lower trap (the same location as in 1993 and 1995). In the 1994 assessment this trap was fished approximately 10 km further upstream. The trap designs and installation in 1996 were identical to those in the 1990-95 assessments. Tags were applied using a double stainless steel wire attachment directly under the anterior end of the dorsal fin. All salmon captured in the two traps were measured (fork length 0.1 cm), and scale sampled. Injured salmon were not tagged. Both small and large salmon were tagged.

Tags that were returned from small salmon which were unknown to be retained or released were apportioned into retained and released categories based on tags returned from catches known to be retained or released (Appendix 2).

The angling exploitation rate (ER) for retained small salmon was estimated based on tags recaptured according to the formulae:

ER = TR / Tav
TR = TRv / RR
TAv = TA x (1 - TL(0.009 x Median Days to Recapture))
RR= # Tags Returned from Big Falls / # Tags Recaptured at Big Falls

where:

TR =Tags recaptured by anglers
TRv=Tags returned voluntarily by anglers
TA=Tags applied to small salmon
TAv =Tags available to angling
TL=Tag loss rate due to tag shedding
RR=Voluntary tag reporting rate by anglers

The voluntary reporting rate (RR), by anglers, of recaptured tags from retained small salmon was estimated from recaptures observed by the creel survey clerks at Big Falls. 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 number of tags available (TAv) to the small salmon retention fishery were estimated from the number of tags applied (TA), 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 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 been available to the retention fishery for a period of time before being caught and released. In the 1995 assessment (Mullins and Reddin, MS 1996), if the number of tags removed from released fish had been adjusted for the period of time they were available to the retention fishery and had been excluded from the total number of tags available, the exploitation rate calculation would have increased by less than 1.5%.

b. Total Returns

The total return of small salmon (TRS) was estimated based on total adjusted angling catch of small salmon retained and the angling exploitation rate according to the Petersen (Single Census) method (Ricker, 1975):

TRS = AC / ER

The total return of large salmon (TRL) was estimated from small salmon returns based on the ratio of large:small salmon captured in the two tagging traps:

TRL = TRS x (# Large / # Small)

In the 1990 and 1991 assessments, the appropriate ratio of large:small salmon returns was considered to be equivalent to the ratio of large:small salmon in the recreational fishery prior to 1984 (7%) when large salmon could be retained (Chaput and Mullins, MS 1991, 1992). However, a commercial fishery was also

permitted in these years. Because of the closure of the commercial fishery in 1992 and the potential for an increase in the river escapement of large salmon, the ratio of large:small salmon captured at the tagging traps was considered to be more representative of returns to the river.

c. Spawning Escapements

The spawning escapement of small and large salmon was obtained by subtracting total angling removals from the total returns. Angling removals included retained small salmon and a 10% mortality rate on released small and large salmon. The number of small salmon released was estimated from the total retained catch based on the ratio of released:retained small salmon observed in the creel survey at Big Falls. Released catches of large salmon were obtained from the DFO catch statistics for the river.

e. Potential Egg Depositions

The potential egg deposition by small and large salmon spawners was calculated based on biological characteristics (mean weight of females and percent female) of small and large salmon and a relative fecundity value of 1,540 eggs/kg (Porter and Chadwick, MS 1983). The mean weight and percent female of small salmon were obtained from recreational catches at Big Falls in 1996 (Appendix 3). The mean weight of female large salmon was 3.7 kg (Porter and Chadwick, MS 1983) and the percentage female was 68.6% based on commercial catches in the Bay of Islands in 1991 (Chaput and Mullins, MS 1992).

Estimation of Conservation Requirements

The conservation egg deposition requirement was calculated based on an optimal egg deposition rate for fluvial (Porter and Chadwick, MS 1983) and lacustrine (Mullins and Chaput, MS 1995) parr rearing area. The egg deposition rate for fluvial area was 2.4 m^2 (Elson, 1957), which includes an adjustment for egg losses due to poaching and disease. The egg deposition rate for lacustrine area was 368 eggs/ha, as described by O'Connell et al. (MS 1991) which does not include an adjustment for poaching and disease.

With the closure of the commercial salmon fishery in 1992, there was a potential for an increase in the size of small and large salmon on the Humber River due to the removal of size-selective gill nets. As a result, the estimated number of spawners required to achieve the conservation egg deposition requirement of 28.3 million eggs was re-examined and updated from that used in previous assessments. The previous spawner requirement of 13,651 small and 1,326 large salmon (Mullins and Chaput, MS 1995) was based on the mean biological characteristics and relative proportions of small and large salmon in 1992-93. The spawner requirement calculated in this document was based on the mean biological characteristics of small and large salmon in 1992-96, or where data was not available, based on default values from previous years. The relative contribution of eggs from small and large salmon was based on the minimum proportion of large salmon observed at the tagging traps in 1992-96. This approach is more cautionary than estimating spawners based on the mean proportion of small and large salmon. It potentially involves less risk from a fisheries management standpoint, because there is a greater likelihood of achieving the minimum contribution from large salmon in a given year than in achieving the mean.

Effects of the Commercial Salmon Moratorium

a. Recruits and Spawners in 1974-96 and Anticipated Returns in 1997

O=Connell et al. (1995) describe a technique whereby it is possible to retrospectively construct total population size of small salmon (or total number of small salmon recruits) prior to any exploitation in selected rivers with counting facilities and to use the number of salmon recruits per spawner to estimate anticipated returns one year in advance. The technique is fully described in O'Connell et al. (1995) and equations used to derive recruits and spawners for the Humber River salmon stock are the same with the exception that large

salmon are included (exploitation rate in commercial fishery = 0.80) and that estimated small and large spawners and recruits have been weighted by the mean proportion of virgin 1SW and 2SW salmon in 1989-96.

b. Analysis to Detect Recruitment Overfishing

Details on analysis to detect recruitment overfishing are provided by O'Connell, et al. (1995). Spawning escapements which produced total small and large salmon spawners on the Humber River in 1980-1996 were constructed by weighting previous spawning escapements by the smolt age distribution of 1SW salmon on the Humber River in 1993.

c. Run timing, Counts and Biological Characteristics

Run timing and counts at the Lower tagging trap and mean biological characteristics information collected from tagging traps and the recreational fishery in 1992-96 were compared to previous years. Run timing was taken as the date when 50% of catches occurred in the Lower tagging trap.

Late-Summer/Fall Run of Salmon to the Lower Humber River (downstream from Deer Lake)

The timing, age and sex composition of the late-summer/fall run of salmon was determined from a review of the information reported in Blair, 1965, and analysis of the daily and annual recreational catch statistics for the Lower Humber River and for all other areas of the Humber River. Qualitative changes in abundance between 1977-86 and 1994-96 was evaluated by comparing the angling catches and the catch rates during the two time periods. Estimates of the average population size 1994-96 was obtained by using a range of probable exploitation rates. These are compared to the exploitation rates calculated for large salmon for the entire Humber River from the mark-recapture studies.

RESULTS

Recreational Fishery Statistics

The recreational fishery on the Humber River in 1996 opened on 3 June and closed on 2 September. The Adies Lake (Fig. 2) quota of 100 small salmon was not reached but this segment closed to angling on 30 July as in previous years. The Tailrace area of Deer Lake was closed to angling for the first time from 29 July to 25 August 1996 because of extremely high exploitation on fish holding up in the area. The Tailrace receives effluent from a hydro-electric power generating station. The closure of the Tailrace area may have affected the number of tag recaptures and the total catch and effort for the river in 1996.

The highest angling effort and the highest number of small salmon retained and released in 1996 was at Big Falls followed by Harrimans Steady (Table 3). Approximately 90% of the retained small salmon and 95% of the released small salmon were taken on or before 31 July 1996 (Table 3). However, only 67% of the large salmon were taken in the same period. The highest number of large salmon released was on the Lower Humber. Angling on the Lower Humber is primarily directed towards large salmon, especially late in the season and this segment normally produces the highest catches. The percentage of the catch taken at Big Falls in 1996 was higher than in 1995 (Table 1), perhaps because of the the closure at the Tailrace which may have resulted in a transfer of effort to Big Falls. The change, compared to previous years, in the method of angling data collection as described above may also have affected the proportion of the total catch recorded at Big Falls.

The experience of anglers expressed at public consultation meetings was that water levels were ideal from June to mid-July 1996, therefore, catch rates were good in this period but water levels were low in August. They also felt that there were more fish in the river in 1995 and 1996 than previous years which

contributed to better catches. Anglers felt that run timing was earlier in 1996 and that it resulted in a lower total angling effort than in previous years because many anglers missed the main run.

Creel Survey Catches at Big Falls

A total of 5,331 interviews were conducted in the creel survey (including 353 interviews with anglers leaving the fishing area for the second or third time on the same day) (Table 4). The peak of angling effort and catch occurred during the week of 25 June to 1 July 1996. Catch and effort dropped off considerably after the end of July.

Anglers fished for an average of 3.5 hours in 1996 which was slightly lower than the average effort expended in 1992-95 (Table 5A). The catch per hour was the same as in 1995 which was the highest in the previous three years of the survey.

The observed total catch of 1,229 retained small salmon in 1996 (Table 5B) was 33% less than the estimated total catch of 1,853 (CI=1,639-2,068) in 1995 (Mullins and Reddin, MS 1996). However, the catch of 782 released small salmon was 15% greater than estimated in 1995. The observed catch of 73 released large salmon was 30% less than that estimated for 1995.

The results of interviews with anglers leaving the fishing area before (0400-0600 hrs) and after (2200-2300 hrs) the normal census day indicated that, on the ten days sampled, approximately 19% of retained small salmon were caught before or after the normal census day and would have been missed by the creel survey clerks. Based on the ratio of **(catches before and after) : (catches during)** the census day, it was estimated that an additional 284 small salmon were retained over the entire season that were missed by the creel survey clerks. The adjusted catch of retained small salmon during the creel survey was 1,492. Plus, another eight small salmon were reported in the DFO catch statistics for two weeks prior to the start of the creel survey for a total of 1,500 small salmon retained at Big Falls in 1996.

Results of creel survey before and after the census day.

Census Day	During (0600-2200)	Before (0400-0600)	After (2200-2300)	Ratio
1-Jul.	54	4	11	
8-Jul.	23	0	6	
15-Jul.	1	0	0	
22-Jul.	2	0	0	
29-Jul.	5	0	0	
5-Aug.	2	0	0	
12-Aug.	1	0	0	
19-Aug.	1	0	0	
26-Aug.	0		0	
2-Sept.	1	0		
Ratio (before)	90	4		0.0444
Ratio (after)	89		17	0.1910

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

a. Angling Exploitation Rate

The Lower tagging trap was operated from 1 June to 3 October and the Upper Trap was operated from 24 May to 2 October 1996. A total of 86 large and 977 small bright salmon were captured the two tagging traps (Table 6). This was less than the total catch in 1995 but the percentage of large salmon increased by 19%. A total of 936 (490 Lower and 446 Upper) small salmon were tagged and released which were potentially available to the recreational fishery (Table 7). Two small salmon tagged in the Lower trap in week 39 were considered not to be available to the fishery.

Tags were not applied at water temperatures above 20 C and the number of tags returned did not appear to be related to the water temperature at the time of tagging (Table 8). However, it is not possible to separate the effect of water temperature at the time of tagging from the effect of the length of time in the river. Nevertheless, tagging mortality was believed to be negligible 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. The tag application process takes approximately 45 seconds.

The distribution of catches of small salmon in the Lower and Upper tagging traps was quite similar and suggested that the tagging occurred over the entire run in 1996 (Fig. 3A-B). However, a portion of the large salmon run may have entered the river prior to the installation of the Lower Trap. The timing of both the small and large salmon runs at the Lower Trap were among the earliest recorded in eight years of operation (Fig. 4A-B).

The week of peak releases from the Lower tagging traps was one week earlier than in the Upper trap (Fig. 5A) and the week of peak recaptures in angling was also one week earlier for fish tagged in the Lower trap than fish tagged in the Upper trap (Fig. 5B). However, for both traps combined, the distributions of catches of tagged and untagged small salmon in angling were similar (Fig. 5C) indicating that tagged and untagged small salmon were evenly dispersed in the population and available to the fishery at the same time.

A total of 88 tagged small salmon were retained and released in 1996 (Table 9). These were distributed throughout all major segments of the river with the largest number coming from Big Falls and Harrimans Steady. These areas also produced the highest tag recaptures in previous years. A total of 67 tag returns were from retained fish, five tags were reported from fish released with the tag, four tags were from released fish and 12 tags were from small salmon not reported as either retained or released (Table 10). These 12 were considered to retained fish because of the high proportion of returned tags that were kown to be from retained fish. A total of 79 tag returns were considered to be from retained small salmon. A total of 27 tags were retained at Big Falls (Table 11) and 25 of these were from the area covered by the creel survey. Three large salmon were recaptured out of 80 tagged (Table 12).

Out of a total of 28 tags (retained and released) observed by the creel survey clerks at Big Falls, 60.71% (17/28) were returned voluntarily by anglers (Table 13). This was similar to the voluntary reporting rate of 60.87% in 1995 (Mullins and Reddin, MS 1996) and 64% estimated in 1994 (Mullins and Reddin, MS 1995).

The median number of days at large for recaptured small salmon was 12 days (Table 14). This was similar to the median number of days at large for tagged salmon in 1993-95. The minimum was three days and the maximum was 72 days. The estimated overall proportion of tags retained during this period was 0.892. After adjustment for tag loss and reporting rate, the angling exploitation rate on retained small salmon was 0.1557. This was the lowest exploitation rate in seven years of assessment (0.25 in 1990-91; 0.22 in 1992; 0.2213 in 1993; 0.2865 in 1994; and 0.1846 in 1995).

The early run timing of small salmon in 1996 (Fig. 4A) may have resulted in fish being available to the fishery for a shorter period of time due quick passage through the system. This would explain the low

angling exploitation rate in 1996 compared to previous years. 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 but the run timing was later and occurred over a much longer time period. This may have resulted in the population being available to the fishery longer in 1994 than in 1996 and, therefore, the exploitation rate was higher. The closure of the Tailrace portion of Deer Lake in 1996 would also have reduced angling exploitation. It is also noted that five Humber River small salmon tagged on 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, a lower tag-loss rate than estimated above would have resulted in a lower angling exploitation rate estimate.

Angling exploitation was highest on small salmon tagged and released in weeks 24-25 (0.1901) and lowest on those tagged in weeks 26-27 (0.0905). The range of angling exploitation rates calculated in Table 14 indicated, to some extent, that the 1996 fishery harvested certain portions of the salmon run more than others. However, the number of fish tagged and recaptured varied greatly between release periods which would have biased the exploitation rate estimates. A stratified estimate of the population size based on bi-weekly exploitation rates may yield a slightly different estimate than that based on a single exploitation rate for the season. However, in previous years, such stratified estimates, using the Darroch (1961) estimator, were not significantly different than the single census Petersen because pooling of release strata was necessary in order to obtain sufficient sample sizes.

All small salmon tagged and released in 1996 were assumed to be destined for the Humber River. However, one large salmon was reported recaptured in Hughes Brook in 1996. Hughes Brook flows into the Humber Arm about 3.0 km north of the Humber River estuary (Fig. 1). Tagged small salmon have also been recaptured in Hughes Brook in the past (2-12 in 1990-93). If 12 had been subtracted from the number of small salmon tagged in 1996 to account for those destined for Hughes Brook, the angling exploitation rate estimate would have increased by 1.3% and the returns estimate would have been approximately 1.3% less (~388 small salmon). This was considered to be negligible and no adjustment was made to the angling exploitation rate.

b. Returns and Escapements of small and large salmon

The adjusted angling catch of retained small salmon in 1996 was 4,740 (95% CI=4,237-5,396) (Table 15). Based on this catch and the angling exploitation rate of 0.1557, it was estimated that 30,445 (95% CI = 25,642 - 36,150) small salmon entered the Humber River in 1996 (Table 16). Based on the ratio of large:small salmon caught in the tagging traps (Table 6), 2,679 (95% CI= 2,497- 2,862) large salmon also entered the river in 1996 (Table 16).

The potential spawning escapement on the Humber River in 1996, after angling removals, was 25,404 small and 2,655 large salmon (Table 16). These spawning escapements would have resulted in potential egg depositions which were 186% of the conservation egg deposition requirement (Table 17) and the highest achieved in seven years of assessment (Table 18).

The estimate of returns and spawning escapements given above were based on tag returns up to 6 January 1997. As of 2 May 1997, one additional tag was returned from a retained small salmon. If this tag had been included in the calculation, the estimates of small and large salmon returns would have been 0.27% lower.

The conservation spawner requirement for the Humber River based on 1992-96 biological characteristics and the minimum percentage of large salmon in 1992-96 of 5.6% is 15,749 small and 934 large salmon (Table 19). This represents a increase of 2,098 in the number of small salmon required and a drecrease of 392 in the number of large salmon. A small change in the number of large salmon required results in a larger change in the number of small salmon (Fig. 6) because small salmon produce fewer eggs. The spawning escapements in 1996 were above the estimated conservation spawner requirements (Figs. 7A-B).

Effects of the Commercial Salmon Moratorium

a. Number of Recruits and Spawners, 1974-96, and Anticipated Returns in 1997

The outcome of calculations of total numbers of salmon recruits, numbers of spawners, and numbers of recruits per spawner are shown in Figs. 8A-E. In 1979-91, prior to the commercial salmon moratorium there was a lot of variability in recruitment from relatively similar spawning escapements (Fig. 8A). The number of small salmon recruits produced per small salmon spawner showed no trend ($r^2=0.13$; df = 14; $P>0.05$) (Fig. 8B) but had declined significantly for large salmon ($r^2=0.60$; df = 13; $P<0.01$) over the 1979-91 period (Fig. 8C). There was also a significant decline ($r^2=0.40$; df = 19; $P<0.01$) in the total number of small and large salmon recruits for Humber River in 1979-91 and this trend continued into the moratorium years (Fig. 8E).

The total recruitment on the Humber River in 1996 was more than twice that anticipated based on the relationship between recruits and spawners in 1979-1995 (Mullins and Reddin, MS 1996). Except for 1990, the lowest recruitment on the Humber River in 1979-96 was experienced during the commercial moratorium years, 1992-96. In fact, 1994 was the lowest. However, this trend appears to have been broken with the higher recruitment observed in 1995 and 1996 and anticipated for 1997. The anticipated recruitment of 39,389 (20,763-68047) small and large salmon on the Humber River in 1997 based on the R/S ratios for small and large salmon in the previous three years will be the third highest since 1979 (Fig. 8D).

It is anticipated that the trend of higher spawning escapements on the river since 1992 will continue in 1997 if there is no increase in recreational fishery harvests (Fig. 8E). There was no identifiable trend in the total number of small and large spawners in 1979-91 (Fig. 8E). However, expressing conservation requirements in terms of salmon adults (horizontal line in Fig. 8E), it is evident that, with the exception of 1994, the spawners in 1992 and especially in 1995 and 1996 were the highest recorded.

b. Analysis to Detect Recruitment Overfishing

Since the closure of the commercial salmon fishery in 1992, 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. 9). With the exception of 1994, spawners in 1992-96 were above the replacement (diagonal) line (Fig. 10). In 1980-91, preceding the moratorium, spawners were above the replacement line in only three out of 12 years. In 1989 and 1991, numbers of spawners were well below the replacement line. Of the total number of 17 data points, nine were below the replacement line.

c. Other Indices

Creel survey estimates of the total catch of small salmon indicate that catches in 1995 and 1996 were the highest recorded since 1991 (Table 5C).

The run timing of small salmon to the Humber River in 1992-96 was substantially earlier than in 1990 and 1991 (Fig. 4A). In 1990 and 1991, 50% of the run did not enter the river until after the closure of the commercial fishery on 11 July.

The mean weight of female small salmon sampled in the recreational fishery and in the tagging traps increased by 12-23% in moratorium years compared to pre-moratorium years (Appendices 3-4). However, the sex composition and mean fork length did not appear to change.

The sea-age distribution, primarily the percentage of repeat spawners, of small and large salmon sampled in the recreational fishery and at the tagging traps did not appear to change in moratorium years compared to pre-moratorium years (Appendices 5-6).

The smolt-age distribution of returning virgin (1SW and MSW) small and large salmon sampled in the recreational fishery and at the tagging traps has shifted in recent years in favour of older smolts (Appendices

7-8). The percentage of age-3 smolts decreased in 1994-96 and the percentage of age-4 and age-5 smolts increased.

Late Summer/Fall Run of Salmon to the Lower Humber River

a. Run Timing and Biological Characteristics

A detailed sampling program of salmon harvested in the commercial fisheries in the Bay of Islands, and the angling fishery in Humber River was conducted in 1942. The following is a summary of some of the results of that study as reported by Blair (1965). The fishery took place from the last week of May to the end of August due to small numbers of salmon being caught before and after these dates. Biological samples were collected between 3 June and 15 August.

i) Run timing in commercial fisheries in Bay of Islands

The distribution of commercial catches at McIvers is shown in Figure 11. Two-sea-winter (2SW) salmon were most abundant in June; 1SW salmon were most abundant in July and August; and 3SW were not represented in the fishery at all until August.

ii) Size composition of the commercial catch

Blair estimated that the total catch of salmon in the Bay of Islands in 1942 was 3,000 - 4,500 fish. Table 20 shows the number of salmon in the catch by size group. Note, only 4% of the large salmon were caught after 6 August (note also that there were no samples August 1-6). Three-sea-winter salmon were only among the samples taken in August (Table 21).

Fishermen report that the salmon caught in August are large salmon averaging about 15 lb (6.8 kg). Blair reports that the fishermen were fairly certain about the time of the run of older salmon, but less certain of the timing of the run of grilse because the fishermen primarily use large mesh (6 inches (152 mm)).

In the angling fishery, all of the 3SW salmon came from samples taken in the Lower Humber River after August 1 (Table 22).

iii) Sex Composition

The sex composition of Humber River salmon are available from samples taken in the commercial and angling fisheries in 1942 (Blair 1965), and from the angling fisheries 1967-83 (DFO files), and from the recreational fisheries in 1992 (Mullins and Chaput 1993), in 1994 (Mullins and Reddin 1995) and in 1996 (Table 17).

Source	Years	Percent Female			
		1SW (n)	2SW (n)	3SW (n)	Previous spawners (n)
Blair (1965)	1942	37.0 (532)	94.6 (296)	60.0 (5)	46.5 (86)
DFO files	1967-83	53.0 (534)	85.7 (14)	81.8 (22)	73.3 (15)
Appendix 3	1988-96	54.9 (951)*	66.7(9)**		

* all salmon < 63 cm.

** all salmon > 63 cm

b. Population size of Large Salmon on the Lower Humber River

An indication of the size of the large salmon population on the Lower Humber River can be obtained by examining the angling catch statistics for the Humber River.

From 1976-84 and from 1988-93, the largest number (61) of large salmon angled on the Lower Humber was in 1981 (Table 23). No catch statistics are available for the period 1985-87. In 1994, 1995 and 1996 the numbers of released large salmon were 66, 93, and 81 respectively. This increase in catch of large salmon is suggestive that the population size began increasing in 1994.

The angling effort on the Lower Humber averaged 1,376 rod days from 1977 to 1986 (Table 24). In 1994 and 1995 the recorded effort averaged 1,429 rod days. The recorded number of rod days decreased to 681 in 1996: however, this decrease is probably an artifact of data collection rather than a decline in actual fishing effort. The CPUE 1977-86 is 0.01 large salmon per rod day. The CPUE for 1994-95 is 0.05 large salmon per rod day which, again, suggests that the population of large salmon is higher in 1994-95 than in the 1977-86 period.

The following table shows the large salmon angling catch and effort statistics, 1994-96 for the Lower Humber River. These data indicate that most of the angling effort and catch of large salmon occurs after 31 July. The CPUE after 31 July is higher than prior to 1 August, in all three years.

	Before 1 August			After 31 July			Total for season		
Year	Rods	Large	CPUE	Rods (%)	Large (%)	CPUE	Rods	Large	CPUE
1994	372	14	0.04	1,026 (73)	52 (79)	0.05	1,398	66	0.05
1995	695	32	1.05	764 (52)	61 (66)	0.08	1,459	93	0.06
1996	55	5	0.09	626 (92)	76 (94)	0.12	681	81	0.12

A comparison of the number of large salmon caught before and after 31 July in the Lower Humber River (text table above) to all other sections of the Humber River (text table below) indicates that prior to 1 August most of the large salmon are caught in areas other than the Lower Humber while after 31 July most of the large salmon are caught in the Lower Humber. The catch rates are higher in the Lower Humber in both time periods.

Large salmon catches and effort, 1994-96, for the Humber River excluding the Lower Humber.

	Before 1 August			After 31 July			Total for season		
Year	Rods	Large	CPUE	Rods (%)	Large (%)	CPUE	Rods	Large	CPUE
1994	3,491	97	0.03	798 (18)	3 (3)	<.01	4,289	100	0.02
1995	4,156	135	0.03	1,240 (23)	5 (4)	<.01	5,396	140	0.03
1996	6,720	155	0.02	1,577 (19)	1 (12)	<.01	8,297	156	0.02

Large salmon catches and effort, 1994-96 for the entire Humber River.

	Before 1 August			After 31 July			Total for season		
Year	Rods	Large	CPUE	Rods (%)	Large (%)	CPUE	Rods	Large	CPUE
1994	2,863	111	0.03	1,842 (32)	55 (33)	0.03	5,687	166	0.03
1995	4,851	167	0.03	2,004 (29)	66 (28)	0.03	6,855	233	0.03
1996	6,775	160	0.02	2,203 (24)	77 (32)	0.04	8,978	237	0.03

A review (see table below) of DFO angling catch statistics after 20 August 1976-82, indicates that relatively few (5.9% to 27.3%) small salmon are caught on the Lower Humber after 20 August. The numbers of large salmon angled after 20 August is small and quite variable, ranging from 0% to 60% of the total

catch of large salmon. However in 1976 and 1977 when the angling season extended until 15 September, there were 28% and 60% of the large salmon angled after August 20 respectively. In 1980 the angling season closed on 7 September and during that year about 47% of the large salmon were caught after 20 August.

Percentage of catch angled after 20 August

Year	Small Salmon	Large Salmon
1976	27.3	27.8
1977	25.8	60.0
1978	8.0	33.3
1979	5.9	0.0
1980	13.8	47.4
1981	7.2	27.9
1982	5.6	3.1

The average number of large salmon in the Humber River, 1992-96 as estimated from the mark recapture study was 1,871 (Table 18). However, this estimate is unlikely to include all of the 3SW component since very few 3SW salmon were caught in the marking trap nets in August and September. The exploitation rates on large salmon in 1994, 1995, and 1996 using the population estimates for large salmon in Table 17 and DFO angling statistics for the Humber River excluding the catches of large salmon after 31 July on the Lower Humber are: 0.11, 0.07, and 0.06.

A range of estimates of the average population size of large salmon on the Lower Humber, 1994-96 was calculated using a range in exploitation rates and using the angling catch after 31 July. These estimates are presented below. Since the large salmon appear to be staging in the Lower Humber, anglers would be fishing over the same fish for two to three weeks. Thus an exploitation of 0.10 -0.15 appears reasonable. Application of these exploitation rates would result in a population estimate between 420 and 630 large salmon. Since many of the large salmon are 2SW and repeat spawners, the actual population size of virgin 3SW salmon is probably less than 200 fish.

ExploitationRate	Angling catch 1994-96	Population estimate
0.05	63.0	1260
0.08	63.0	788
0.10	63.0	630
0.15	63.0	420
0.20	63.0	315
0.25	63.0	252

DISCUSSION

The increase in total recruitment and spawning escapement on the Humber River in 1996 compared to 1995 and 1994 was not anticipated based on the recruit to spawner relationship observed in the three previous years. However, the ratio of recruits:spawners, particularly for small salmon has increased in the last three years (1994-96) and it should not be surprising if the same hold true for 1997. Recruitment in 1996 was twice that anticipated and recruitment in 1995 was 77% greater than anticipated. This can be attributed to an

increase in the survival of smolts at sea. However, it may also be a function of the variability in the recruit to spawner relationship.

It should be noted that anticipated recruitment on the Humber River in 1997 will not be produced entirely by spawning escapements after the commercial salmon moratorium. Assuming that the smolt age distribution of 1SW recruits in 1997 is similar to that observed in 1994-96 (approximately 50/50 ages 3 & 4), then only 50% of the recruitment will be produced by spawners in the first year of the moratorium. The other 50% of recruits will be produced by the relatively low escapement of 1991. Likewise, 2SW recruits in 1997, will be produced by the relatively low spawning escapements in 1990 and 1991 which also produced the relatively high recruitment of small salmon in 1996. 1SW recruits from the first moratorium year-class (1992) will return to the Humber River in 1997 and 1998 and 2SW recruits will not return until 1998 and 1999.

In a stock with a healthy spawning population it is suggested that points in the spawner-recruit relationship described in Fig. 11 should fall both above and below the line in a 50:50 distribution. Also, the points should fall above the conservation spawner requirement line which in the case of the Humber occurred in three years of five years (1992, 1993, 1995 and 1996) since the closure of the commercial salmon fishery. It is concluded from this that the Humber River salmon stock, having been below the conservation requirement in some years, is now in a position to increase in size.

Assuming that freshwater and marine survival and angling exploitation on the Humber River in 1997 remains at the current level, the spawning escapement, based on trend analysis, is expected to again exceed the conservation requirement. However, it must be kept in mind that, the population size of salmon on this river in moratorium years is still far below estimates of the total population size in pre-moratorium years.

The current assessment of the status of the Humber River salmon stock is based on returns to the river in June-August. While returns in June-August represent by far the majority, there is evidence that a run of large salmon enters the river in the fall, presumably spawning in the lower part of the river. We have little information on either the abundance or the biology of salmon entering the Humber River in the fall. Based on the low catches (2 1SW and 1 MSW) in the tagging traps operated in September and early October 1996, it is expected that the fall run is quite small.

The data collected in the commercial fishery in 1942, and from the angling fishery supports the hypothesis that there is a distinct run of 3SW salmon which begins entering the Humber River in early August. No information is available to determine the duration of the run. However, the low catches by fishermen in Bay of Islands (1942) would suggest that the peak of the run is in August. Anglers, however, report catching bright salmon in September. This August/September run of large salmon appears to be primarily limited to the Humber River downstream from Deer Lake.

The population of 3SW salmon is probably less than 200 fish since only a portion of the August/September run of large salmon is 3SW. The population size of large salmon in the Lower Humber appears to have increased in the period 1994-96, which could be attributed to the closure of the commercial fisheries and possible increase in repeat spawners resulting from the increase in the population of small salmon since 1992 (Table 18). There is insufficient information to determine what portion of the increase is 3SW salmon. Progeny from the 1994 spawners would not be expected to return until years 2001 and 2002.

The CPUE for large salmon is higher in the Lower Humber River than in the other areas of the Humber, probably due to the large salmon staging in the Lower Humber and being continually fished over. This could imply a higher exploitation rate on the large salmon in the Lower Humber than on large salmon in other parts of the river.

Management Considerations

The population of large salmon that enters the Lower Humber River has a 3SW salmon component. This population should be managed as a unique stock, and managed separately from the main grilse run to the Humber River. There is only one other population of 3SW salmon in Newfoundland, and it is in the Highlands River. The Humber River 3SW salmon stock appears to be limited to that portion of the Humber

River downstream from Deer Lake. The population size appears to be small. A precautionary approach should be taken in managing this valuable unique stock. No expansion of the fishing mortality is advised.

ACKNOWLEDGEMENTS

Funding for the for the operation of the two tagging traps and for conducting the creel survey at Big Falls in 1996 was provided in part by grants from the Canada/Newfoundland Agreement for Salmonid Enhancement and Conservation to Mr. W. Tucker and to the Humber Valley Development Association.

REFERENCES

Blair, A. A. 1965. Bay of Islands and Humber River salmon investigations. J. Fish. Res. Bd. Can. 22: 599-620.

Chaput, G., and C. Mullins. MS 1991. The status of the Atlantic salmon stock of Humber River/Bay of Islands Newfoundland, 1990. CAFSAC Res. Doc. 91/14. 28 p.

Chaput, G., and C. Mullins. MS 1992. The status of the Atlantic salmon stock of Humber River/Bay of Islands Newfoundland, 1991. CAFSAC Res. Doc. 92/28. 34 p.

Chaput G., R. Jones, and C. C. Mullins. MS 1992. A practical assessment of bus route creel surveys and lattice sampling design for estimating the recreational catch of Atlantic salmon. CAFSAC Working Paper 92/16.

Chaput, G., R. Jones, L. Forsythe, and P. Leblanc. MS 1993. Assessment of Atlantic salmon in the Margaree River, Nova Scotia, 1993. CAFSAC Res. Doc. 93/ 38 p.

Darroch, J. N. 1961. The two-sample capture-recapture census when tagging and sampling are stratified. Biometrika 48: 241-260.

Elson, P.F. 1957. Using hatchery reared Atlantic salmon to best advantage. Can. Fish. Cult. 21: 7-17.

Hare Fisheries and Environmental Consultants. 1990. A strategy for enhancing and managing the Atlantic salmon resource in the Bay of Islands - Humber River ecosystem. Prepared for the Salmon Preservation Association for the waters of Newfoundland (SPAWN). 53 p.

Mullins, C. C. and R. R. Claytor. MS 1989. Recreational Atlantic salmon catch, 1987 and 1988, and annual summaries, 1973-1988, for West Newfoundland and South Labrador, Gulf Region. Can. Data Rep. Fish. Aquat. Sci. No. 748. 192 p.

Mullins, C. C. and G. Chaput. MS 1993. The Status of the Atlantic Salmon Stock of Humber River/Bay of Islands, Newfoundland, 1992. DFO Atl. Fish. Res. Doc. 93/34, 53 p.

Mullins, C. C. and G. Chaput. MS 1995. The Status of the Atlantic Salmon Stock of Humber River/Bay of Islands, Newfoundland, 1993. DFO Atl. Fish. Res. Doc. 95/84, 48 p.

Mullins, C. C. and D. G. Reddin. MS 1995. The Status of the Atlantic Salmon Stock of Humber River/Bay of Islands, Newfoundland, 1994. DFO Atl. Fish. Res. Doc. 95/115, 59 p.

Mullins, C. C. and D. G. Reddin. MS 1996. The Status of the Atlantic Salmon Stock of Humber River/Bay of Islands, Newfoundland, 1995. DFO Atl. Fish. Res. Doc. 93/139, 51 p.

Mullins, C. C., J. A. Wright, and R. R. Claytor. MS 1989. Recreational Atlantic salmon catch, 1986 and annual summaries, 1953-1986 for West Newfoundland and South Labrador, Gulf Region. Can. Data Rep. Fish. Aquat. Sci. No. 715. 124 p.

O'Connell, M. F., J. B. Dempson, and R. J. Gibson. MS 1991. Atlantic salmon (Salmo salar L.) smolt production parameter values for fluvial and lacustrine habitats in insular Newfoundland. CAFSAC Res. Doc. 91/19. 11 p.

O'Connell, M. F., D. G. Reddin, and E. G. M. Ash. MS 1995. Status of Atlantic Salmon (*Salmo salar* L.) In Gander River, Notre Dame Bay (SFA 4), Newfoundland, 1994. DFO Atl. Fish. Res. Doc. 95/123 25 p.

Porter, T. R. and E. M. P. Chadwick. MS 1983. Assessment of Atlantic salmon stocks in statistical areas K and L, western Newfoundland, 1982. CAFSAC Res. Doc. 83/87. 86 p.

Porter, T. R., L. G. Riche, and G. R. Traverse. MS 1974. Catalogue of rivers in Insular Newfoundland Volume C. Data Record Series No. NEW/D-74-9.

Ricker, W. E. 1975. Computation and Interpretation of Biological Statistics of Fish Populations. Bull. Fish. Res. Board Can. 191:382 p.

Sokal, R. R., and F. J. Rohlf. 1969. Biometry. W. H. Freeman and Company, 776 p.

Table 1. Percentage of Humber River angling catch and tag returns from Big Falls, 1984-96.

	Angling Catch Small salmon retained			Tag Returns Small salmon retained		
	Humber	Big Falls		Humber	Big Falls	
Year	N	N	%	N	N	%
1984	2872	1069	37.2	.	.	.
1985	2430	989	40.7	.	.	.
1986	3456	1367	39.6	.	.	.
1987	3074	1234	40.1	.	.	.
1988	4042	1563	38.7	.	.	.
1989	1214	316	26.0	.	.	.
1990	3054	1138	37.3	.	.	.
1991	1431	504	35.2	.	.	.
1992	2234	1497	67.0	32	22	68.8
1993	2206	882	40.0	119	48	40.3
1994	1550	651	42.0	97	37	38.1
1995	1825	549	30.1	189	93	49.2
1996	2448	1237	50.5	79	25	31.6
Mean (92-95)			44.8			49.1

Table 2. Equations used in estimation of angling exploitation rate, total catch and total returns of Atlantic salmon to the Humber River, 1996. Parameters in bold type changed values with each iteration of the simulation procedure.

1. EXPLOITATION RATE	=	Tags Recaptured / Tags Available
a. Tags Recaptured	=	Tags Returned / Reporting Rate
Reporting Rate	=	**Tags Returned from Big Falls** / **Tags Recaptured at Big Falls** = 17 / 28 = 0.6071
b. Tags Available	=	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 72 days; Median = 12.0**
2. CATCH (Small)	=	Adjusted Catch at Big Falls / Proportion of Tags/Catch from Big Falls **(Proportion tags from Big Falls, 1996 = 25/79 = 0.3165)**
3. RETURNS (Small) (Petersen single census)	=	CATCH (Small) / EXPLOITATION RATE
4. RETURNS (Large)	=	RETURNS (Small) x **(Ratio Large:Small = 86/977 = 0.0880)**

The equations were solved 5000 times to generate the distribution from which confidence limits were determined.

Table 3. Recreational effort and catches of small and large salmon recorded for each segment of the Humber River, 1996.

Segment Name	Up to July 31								Season Totals 1996			
	Effort (Rod days)	Small		Large	Effort (Rod days)	Small		Large	Effort (Rod days)	Small		Large
		Retained	Released	Released		Retained	Released	Released		Retained	Released	Released
Lower Humber	55	7	4	5	626	63	22	76	681	70	26	81
Deer Lake	217	124	41	0	0	0	0	0	217	124	41	0
Little Falls	763	436	144	20	243	50	4	0	1006	486	148	20
Big Falls*	4363	1207	784	78	665	30	5	1	5028	1237	789	79
Adies Stream	98	35	0	0	188	46	14	0	286	81	14	0
Adies Lake	104	52	0	0	0	0	0	0	104	52	0	0
Harrimans Steady	1093	298	313	57	340	46	14	0	1433	344	327	57
Taylors Brook	82	34	0	0	141	20	5	0	223	54	5	0
Total	6775	2193	1286	160	2203	255	64	77	8978	2448	1350	237

*** Big Falls data in 1996, was based on a combination of effort and catches observed in the creel survey and observed and estimated by river guardians.**

In previous years creel survey observations were typically higher than the estimated and observed catches reported by river guardians (Mullins and Reddin, MS 1996).

Table 4. Creel survey observations at Big Falls, 1996.

Week	Anglers Interviewed	Effort		Hours per Angler	Small		Large Released	Total Catch	Catch per Hour
		Rods days	Hours		Retained	Released			
June 18-24	791	768	2871.3	3.6	285	215	30	500	0.17
June 25-July 1	1329	1201	4971.9	3.7	400	235	10	635	0.13
July 2-8	928	866	3434.9	3.7	241	151	16	392	0.11
July 9-15	641	607	2283.7	3.6	122	89	10	211	0.09
July 16-22	310	302	900.8	2.9	67	27	4	94	0.10
July 23-29	459	428	1770.7	3.9	73	54	2	127	0.07
July 30-Aug. 5	481	435	1668.7	3.5	26	7	0	33	0.02
Aug. 6-12	159	153	413.9	2.6	2	2	1	4	0.01
Aug. 13-19	91	82	209.7	2.3	2	1	0	3	0.01
Aug. 20-26	59	57	116.5	2.0	4	1	0	5	0.04
Aug. 27-Sept. 2	83	79	224.5	2.7	7	0	0	7	0.03
Total	5331	4978	18866.6	3.5	1229	782	73	2011	0.11

Table 5A. Observed recreational effort and catches of small and large salmon in the creel survey at Big Falls, 1991-96.
Creel surveys were conducted between 0600-2200 hours daily.

Year	Survey Dates	Anglers Interviewed	Hours Fished	Hours per Angler	Small salmon				Large Released	Total Catch	Catch per Hour	Carlin Tags Observed
					Retained	Released	Total	Rel:Ret				
1991	22 Jun.-30 Aug.	726	1600	2.20	136	9	145	0.0662	3	148	0.09	0
1992**	16 Jun.-30 Aug.	607	2628	4.33	738	59	797	**	25	822	**	5
1993	9 Jun.- 20 Aug.	1613	6031	3.74	412	30	442	0.0728	20	462	0.08	2
1994***	19 Jun.-5 Sept.	3839	14219	3.70	765	436	1201	0.5699	63	1264	0.09	14
1995	17 Jun.-5 Sept.	1244	4767	3.83	375	137	512	0.3653	17	529	0.11	23
1996***	18 Jun.-2 Sept.	5331	18867	3.54	1229	782	2011	0.6363	73	2084	0.11	28

*** CPUE based on total catch**

***** 1994&96 values represent the entire catch and effort at Big Falls.**

Table 5B. Estimated total recreational effort and catches of small and large salmon at Big Falls, 1991-96.

Year	Effort (hours)	95% CI	Small salmon					Large salmon		Total Catch
			Retained	95% CI	Released	95% CI	Total	Released	95% CI	
1991	26937	(23476-30398)	450	(354-546)	.	.	450	16	(-4-36)	466
1992*	35616	(31954-39279)	3001	(2702-3301)	377	(306-447)	3378	111	(52-170)	3489
1993	75610	(69082-82138)	1676	(1470-1882)	113	(77-149)	1789	106	(63-150)	1895
1994	14219	.	765	.	436	.	1201	63	.	1264
1995	22646	(20709-24582)	1853	(1639-2068)	678	(512-844)	2531	104	(36-172)	2635
1996	18867	.	1229	.	782	.	2011	73	.	2084

*** The effort estimate for 1992 is the effort expended by successful anglers.**

Table 5C . Estimated total recreational catches of small salmon on the Humber River, 1991-96.

Year	Retained	95% CI	Released	Total
1991	804	.	53	857
1992	4,349	.	317	4666
1993	4,161	(3401-5193)	303	4464
1994	2,523	(2207-2942)	1,438	3961
1995	5,150	(4799-5557)	1,881	7031
1996	4,740	(4237-5396)	3,016	7756

Table 6. Captures of bright Atlantic salmon in Humber River tagging traps. 1990-96.

Year	Lower			Upper			Total			Ratio Large: Small	Prop. Large
	Large	Small	Total	Large	Small	Total	Large	Small	Total		
1989	5	2	7	.	.	0	5	2	7	.	.
1990	22	257	279	.	.	0	22	257	279	0.0856	0.0789
1991	4	104	108	.	.	0	4	104	108	0.0385	0.0370
1992	29	181	210	.	.	0	29	181	210	0.1602	0.1381
1993	45	699	744	11	244	255	56	943	999	0.0594	0.0561
1994*	79	438	517	3	187	190	82	625	707	0.1312	0.1160
1995	104	844	948	39	1115	1154	143	1959	2102	0.0730	0.0680
1996	63	516	579	23	461	484	86	977	1063	0.0880	0.0809
Mean (92-95)	64	541	605	.	.	.	78	927	1005	0.1060	0.0945
Mean (92-96)											0.0918

* Upper trap fished 10 km upstream.

Table 7. Catches of Atlantic salmon at two tagging traps operated in the estuary of the Humber River in 1996.

		LKelt		Large			SKelt		Small					
		Tagged	ALL	Injured	Tagged	ALL	Tagged	ALL	Broodstoc	Injured	Mortality	Tagged	ALL	ALL
		N	N	N	N	N	N	N	N	N	N	N	N	N
AREA	WK													
1	22	.	.	.	8	8	8	8	.	.	.	1	1	17
	23	.	.	2	24	26	3	3	.	.	.	24	24	53
	24	.	.	.	18	18	1	1	.	2	1	79	82	101
	25	.	.	2	3	5	.	.	.	8	.	308	316	321
	26	.	.	.	1	1	.	.	.	3	1	44	48	49
	28	.	.	.	1	1	.	.	.	.	.	6	6	7
	29	.	.	.	1	1	.	.	.	.	.	10	10	11
	30	.	.	.	.	.	.	.	.	.	.	9	9	9
	31	.	.	.	2	2	.	.	8	.	1	4	13	15
	32	.	.	.	.	.	.	.	.	.	.	3	3	3
	34	.	.	.	.	.	.	.	.	.	.	1	1	1
	35	.	.	.	.	.	.	.	.	.	.	1	1	1
	39	.	.	.	1	1	.	.	.	.	.	2	2	3
	ALL	.	.	4	59	63	12	12	8	13	3	492	516	591
2	WK													
	21	.	.	.	.	.	7	7	.	.	.	.	.	7
	22	.	.	.	.	.	7	7	.	.	.	2	2	9
	24	3	3	1	5	6	.	.	.	4	1	88	93	102
	25	.	.	1	4	5	.	.	.	6	1	103	110	115
	26	.	.	.	6	6	.	.	.	1	.	161	162	168
	27	.	.	.	2	2	.	.	.	2	.	59	61	63
	28	.	.	.	4	4	.	.	.	.	.	25	25	29
	29	.	.	.	.	.	.	.	.	.	.	4	4	4
	31	.	.	.	.	.	.	.	.	.	.	4	4	4
	ALL	3	3	2	21	23	14	14	.	13	2	446	461	501
ALL	WK													
	21	.	.	.	.	.	7	7	.	.	.	.	.	7
	22	.	.	.	8	8	15	15	.	.	.	3	3	26
	23	.	.	2	24	26	3	3	.	.	.	24	24	53
	24	3	3	1	23	24	1	1	.	6	2	167	175	203
	25	.	.	3	7	10	.	.	.	14	1	411	426	436
	26	.	.	.	7	7	.	.	.	4	1	205	210	217
	27	.	.	.	2	2	.	.	.	2	.	59	61	63
	28	.	.	.	5	5	.	.	.	.	.	31	31	36
	29	.	.	.	1	1	.	.	.	.	.	14	14	15
	30	.	.	.	.	.	.	.	.	.	.	9	9	9
	31	.	.	.	2	2	.	.	8	.	1	8	17	19
	32	.	.	.	.	.	.	.	.	.	.	3	3	3
	34	.	.	.	.	.	.	.	.	.	.	1	1	1
	35	.	.	.	.	.	.	.	.	.	.	1	1	1
	39	.	.	.	1	1	.	.	.	.	.	2	2	3
	ALL	3	3	6	80	86	26	26	8	26	5	938	977	1092

Table 8. Mean surface water temperatures recorded at Lower and Upper tagging traps on the Humber River, 1996.

Surface Temperature (C)	Mean	No. Small Tagged	No. Recaptured	Proportion Recaptured
0.0-4.9				
5.0-9.9	7.5	189	14	0.07
10.0-14.9	11.7	727	64	0.09
15.0-19.9	16.6	20	1	0.05
20 & up				
		936	79	0.08

Table 9. Recapture location of small salmon by angling on the Humber River in 1996.

Small

		RECAPTURE LOCATION									
		Unknown Loc.	Humber River	Lower Humber	Deer Lake	Little Falls	Big Falls	Adies Stream	Harrimans Steady	Taylors Brook	ALL
RELEASE:		N	N	N	N	N	N	N	N	N	N
AREA	WK										
1	22	.	.	.	.	.	1	.	.	.	1
	23	.	.	.	.	.	.	.	1	.	1
	24	1	.	.	.	1	3	1	1	.	7
	25	.	3	5	1	8	18	3	5	1	44
	26	.	1	1	.	.	1	.	.	.	3
	30	.	.	.	.	.	.	.	1	.	1
	ALL	1	4	6	1	9	23	4	8	1	57
2	WK										
	24	.	1	.	.	1	5	3	1	.	11
	25	.	.	.	.	.	2	.	3	.	5
	26	.	.	2	.	2	5	.	3	.	12
	28	.	2	.	.	.	.	.	1	.	3
	ALL	.	3	2	.	3	12	3	8	.	31
ALL	WK										
	22	.	.	.	.	.	1	.	.	.	1
	23	.	.	.	.	.	.	.	1	.	1
	24	1	1	.	.	2	8	4	2	.	18
	25	.	3	5	1	8	20	3	8	1	49
	26	.	1	3	.	2	6	.	3	.	15
	28	.	2	.	.	.	.	.	1	.	3
	30	.	.	.	.	.	.	.	1	.	1
	ALL	1	7	8	1	12	35	7	16	1	88

Table 10. Recaptures of tagged small salmon on the Humber River in 1996.
Note: 5=mortality;7=beach seine;3=angled (ret.);17&18=angled (rel.);
19=angled(unk.);161= Lower trap;162=Upper trap.

Small

		RECAPTURE GEAR							
		.	3	17	18	19	161	162	ALL
		N	N	N	N	N	N	N	N
AREA	WK								
1	22	.	1	.	.	.	.	.	1
	23	23	1	.	.	.	.	.	24
	24	72	7	.	.	.	.	.	79
	25	260	32	2	2	8	4	.	308
	26	40	2	1	.	.	.	1	44
	28	6	.	.	.	.	.	.	6
	29	10	.	.	.	.	.	.	10
	30	8	1	.	.	.	.	.	9
	31	4	.	.	.	.	.	.	4
	32	3	.	.	.	.	.	.	3
	34	1	.	.	.	.	.	.	1
	35	1	.	.	.	.	.	.	1
	39	2	.	.	.	.	.	.	2
	ALL	430	44	3	2	8	4	1	492
2	WK								
	22	2	.	.	.	.	.	.	2
	24	77	10	.	.	1	.	.	88
	25	97	3	2	.	.	1	.	103
	26	148	8	.	2	2	1	.	161
	27	59	.	.	.	.	.	.	59
	28	22	2	.	.	1	.	.	25
	29	4	.	.	.	.	.	.	4
	31	4	.	.	.	.	.	.	4
	ALL	413	23	2	2	4	2	.	446
ALL	WK								
	22	2	1	.	.	.	.	.	3
	23	23	1	.	.	.	.	.	24
	24	149	17	.	.	1	.	.	167
	25	357	35	4	2	8	5	.	411
	26	188	10	1	2	2	1	1	205
	27	59	.	.	.	.	.	.	59
	28	28	2	.	.	1	.	.	31
	29	14	.	.	.	.	.	.	14
	30	8	1	.	.	.	.	.	9
	31	8	.	.	.	.	.	.	8
	32	3	.	.	.	.	.	.	3
	34	1	.	.	.	.	.	.	1
	35	1	.	.	.	.	.	.	1
	39	2	.	.	.	.	.	.	2
	ALL	843	67	5	4	12	6	1	938

Table 11. Recapture week and location of tagged small salmon in 1996.

Angled (Ret.)

	Small									
	RECAPTURE LOCATION									
	Unknown Loc.	Humber River	Lower Humber	Deer Lake	Little Falls	Big Falls	Adies Stream	Harrima-ns Steady	Taylors Brook	ALL
RECWK										
.	.	1	.	.	.	1	.	2	.	4
25	1	.	.	.	3	3	1	1	.	9
26	.	.	4	1	3	12	.	1	.	21
27	.	.	2	.	3	3	1	2	.	11
28	.	.	1	.	.	3	.	1	1	6
29	.	.	.	.	.	2	2	2	.	6
30	.	1	.	.	.	.	.	1	.	2
31	.	1	.	.	.	.	2	1	.	4
32	.	.	.	.	.	1	.	.	.	1
33	.	.	.	.	.	.	1	.	.	1
34	.	.	.	.	.	1	.	.	.	1
35	.	.	.	.	.	1	.	.	.	1
ALL	1	3	7	1	9	27	7	11	1	67

Table 12. Recaptures of tagged large salmon on the Humber River in 1996.
Note: 5=mortality;7=beach seine;18=angled (rel.);161= Lower trap.

Large

		RECAPTURE GEAR					
		.	5	7	18	161	ALL
		N	N	N	N	N	N
AREA	WK						
1	22	8	.	.	.	.	8
	23	22	.	.	1	1	24
	24	17	.	1	.	.	18
	25	2	.	.	1	.	3
	26	1	.	.	.	.	1
	28	1	.	.	.	.	1
	29	1	.	.	.	.	1
	31	2	.	.	.	.	2
	39	1	.	.	.	.	1
	ALL	55	.	1	2	1	59
2	WK						
	24	5	.	.	.	.	5
	25	4	.	.	.	.	4
	26	6	.	.	.	.	6
	27	1	1	.	.	.	2
	28	4	.	.	.	.	4
	ALL	20	1	.	.	.	21
ALL	WK						
	22	8	.	.	.	.	8
	23	22	.	.	1	1	24
	24	22	.	1	.	.	23
	25	6	.	.	1	.	7
	26	7	.	.	.	.	7
	27	1	1	.	.	.	2
	28	5	.	.	.	.	5
	29	1	.	.	.	.	1
	31	2	.	.	.	.	2
	39	1	.	.	.	.	1
	ALL	75	1	1	2	1	80

Table 13. Carlin tag recaptures observed by creel survey clerks and returned voluntarily by anglers in 1996.

Recapture Location	Carlin Tag Number	Date Tagged (yymmdd)	Recapture date observed by clerk (yymmdd)	Recapture date reported by angler (yymmdd)	Kept/ Rel'd	Date Tag Rec'd (yymmdd)
BIG FALLS	N-2992	950706	960711	960711	R	960925
BIG FALLS	N-3619	960603	960629	960629	K	960916
BIG FALLS	N-3686	960611	.	.	K	.
BIG FALLS	N-3689	960611	960619	960619	K	960620
BIG FALLS	N-3690	960611	.	.		.
BIG FALLS	N-3773	960611	.	.	K	.
BIG FALLS	N-3782	960612	960619	960620	K	960620
BIG FALLS	N-3783	960612	.	.	R	.
BIG FALLS	N-3804	960613	.	.	R	.
BIG FALLS	N-3811	960614	.	.		.
BIG FALLS	N-3827	960614	960627	960627	K	960704
BIG FALLS	N-3829	960614	960701	960702	K	961108
BIG FALLS	N-3856	960615	960705	960705	K	960801
BIG FALLS	N-3940	960617	960625	960625	K	960630
BIG FALLS	N-3945	960617	960626	960626	K	960916
BIG FALLS	N-4028	960620	960630	960630	K	960916
BIG FALLS	N-4069	960620	960630	960628	K	960911
BIG FALLS	N-4077	960620	.	.	K	.
BIG FALLS	N-4092	960620	.	.	K	.
BIG FALLS	N-4172	960622	960629	.	K	961217
BIG FALLS	N-4185	960622	960630	960630	K	960916
BIG FALLS	N-4264	960622	.	.	R w tag	.
BIG FALLS	N-4302	960623	.	.	K	.
BIG FALLS	N-4476	.	.	.	K	.
BIG FALLS	N-4354	960624	960704	960704	K	960829
BIG FALLS	N-2628	950701	960827	960825	K	960919
CACHE RAPIDS	N-4576	960701	960727	960727	K	960814
BIGFALLS	N-4036	960620	960626	960628	K	960630
BIGFALLS		960730			R	
Total	28					17
Tag Reporting Rate						0.6071

Table 14. Estimation by two week period of angling exploitation rate based on tags available from the two estuarial tagging traps in 1996. Adjustments are made for tag loss and reporting rate.

Release Period	No. Small Tagged* (X1)	Median Days to Recapture (X2)	Proportion of Tags Retained (X3=1-(X2*0.009))	Adjusted Tags Available (X4=X1*X3)	Tags Returned (Ret) (X5)	Reporting Rate (X6)	Adjusted Tags Recaptured (X7=X5/X6)	Adjusted Angling ER (X8=X7/X4)
22-23	27	17	0.847	23	2	0.6071	3	0.1304
24-25	578	10	0.910	526	61	0.6071	100	0.1901
26-27	264	18	0.838	221	12	0.6071	20	0.0905
28-29	45	17	0.847	38	3	0.6071	5	0.1316
30-31	17	12	0.892	15	1	0.6071	2	0.1333
32-35	5	12	0.892	4	0	0.6071	0	0.0000
Overall	936	12	0.892	835	79	0.6071	130	0.1557

* No adjustment is made for tagged salmon not destined for the Humber River.

Table 15. Estimation of total catch of retained small Atlantic salmon on the Humber River, 1996. Numbers in parentheses are estimated 95% confidence limits.

SMALL CATCH (Ret.) = $\frac{\textbf{Adjusted Catch at Big Falls}}{\textbf{Prop. Humber Catch from Big Falls}}$

$= \frac{1500}{0.3165}$

= **4,740** (4,237 - 5,396)

Where:

Prop. Humber Catch taken at Big Falls = $\frac{\text{Big Falls Tags (Retained Small)}}{\text{Humber Tags (Retained Small)}} = \frac{25}{79} = 0.3165$

Table 16. Estimated returns and spawning escapement of Atlantic salmon on the Humber River, 1996.

	Parameter Value	95% C.I.	
		Lower	Upper
ESTIMATED PARAMETERS:			
Tags Recaptured*	130	116	147
Tags Available**	835	824	852
Exploitation Rate	0.1557	0.1408	0.1725
Ratio Large:Small	0.0880	0.0820	0.0940
Est. Small Retained	4,740	5,396	4,237
Ratio Small Rel..:Ret. (Creel)	0.6363		
Est. Small Released	3,016	3,433	2,696
Large Released (DFO)	237		
Assumed catch & release mortality rate	10%		
ESTIMATED RETURNS AND SPAWNING ESCAPEMENT:			
Petersen - single census estimate (95% CI from Ricker (1975))			
Returns:			
SMALL	30,445	25,642	36,150
LARGE	2,679	2,103	3,398
TOTAL	33,125	27,744	39,548
Potential Spawning Escapement: (adjusted for catch & release mortality)			
SMALL	25,404	20,246	31,913
LARGE	2,655	2,079	3,374
TOTAL	28,059	22,325	35,287

* Adjusted for mean reporting rate of 0.6071

** Adjusted for tag loss based on 0.009 tags/day.

Table 17. Estimation of the percentage of the conservation egg deposition requirement achieved in the Humber River, 1996.

Fluvial Rearing Units (100 sq. m): 115,307 (Porter and Chadwick, 1983)
Lacustrine Area (ha): 1,751 (Mullins and Chaput, MS 1994)

Minimum Egg Deposition Rate: 240 eggs per Rearing Unit
368 eggs per ha of Lacustrine Area

Biological Characteristics, 1996:

Fecundity: 1,540 eggs / kg

Small:	% overall	91.9	(tagging trap, 1996)
(<63 cm)	% female	59.9 (n=187)	(recreational, 1996)
	mean wt females	1.8 kg (n=109)	(recreational, 1996)
Large:	% overall	8.1	(tagging trap, 1996)
(>=63 cm)	% female	68.6	(commercial, 1991)
	mean wt females	3.7 + kg	(Porter and Chadwick, 1983)

Percent Conservation Egg Deposition Achieved, 1996:

= potential egg depositions / minimum conservation requirement X 100

$$= \frac{\text{small spawners x (eggs per small spawner) + large spawners x (eggs per large spawner)}}{\text{(Rearing Units x 240 eggs / unit) + (Lacustrine Area x 368 eggs / ha)}} \times 100$$

Where:

Eggs per Small Spawner = (.599 * 1.8 * 1,540)
= 1,660

Eggs per Large Spawner = (.686 * 3.7 * 1,540)
= 3,909

$$= \frac{\text{small spawners x } 1{,}660 \quad \text{large spawners x } 3{,}909}{28{,}318{,}048} \times 100$$

Where: Petersen (single census)

Small Spawners	=	25,404
Large Spawners	=	2,655
Total	=	28,059

= 186%

Table 18. Summary of Atlantic salmon spawning escapement and the percentage of the conservation egg deposition requirement achieved on the Humber River, 1990-96. Catch is based on creel survey results.
Conservation egg deposition requirement: 28.3 million eggs

	Estimated Returns			Angling Catch			Spawning Escapement*			% Egg Requirement
				Small		Large				
Year	Small	Large	Total	Retained	Released	Released	Small	Large	Total	Achieved**
1990	12,216	855	13,071	3,054	.	75	9,162	848	10,010	60
1991	5,724	401	6,125	1,431	.	11	4,293	400	4,693	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
Mean (92-95)	17,985	1,669	19,654	4,046	985	175	13,841	1,651	15,492	95

* Spawning escapements are adjusted from previous reports to account for 10% mortality on released fish.

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

Table 19. Estimation of conservation spawner requirements for the Humber River.

Fluvial Rearing Units:		115,307	(100 sq. m)	(Porter and Chadwick, 1983)
Lacustrine Area:		1,751	ha	(Mullins and Chaput, MS 1995)
Optimal Egg Deposition:		240	eggs/unit	(Elson, 1957)
		368	eggs/ha	(O'Connell et al., 1991)
Fecundity:		1,540	eggs/kg	(Porter and Chadwick, 1983)
Small -	% overall	94.4	(minimum, 1992-96)	
	% female	56.5	(recreational, 1992-96)	
	mean wt	1.8	(recreational, 1992-96)	
Large -	% overall	5.6	(minimum, 1992-96)	
	% female	68.6	(commercial, 1991)	
	mean wt	3.7	(Porter and Chadwick, 1983)	
Egg Deposition Requirement:		28,318,048	eggs	

	Small	Large	Total
Eggs per spawner:	1,478	219	1,697

Total Spawners Required: 16,684 (Small & Large)

	total
Small	15,749
Large	934
Total	16,684

Table 20. Total catches (in numbers) and daily averages, by quarter-month periods, for grilse and older "salmon" caught by 14 gill-net fishermen at McIvers, Bay of Islands in 1942. Also shown is the amount of gear used, and the catch per unit of gear. Grilse and "salmon" were classified by size (1 square fathom = 3,345 square metres) (Blair 1965, Table I).

End of quarter month period	Square fathoms of gear		Number of fish						Fish per 1000 square fathoms per day		
			Grilse		"Salmon"		Total				
	Total	Av.	No.	Av.	No.	Av.	No.	Av.	Grilse	"Salmon"	Total
May 31	3,600	450	0	...	7	0.9	7	0.9	...	1.9	1.9
June 7	21,388	3055	0	...	132	18.9	132	18.9	...	6.2	6.2
June 15	58,426	7303	3	0.4	421	52.6	424	53.0	0.1	7.2	7.3
June 23	61,526	7691	31	3.9	227	28.4	258	32.3	0.5	3.7	4.2
June 30	47,499	6786	166	23.7	209	29.9	375	53.6	3.5	4.4	7.9
July 7	34,469	4924	274	39.1	61	8.7	335	47.9	7.9	1.8	9.7
July 15	27,066	3383	311	38.9	14	1.8	325	40.6	11.5	0.5	12.0
July 23	12,328	1541	170	21.2	14	1.8	184	23.0	13.7	1.2	14.9
July 31	9,908	1238	56	7.0	13	1.6	69	8.6	5.7	1.3	7.0
Aug. 7	9,114	1302	19	2.7	27	3.9	46	6.6	2.1	3.0	5.1
Aug. 15	9,296	1162	8	1.0	16	2.0	24	3.0	0.9	1.7	2.6
Aug. 23	8,600	1075	3	0.4	6	0.8	9	1.1	0.3	0.7	1.0
Aug. 31	1,500	375	2	0.5	1	0.2	3	0.8	1.4	0.6	2.0
Total:	304,720	3174	1043	10.9	1148	12.0	2191	22.8	3.4	3.8	7.2

Table 21. Percentage of the various sea-age classes in samples from the commercial salmon fishery of Bay of Islands (Blair 1965, Table II).

	Maiden fish-years at sea			Previously spawned				Total older	
	Grilse	2+	3+	Once	Twice	Three times	Total	than grilse	No. of fish
	%	%	%	%	%	%	%	%	
June 1-15	2.6	76.8	...	18.1	2.5	...	20.6	97.4	155
June 16-30	39.6	50.6	...	9.4	0.4	....	9.8	60.4	255
July 1-15	81.1	14.0	...	3.4	0.9	0.6	4.9	18.9	349
July 16-31	83.0	8.2	...	7.0	1.8	...	8.8	17.0	171
Aug. 1-15	64.0	8.0	20.0	8.0	...	...	8.0	36.0	25
Total	57.2	32.8	0.5	8.2	1.2	0.2	9.5	42.8	955

Table 22. Percentage of the various sea-age classes in samples from the commercial salmon fishery on the Humber River in 1942 (Blair 1965, Ttable III).

	Maiden fish-years at sea			Previously spawned				Total older	
	Grilse	2+	3+	Once	Twice	Four times	Total	than grilse	No. of fish
	%	%	%	%	%	%	%	%	
June 16-30	70.6	23.5	...	5.9	...	....	5.9	29.4	17
July 1-15	100.0	...	...	...	...	...	...	...	2
July 16-31	66.7	...	...	...	...	33.3	33.3	33.3	3
Aug. 1-15	...	33.3	66.7	...	...	...	...	100.0	3
Aug. 16-31	44.4	...	33.3	11.1	11.1	...	22.2	55.6	9
Sept. 1-15	...	...	100.0	...	...	...	...	100.0	2
Sept. 16-30	66.7	...	33.3	...	...	...	...	33.3	3
Total	56.4	12.8	20.5	5.1	2.6	2.6	10.3	43.6	39

Table 23. Large salmon catches from sections of the Humber River, 1976 -1996.
River sections are shown in Figures 1 and 2.

	Large salmon (number) by location on Humber River								
Year	Humber River Total	Lower Humber	Deer Lake	Harrimans Steady	Little Falls	Big Falls	Adies Stream	Adies Lake	Taylor's Brook
1976	61	18	0	10	5	14	4	10	.
1977	45	10	1	0	6	26	2	0	0
1978	187	6	19	2	32	111	16	1	0
1979	27	10	0	4	0	13	0	0	0
1980	303	19	4	4	99	157	10	10	0
1981	153	61	2	1	6	78	4	1	0
1982	95	32	1	3	4	53	2	0	0
1983	47	13	1	1	4	24	1	2	1
1984	40	2	0	6	5	27	0	0	0
1985	0	0	0	0	0	0	0	0	.
1986	0	0	0	0	0	0	0	0	.
1987	0	0	0	0	0	0	0	0	0
1988	144	4	0	0	30	86	16	0	8
1989	8	1	0	0	0	7	0	0	0
1990	75	54	0	0	7	14	0	0	0
1991	11	11	0	0	0	0	0	0	0
1992	177	22	0	17	14	113	7	3	17
1993	125	48	0	0	15	42	12	2	6
1994	166	66	0	11	31	51	4	3	0
1995	233	93	0	43	30	47	6	6	8
1996	237	81	0	57	20	79	0	0	0
Mean									
1992-1996	188	62	0	26	22	66	6	3	6
1987-1991	48	14	0	0	7	21	3	0	2
1977-1986	90	15	3	2	16	49	4	1	0

Table 24. Angling effort (rod-days) on sections of the Humber River, 1976 -1996.
River sections are shown in Figures 1 and 2.

	Effort (rod-days) by location on Humber River								
Year	Humber River Total	Lower Humber	Deer Lake	Harrimans Steady	Little Falls	Big Falls	Adies Stream	Adies Lake	Taylor's Brook
1976	10489	1415	430	1454	1620	4076	369	1125	.
1977	6127	1243	494	288	778	2445	316	407	156
1978	7633	1312	883	503	1036	2390	491	598	420
1979	7961	1540	737	1010	891	2696	441	274	372
1980	8292	941	879	761	1365	3310	515	338	183
1981	8701	1355	701	708	914	3718	602	447	256
1982	8737	1240	206	816	1476	4194	318	370	117
1983	7746	1762	1224	803	945	1746	387	539	340
1984	7189	1359	322	1281	1174	2412	377	6	258
1985	7211	1196	570	282	1079	2807	479	798	.
1986	8635	1814	586	465	1082	2634	484	1570	.
1987	7250	1764	482	1005	804	2377	129	641	48
1988	8521	1247	144	923	1769	2894	512	630	402
1989	6014	749	434	713	783	1543	1200	220	372
1990	7008	805	193	1319	980	2377	300	843	191
1991	5770	1038	465	922	357	2014	411	63	500
1992	6072	1237	414	1034	360	2698	115	114	100
1993	7023	976	249	1210	936	2657	501	104	390
1994	5687	1398	118	559	745	2398	211	71	187
1995	6855	1459	237	1587	917	2040	336	77	207
1996	8978	681	217	1433	1006	5028	286	104	223
Mean									
1992-1996	6923	1150	247	1165	793	2964	290	94	221
1987-1991	6913	1121	344	976	939	2241	510	479	303
1977-1986	7823	1376	660	692	1074	2835	441	535	210

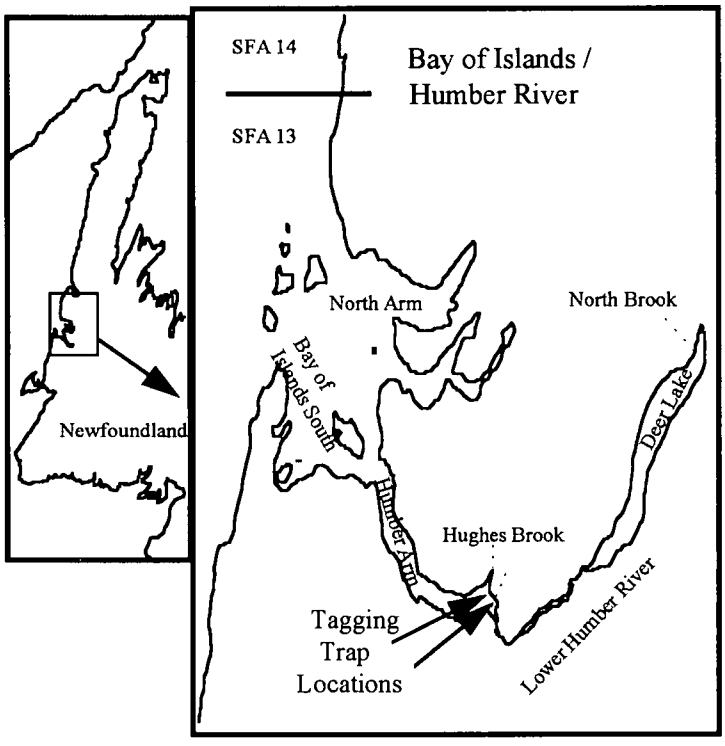


Figure 1. Location of two Atlantic salmon tagging traps operated on the Humber River in 1996.

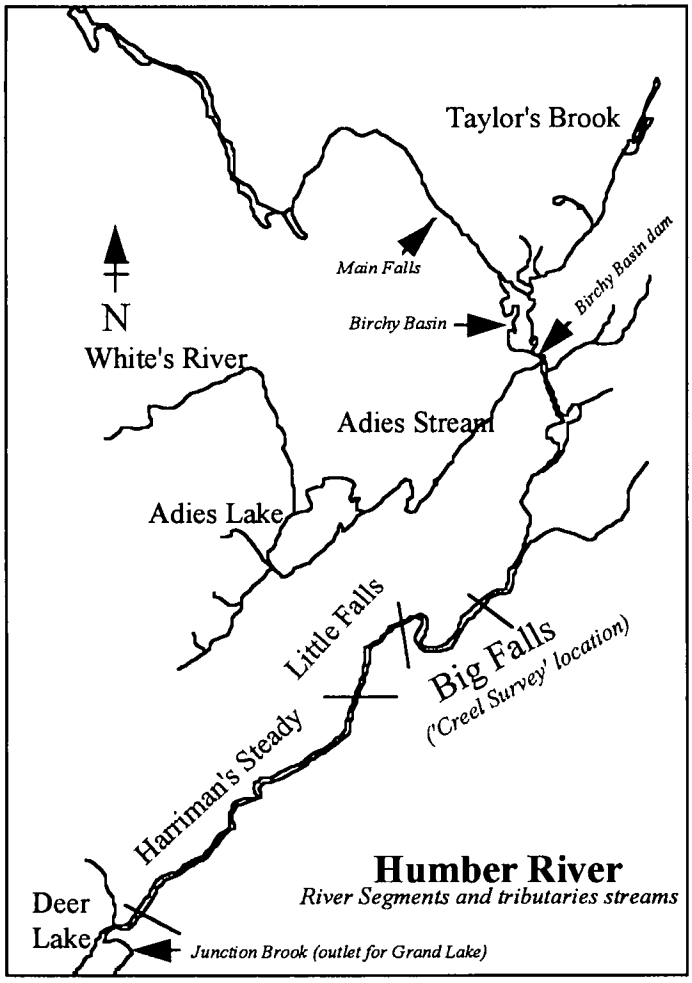


Figure 2. River segments of the Humber River, upstream of Deer Lake and showing the Big Falls Creel Survey location.

From Hare, 1990.

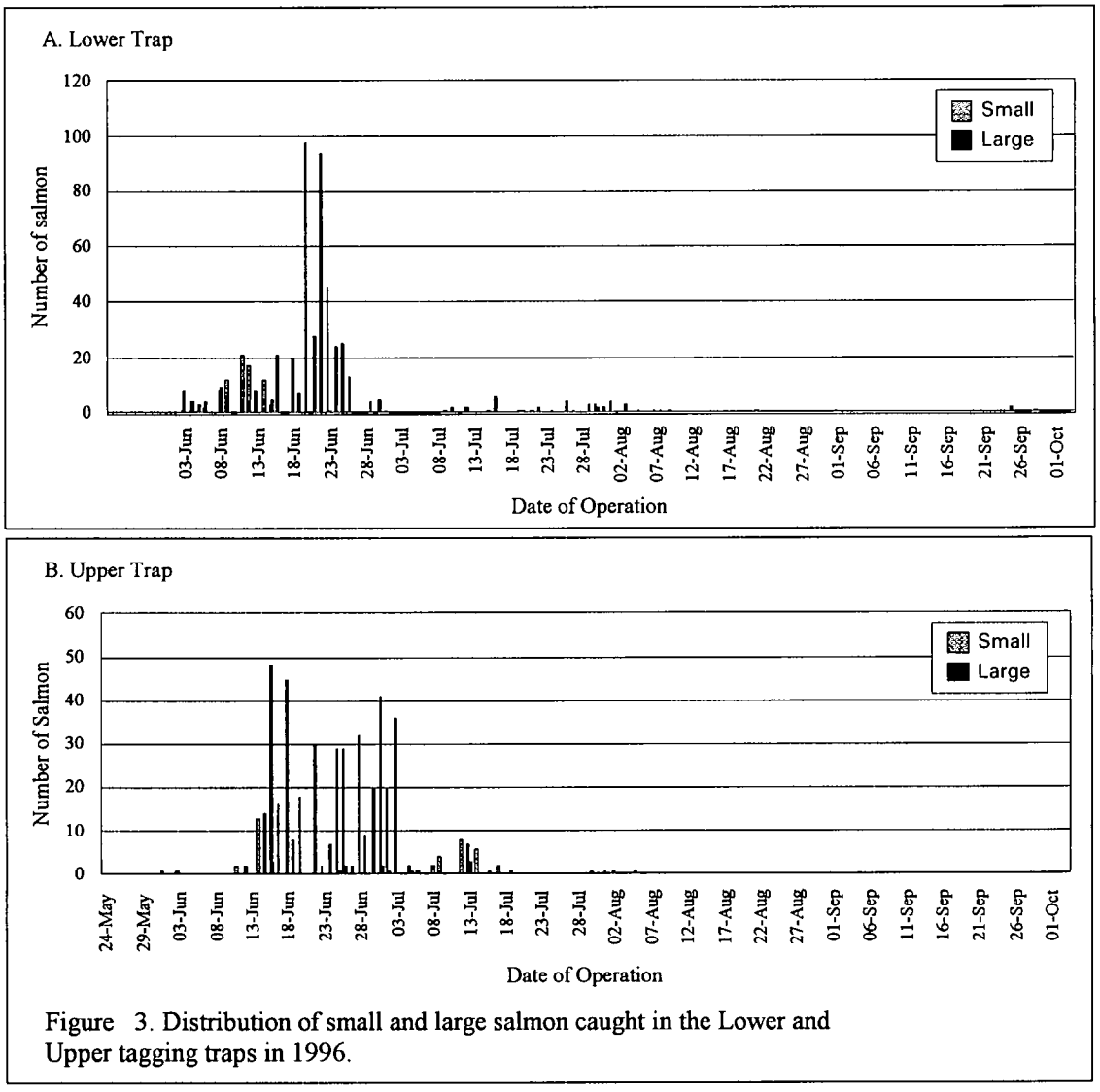


Figure 3. Distribution of small and large salmon caught in the Lower and Upper tagging traps in 1996.

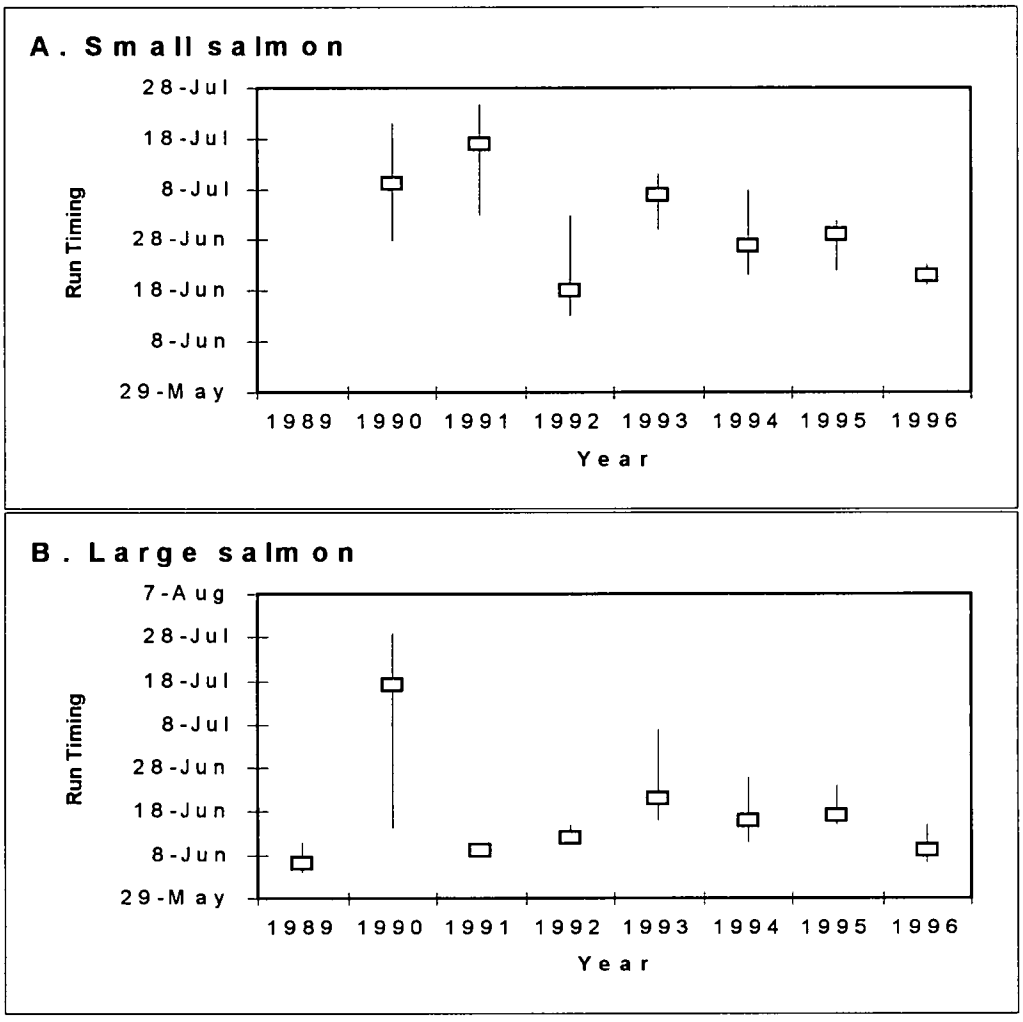


Figure 4. Run timing of small and large Atlantic salmon at the Lower tagging trap on the Humber River, 1989-96. Lines represent the 25th to the 75th percentiles of the cumulative run and the centre symbol represents the 50th percentile of the run.

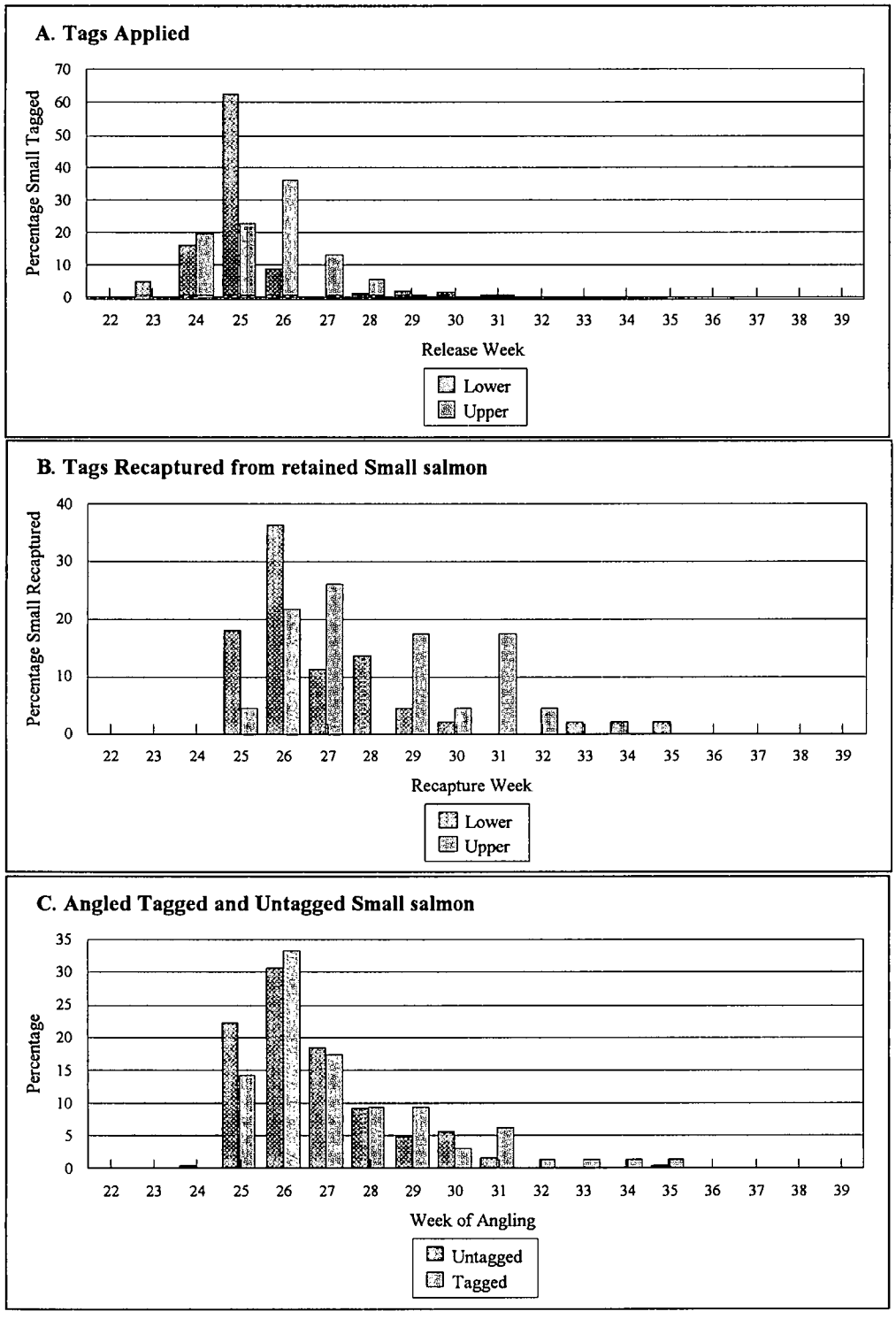


Figure 5. Weekly distribution of tag applications and recaptures in angling of both tagged and untagged small salmon on the Humber River in 1996.

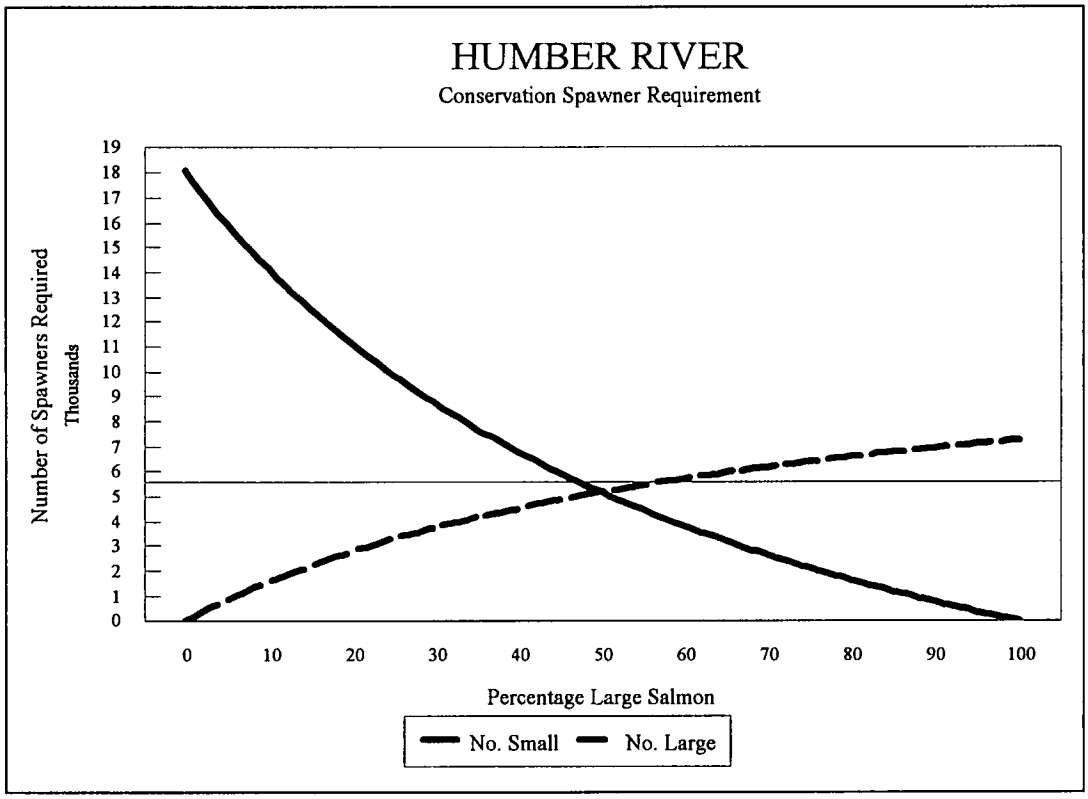


Figure 6. Simulation of Atlantic salmon conservation requirements for the Humber River in terms of small and large salmon spawners based on varying percentage contribution of eggs from large salmon.

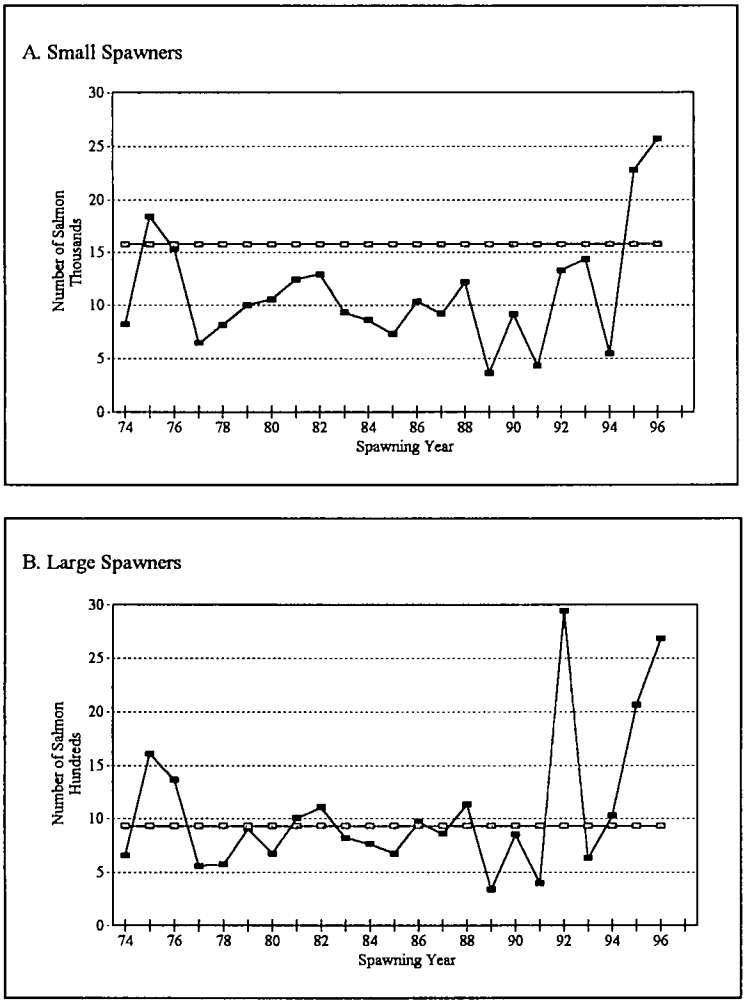
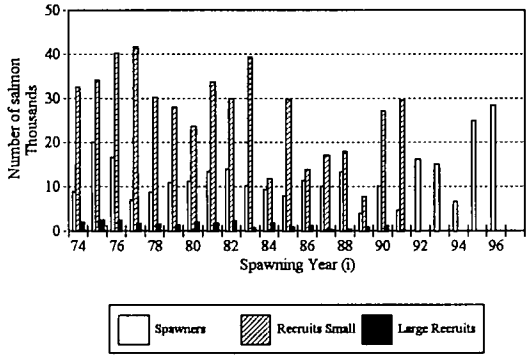
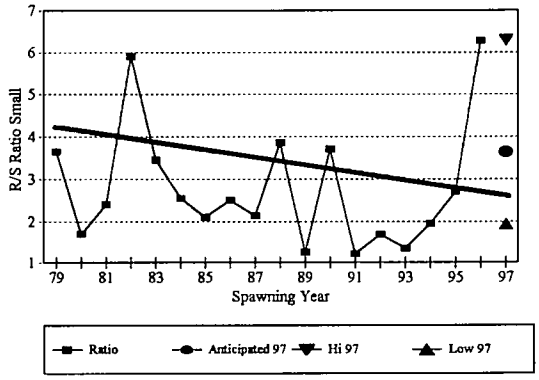


Figure 7. Estimated small and large Atlantic salmon spawners on the Humber River. 1974-96. Horizontal lines represent the conservation spawner requirements.

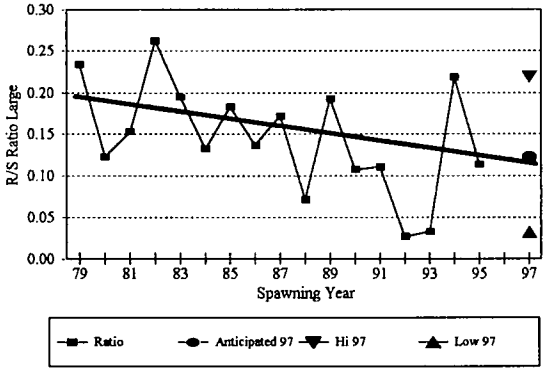
A. Stock & Recruit



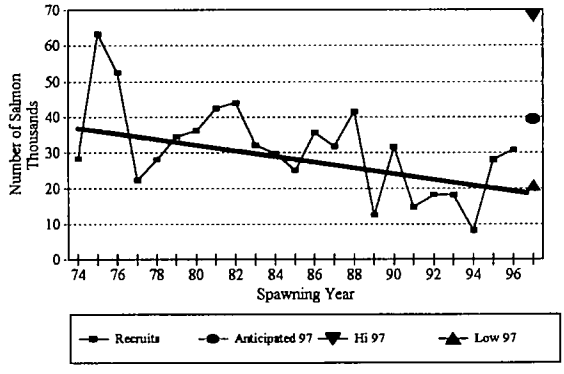
B. Recruits per Small Spawner



C. Recruits per Large Spawner



D. Total Recruits



E. Total Spawners

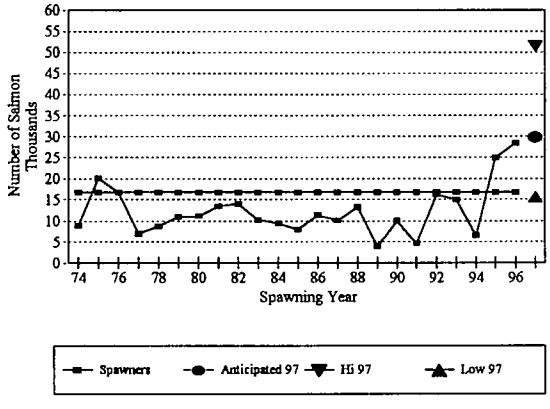


Figure 8. Stock and recruit relationship for Humber River Atlantic salmon 1974-1996 an values for 1997. Diagonal lines are trend lines. Horizontal line in Figure 8E represents the total conservation spawner requirement.

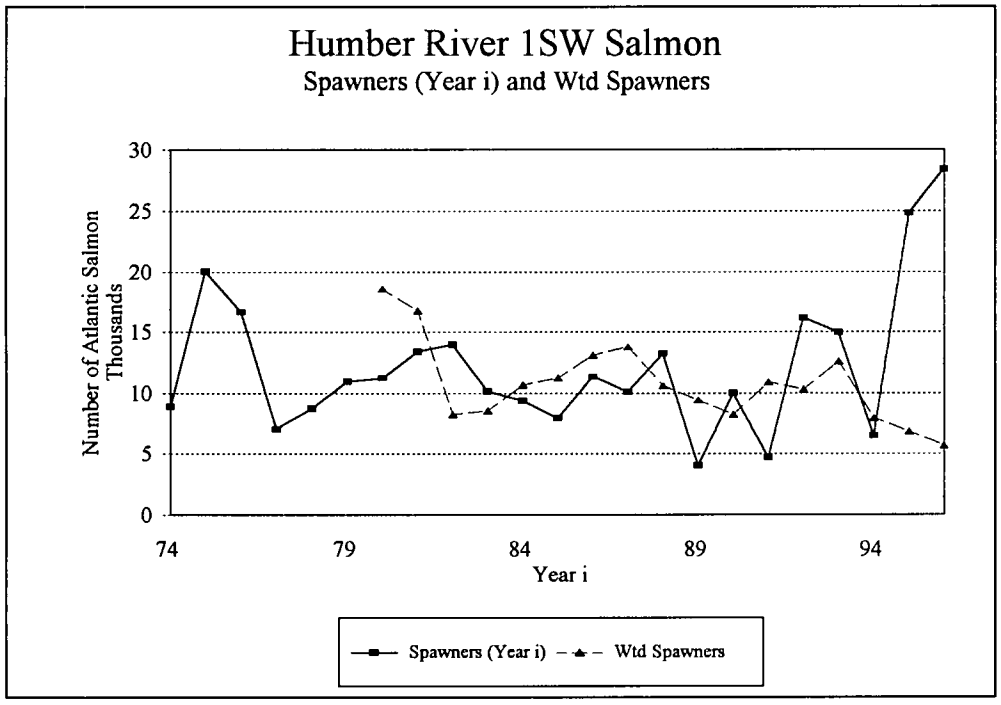


Figure 9. Relationship between total spawners in Year i and spawner recruits adjusted for yearclass (wtd spawners).

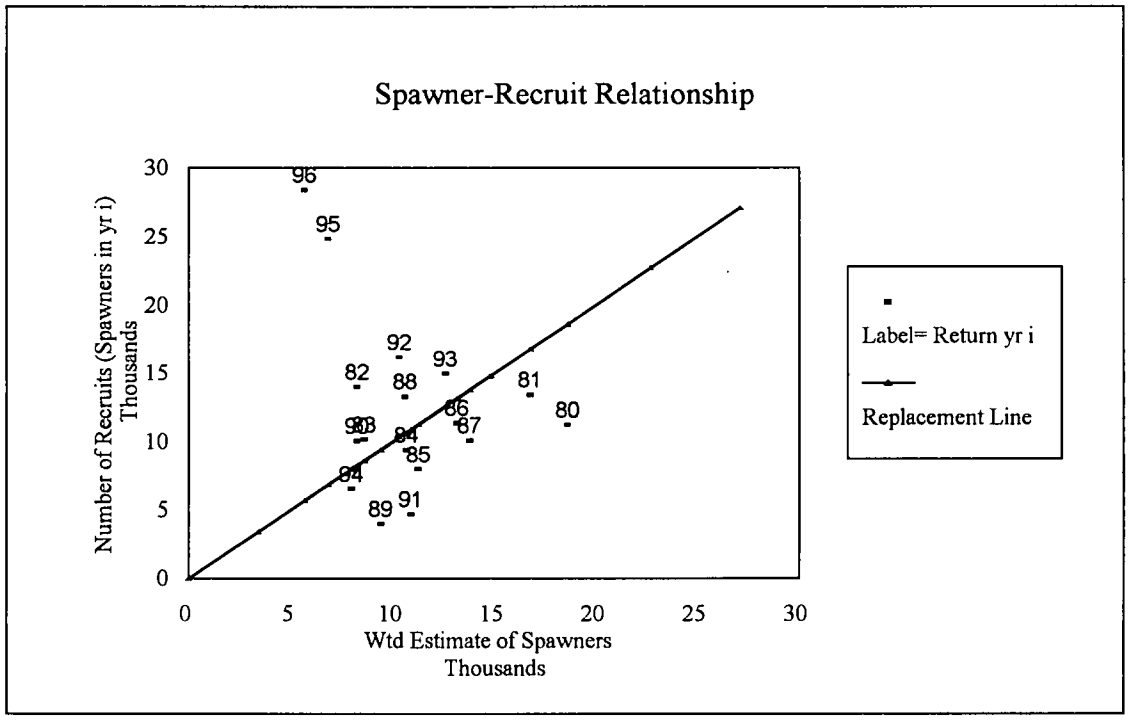


Figure 10. Relationship between 1SW salmon spawners and recruits on the Humber River, 1980-96.

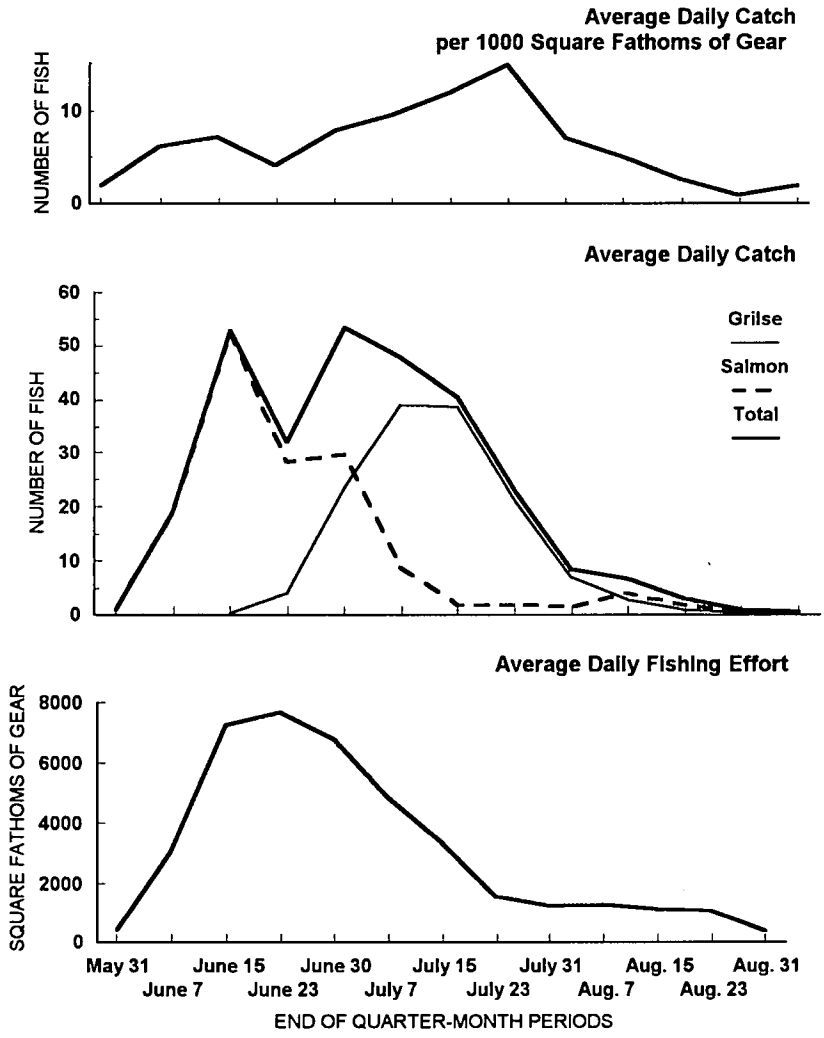


Figure 11. Average daily fishing effort, average daily catch, and average daily catch per 1000 square fathoms of gear by quarter-month periods, for 14 fishermen fishing gill nets at McIvers, Bay of Islands, 1942 (from Blair 1965).

Appendix 1. Creel survey schedule, 1996.

SURVEY PERIODS: TIME:

A= 06:00 to 10:00
B= 10:00 to 14:00
C= 14:00 to 18:00
D= 18:00 to 22:00

CLERKS: # NAME:

1. _____ 4. _____ 7. _____
2. _____ 5. _____ 8. _____
3. _____ 6. _____ 9. _____

LOCATION:
Boat=boat landing
Stair=stairway below falls
Point=mistaken point

Note1: Clerks will remain at their designated location for the duration of their shift. Shifts are 8 hours long. The work day will begin and end at the same location.

Note2: You still need to record on the data sheet each 4 hour PERIOD (A, B, C, or D) worked. You can use a new sheet for each 4 hour period. Also remember to record the 15 minute intervals.

Big Falls Creel Survey Schedule, 1996

Week	Day of Week	Date Day	Date Mon.	SURVEY PERIOD / LOCATION 0500 - 0600 Point	0500 - 0600 Stair	0500 - 0600 Boat	0600 - 1400 Point	0600 - 1400 Stair	0600 - 1400 Boat	1400 - 2200 Point	1400 - 2200 Stair	1400 - 2200 Boat	2200 - 2300 Point	2200 - 2300 Stair	2200 - 2300 Boat	Data/ Scales	Data/ Scales	Day Off	Day Off
	Mon.	17	Jun.	Orientation															
1	Tues.	18	Jun.				1	2		3	4							5	6
1	Wed.	19	Jun.				2	3		4	5							6	1
1	Thurs.	20	Jun.				3	4		5	6							1	2
1	Fri.	21	Jun.				4	5		6	1							2	3
2	Sat.	22	Jun.				5	6		1	2							3	4
2	Sun.	23	Jun.				6	1		2	3							4	5
2	Mon.	24	Jun.				1	2		3	4					5	6		
2	Tues.	25	Jun.				2	3		4	5							6	1
2	Wed.	26	Jun.				3	4		5	6							2	1
2	Thurs.	27	Jun.				4	5		6	1							2	3
2	Fri.	28	Jun.				5	6		1	2							3	4
3	Sat.	29	Jun.				6	1		2	3							4	5
3	Sun.	30	Jun.				1	2		3	4							5	6
3	Mon.	1	Jul.				2	3		4	5					6	1		
3	Tues.	2	Jul.				3	4		5	6							1	2
3	Wed.	3	Jul.				4	5		6	1							3	2
3	Thurs.	4	Jul.				5	6		1	2							3	4
3	Fri.	5	Jul.				6	1		2	3							4	5
4	Sat.	6	Jul.				1	2		3	4							5	6
4	Sun.	7	Jul.				2	3		4	5							6	1
4	Mon.	8	Jul.				3	4		5	6					1	2		

Appendix 2. Adjustments to tag returns for unknown retained and released fish.

Tag Release Week	Tags from fish retained code=3	Tags from fish released with tag code=17	Tags from fish released without tag code=18	Total tags removed from fish	Prop. tags from retained fish	Prop. tags from released fish	Tags removed from unknown ret. or rel fish code=19	Estimated # Unknowns Ret.	Estimated # Unknowns Rel. wo Tag	**Adjusted # tags from fish retained**	**Adjusted # tags from fish rel. wo tag**	Tags Available
22	1	0	0	1	1.00	0.00	0			**1**	0	3
23	1	0	0	1	1.00	0.00	0			**1**	0	24
24	17	0	0	17	1.00	0.00	1	1	0	**18**	0	167
25	35	4	2	37	0.95	0.05	8	8	0	**43**	2	411
26	10	1	2	12	0.83	0.17	2	2	0	**12**	2	205
27	0	0	0	0	0.94	0.06	0	0	0	**0**	0	59
28	2	0	0	2	1.00	0.00	1	1	0	**3**	0	31
29	0	0	0	0	0.94	0.06	0	0	0	**0**	0	14
30	1	0	0	1	1.00	0.00	0	0	0	**1**	0	9
31	0	0	0	0			0			**0**	0	8
32	0	0	0	0			0			**0**	0	3
33	0	0	0	0			0			**0**	0	0
34	0	0	0	0			0			**0**	0	1
35	0	0	0	0			0			**0**	0	1
36	0	0	0	0			0			**0**	0	2
Total	67	5	4	71	0.94	0.06	12	12	0	**79**	4	938

Appendix 3. Mean fork length, weight and sex composition of small and large female Atlantic salmon of the Humber River, 1988-1996. Sex is 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
	PRE-M	2	63.4	63.2	63.5	0.2	0	.	.	.	.	1	1	100.0
	MORAT.	13	66.1	63.0	93.5	8.6	4	2.4	2.0	2.7	0.3	8	5	62.5
	Total	15	65.7	63.0	93.5	8.0	4	2.4	2.0	2.7	0.3	9	6	66.7
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	2.0	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	118	55.5	48.0	62.0	2.7	18	1.6	1.2	1.9	0.2	72	37	51.4
	96	294	55.6	47.0	62.5	2.7	109	1.8	1.1	2.8	0.3	187	112	59.9
	PRE-M	439	54.8	43.3	62.5	3.0	74	1.6	1.0	2.5	0.2	243	122	50.2
	MORAT.	1268	55.7	47.0	62.8	2.8	254	1.8	1.0	2.8	0.3	708	400	56.5
	Total	1707	55.5	43.3	62.8	2.9	328	1.7	1.0	2.8	0.3	951	522	54.9

Appendix 4. Mean fork length, weight and sex composition of small and large female Atlantic salmon of the Humber River, 1988-1996. Sex is determined from internal examination.

Tagging 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	.
	PRE-M	31	73.7	63.0	92.0	7.3	0	.	.	.	.	5	5	100.0
	MORAT.	396	74.9	63.0	115.0	6.0	1	5.0	5.0	5.0	.	1	1	100.0
	Total	427	74.9	63.0	115.0	6.1	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
	PRE-M	359	54.0	37.3	62.8	3.8	24	1.3	0.9	1.9	0.2	68	48	70.6
	MORAT.	4677	53.2	34.7	62.9	2.8	58	1.6	1.0	2.8	0.4	100	67	67.0
	Total	5036	53.2	34.7	62.9	2.9	82	1.5	0.9	2.8	0.4	168	115	68.5

Appendix 5. Sea-age distribution of small and large Atlantic salmon of the Humber River

Angling

		SEA-AGE					
		1SW		1SW RS		Total	
		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
	PRE-M	2	100.0	.	.	2	100.0
	MORAT.	9	69.2	4	30.8	13	100.0
	Total	11	73.3	4	26.7	15	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	109	99.1	1	0.9	110	100.0
	96	289	99.0	3	1.0	292	100.0
	PRE-M	428	99.3	3	0.7	431	100.0
	MORAT.	1201	99.2	10	0.8	1211	100.0
	Total	1629	99.2	13	0.8	1642	100.0

Appendix 6. Sea-age distribution of small and large Atlantic salmon of the Humber River

Tagging Traps

		SEA-AGE									
		1SW		2SW		1SW RS		2SW RS		Total	
		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
	PRE-M	6	20.0	9	30.0	14	46.7	1	3.3	30	100.0
	MORAT.	14	3.6	164	42.1	188	48.2	24	6.2	390	100.0
	Total	20	4.8	173	41.2	202	48.1	25	6.0	420	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
	PRE-M	337	94.4	.	.	20	5.6	.	.	357	100.0
	MORAT.	3956	98.0	1	0.0	80	2.0	.	.	4037	100.0
	Total	4293	97.7	1	0.0	100	2.3	.	.	4394	100.0

Appendix 7. Smolt-age distribution of small and large Atlantic salmon of the Humber River. Virgin spawners only.

Angling

		SMOLT-AGE															
		2			3			4			5			Total			
		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
	PRE-M	.	.	.	2	100.0	3.0	.	.	.	.	.	.	2	100.0	3.0
	MORAT.	.	.	.	7	77.8	3.0	2	22.2	4.0	.	.	.	9	100.0	3.2
	Total	.	.	.	9	81.8	3.0	2	18.2	4.0	.	.	.	11	100.0	3.2
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	.	.	.	59	54.1	3.0	50	45.9	4.0	.	.	.	109	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
	PRE-M	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
	MORAT.	15	1.3	2.0	766	64.2	3.0	404	33.8	4.0	9	0.8	5.0	1194	100.0	3.3
	Total	36	2.2	2.0	1073	66.2	3.0	501	30.9	4.0	10	0.6	5.0	1620	100.0	3.3

Appendix 8. Smolt-age distribution of small and large Atlantic salmon of the Humber River. Virgin spawners only.

Tagging Traps

		SMOLT-AGE																		
		2			3			4			5			6			Total		
		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
	PRE-M	1	6.7	2.0	11	73.3	3.0	3	20.0	4.0	.	.	.	.	.	.	15	100.0	3.1
	MORAT.	6	3.4	2.0	108	61.0	3.0	63	35.6	4.0	.	.	.	.	.	.	177	100.0	3.3
	Total	7	3.6	2.0	119	62.0	3.0	66	34.4	4.0	.	.	.	.	.	.	192	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
	PRE-M	10	3.0	2.0	299	88.7	3.0	28	8.3	4.0	.	.	.	.	.	.	337	100.0	3.1
	MORAT.	41	1.0	2.0	2217	56.4	3.0	1621	41.2	4.0	53	1.3	5.0	2	0.1	6.0	3934	100.0	3.4
	Total	51	1.2	2.0	2516	58.9	3.0	1649	38.6	4.0	53	1.2	5.0	2	0.0	6.0	4271	100.0	3.4

Appendix 9. Total production from Humber River, Nfld salmon stocks. River escapements are adjusted for virgin spawners only.

Spawning	Recruit	Total river escapement		Adjusted river escapement		Total recruits (R/0.4)	(R/0.2)		Angling Removals			Spawning escapement			Spawning escapement adj. for Recruit year (i+5)			Total recruits adj. for year-class			Recruits/spawners (R/S ratio)			% large salmon by	Multiplier for large
Year (i)	Year (i+5)	Small	Large	Small	Large	Small	Large	Total	Small	Large	Total	Small	Large	Total	Small	Large	Total	Small	Large	Total	Small	Large	Total	smolt class	salmon
																			1628						
74	79	10968	768	10631	326	26578	1628	28206	2742	107	2849	8226	661	8887				26578	3648	30226				12.1	1.06
75	80	24588	1721	23833	730	59583	3648	63231	6147	114	6261	18441	1607	20048				59583	3029	62612				4.8	1.06
76	81	20408	1429	19781	606	49454	3029	52482	5102	61	5163	15306	1368	16674				49454	1280	50734				2.5	1.06
77	82	8632	604	8367	256	20917	1280	22198	2158	45	2203	6474	559	7033				20917	1615	22533				7.2	1.06
78	83	10888	762	10554	323	26384	1615	27999	2722	187	2909	8166	575	8741				26384	1984	28368				7.0	1.06
79	84	13372	936	12961	397	32404	1984	34388	3343	27	3370	10029	909	10938	8226	661	8887	32404	2083	34487	3.6462	0.2344	3.8806	6.0	1.06
80	85	14048	983	13617	417	34042	2083	36125	3512	303	3815	10536	680	11216	18441	1607	20048	34042	2452	36494	1.6980	0.1223	1.8203	6.7	1.06
81	86	16528	1157	16021	490	40051	2452	42504	4132	153	4285	12396	1004	13400	15306	1368	16674	40051	2543	42595	2.4020	0.1525	2.5546	6.0	1.06
82	87	17148	1200	16622	509	41554	2543	44097	4287	95	4382	12861	1105	13966	6474	559	7033	41554	1846	43400	5.9084	0.2625	6.1709	4.3	1.06
83	88	12440	871	12058	369	30145	1846	31991	3110	47	3157	9330	824	10154	8166	575	8741	30145	1704	31849	3.4487	0.1950	3.6437	5.4	1.06
84	89	11488	804	11135	341	27838	1704	29542	2872	40	2912	8616	764	9380	10029	909	10938	27838	1441	29280	2.5451	0.1318	2.6769	4.9	1.06
85	90	9720	680	9422	288	23554	1441	24995	2430	0	2430	7290	680	7970	10536	680	11216	23554	2052	25606	2.1000	0.1829	2.2830	8.0	1.06
86	91	13824	968	13400	410	33499	2052	35551	3456	0	3456	10368	968	11336	12396	1004	13400	33499	1825	35324	2.4999	0.1362	2.6361	5.2	1.06
87	92	12296	861	11919	365	29796	1825	31621	3074	0	3074	9222	861	10083	12861	1105	13966	29796	2399	32196	2.1335	0.1718	2.3053	7.5	1.06
88	93	16168	1132	15672	480	39179	2399	41578	4042	0	4042	12126	1132	13258	9330	824	10154	39179	723	39902	3.8585	0.0712	3.9297	1.8	1.06
89	94	4868	341	4719	145	11796	723	12519	1217	0	1217	3651	341	3992	8616	764	9380	11796	1812	13609	1.2576	0.1932	1.4508	13.3	1.06
90	95	12216	855	11841	362	29602	1812	31415	3054	0	3054	9162	855	10017	7290	680	7970	29602	850	30452	3.7142	0.1066	3.8209	2.8	1.06
91	96	5724	401	5548	170	13871	850	14721	1431	0	1431	4293	401	4694	10368	968	11336	13871	1248	15119	1.2236	0.1101	1.3337	8.3	1.06
92		17571	2945	17032	1248	17032	1248	18280	4349	0	4349	13222	2945	16167	9222	861	10083	17032	270	17301	1.6891	0.0267	1.7159	1.6	1.07
93		18477	636	17910	270	17910	270	18179	4161	0	4161	14316	636	14952	12126	1132	13258	17910	437	18346	1.3509	0.0329	1.3838	2.4	1.02
94		7995	1030	7750	437	7750	437	8186	2523	0	2523	5472	1030	6502	3651	341	3992	7750	875	8624	1.9413	0.2192	2.1604	10.1	1.06
95		27898	2064	27042	875	27042	875	27916	5150	0	5150	22748	2064	24812	9162	855	10017	27042	1136	28177	2.6996	0.1134	2.8129	4.0	1.03
96		30445	2679	29510	1136	29510	1136	30646	4740	0	4740	25705	2679	28384	4293	401	4694	29510			6.2868				
97															13222	2945	16167								
															14316	636	14952								
															5472	1030	6502								
															22748	2064	24812								
															25705	2679	28384								

Anticipated Returns in 1997
(based on the average R/S in 1993-96)

	R/S Ratio			No. of Salmon		
	Small	Large	Total	Small	Large	Total
Mean	3.6426	0.1218	3.7644	38518	871	39389
Hi	6.2868	0.2192	6.5060	66480	1567	68047
Low	1.9413	0.0329	1.9742	20528	235	20763

Estimate of Precision
Observed - expected returns in 1992-96.
Comparison in 92-95 based on R/S ratio in 1992-94.

Recruit	Expected No.		Diff (Obs-exp)		% Diff (Obs/Exp)	
Year	Small	large	Small	Large	Small	large
92	16992	612	40	636	0	51
93	21381	595	-3472	-326	-19	-121
94	8475	682	-725	-245	-9	-56
95	15432	320	11610	555	43	63
96	15073	637	14438	499	49	44
Mean					13	-4