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THE STATUS OF THE ATLANTIC SALMON (*Salmo salar* L.) STOCK OF THREE SELECTED RIVERS IN SFA 14A, NEWFOUNDLAND, 1997

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ABSTRACT

Small salmon returns to Lomond River in 1997 were 31% higher than in 1996 but were 45% lower on Torrent River and 59% lower on Western Arm Brook. Large salmon returns to Lomond River were 21% lower than in 1996 but were 32% higher on Torrent River and 10% higher on Western Arm Brook. Returns of both small and large salmon were higher than the 1984-91 means on all three rivers. The proportion of large salmon increased since 1992 on all three rivers and was the highest recorded on Torrent River and Western Arm Brook in 1997. Conservation egg deposition and spawner requirements were exceeded on all three rivers in 1997. The low number of small salmon returns to Western Arm Brook in 1997 was unexpected because smolt survival since 1992 had increased compared to pre-moratorium years. Smolt survival in 1997 was only 3.0%, 50% less than the 1992-96 mean. The total population size of small salmon in some per-moratorium years was higher than in moratorium years on all three rivers. This trend is not expected to change in 1998. However, on the basis of the recruit and spawner relationships and provided that the smolt survival remains the same, recruitment of small salmon is expected to be higher in 1998 than in 1997. Spawning escapements are expected to exceed conservation requirements on all three rivers in 1998. Smolt production of 23,845 on Western Arm Brook in 1997 was the highest recorded. If smolt survival continues to decline in 1998, returns will be lower than expected on all three rivers.

RÉSUMÉ

Les remontées de petits saumons vers la rivière Lomond en 1997 ont augmenté de 31 % par rapport à 1996, tandis qu'elles ont diminué de 45 % dans la rivière Torrent et de 59 %, dans le Western Arm Brook. Les remontées de gros saumons vers la Lomond ont diminué de 21 % par rapport à 1996, mais elles ont progressé de 32 % dans la Torrent et de 10 % dans le Western Arm Brook. Les remontées des petits comme des gros saumons vers les trois cours d'eau ont été supérieures aux moyennes des années 1984 à 1991. Dans les trois, également, les proportions de gros saumons se sont accrues depuis 1992 et, en 1997, elles ont été les plus fortes enregistrées dans la rivière Torrent et le Western Arm Brook. En 1997, la ponte et le nombre de géniteurs nécessaires à la conservation ont été excédés dans les trois cours d'eau. La faiblesse de la remontée des petits saumons dans le Western Arm Brook en 1997 était inattendue, car, depuis 1992, la survie des saumoneaux s'était améliorée par rapport aux années précédant le moratoire. En 1997, la survie des saumoneaux était seulement de 3 %, soit 50 % de moins que la moyenne des années 1992 à 1996. L'abondance totale des petits saumons dans les trois rivières a été plus importantes au cours de certaines années avant le début du moratoire qu'elle ne l'a été depuis. Cette tendance devrait se maintenir en 1998. Cependant, en se basant sur la relation entre les recrues et les géniteurs et à la condition que la survie des saumoneaux se maintienne, on peut prévoir une hausse du recrutement des petits saumons en 1998 par rapport à 1997. On estime qu'en 1998, les échappées de géniteurs surpasseront les besoins de conservation dans les trois cours d'eau. En 1997, la production de 23 845 saumoneaux dans le Western Arm Brook a été la plus forte enregistrée. Si la survie des saumoneaux poursuit son déclin en 1998, les remontées dans les trois cours d'eau seront inférieures aux attentes.

INTRODUCTION

Lomond River, Torrent River, and Western Arm Brook are three of fourteen scheduled rivers in Salmon Fishing Area (SFA) 14A (Fig. 1). Returns of adult Atlantic salmon have been monitored at fish passage facilities on Lomond and Torrent since the 1960s and at a counting fence on Western Arm Brook since 1971. The smolt output of Western Arm Brook has also been monitored since 1971. The fishway on Lomond River is located approximately 5.0 km upstream from the mouth of the river and the fishway on Torrent River is 2.0km upstream from the mouth. The counting fence on Western Arm Brook is located just above the head of tide.

Recreational fisheries on these rivers are controlled on an individual river basis. On Lomond River, angling is restricted to downstream of the fishway and is currently controlled by a river quota of 375 retained small salmon. The restriction above the fishway has been in place since 1978 and the quota of 375 small salmon has been in place since 1995 when it was increased from a quota of 350 small salmon that was in place in 1986-94. Angling on Torrent River is also restricted to downstream of the fishway and catch and release angling only is permitted until a minimum spawning escapement of 750 salmon have passed upstream – retention angling is then permitted. This minimum spawning escapement of 750 fish has been in place since 1995 when it was reduced from the 1,000 fish that was in place since the 1970s. Prior to 1996, catch and release angling was not permitted prior to the minimum spawning escapement being achieved. The recreational fishery on Western Arm Brook has been closed since 1989.

This is the sixth year of the commercial salmon moratorium implemented in 1992. The moratorium was a major management initiative to rebuild declining salmon stocks. The objective was to reduce commercial fishing mortality in order to provide the potential for increased river returns. In addition, recreational fishing mortality has been controlled since 1992 to increase spawning escapements.

The effect of the commercial salmon moratorium on salmon stock abundance can be evaluated on Lomond River, Torrent River and Western Arm Brook by comparing the recruitment in the moratorium years (1992-97) with recruitment in pre-moratorium years (1984-91). However, it must be kept in mind that, although, the commercial salmon moratorium was implemented in SFA 14A in 1992, it was not until August 1993 that the commercial cod moratorium was implemented in this area. As a result, in 1992, the potential still existed for a high fishing mortality of salmon at sea because of the presence of cod traps. Spawning escapements on these rivers can also be evaluated relative to the conservation egg deposition and spawner requirements.

The effect of the moratorium on the survival of salmon at sea can be evaluated at Western Arm Brook based on smolt and adult counts. Smolt-to-adult survival as well as the relationship between spawners and subsequent recruitment can be used to derive an expectation of adult returns in 1998.

METHODS

RECREATIONAL FISHERY DATA

Recreational fishery data on Lomond River and Torrent River in 1997 were collected from license stub returns (O'Connell, 1998). In previous years these data were compiled from weekly reports of small (<63 cm) and large (>= 63 cm) salmon catches completed by the Department of Fisheries and Oceans (DFO) river guardians (Mullins et al., MS 1989; Mullins and Jones, MS 1993a; and Mullins and Jones, MS 1993b). The 1997 data is not comparable to the data of previous years. The recreational fishery on Western Arm Brook remained closed for the 1997 season.

ADULT RETURNS AND SPAWNING ESCAPEMENTS

Counts at counting facilities on Lomond River Torrent River and Western Arm Brook were used as indices for the total returns to the river (TRR) of small and large salmon based on:

$$TRR = C + RET + REL \times 0.1$$

where:

C = count of salmon at counting facility
RET = number of salmon retained (based on license stub returns)
REL = number of salmon released (based on license stub returns)

A mortality rate of 10% was used for released small and large salmon based on consultations with anglers. It was assumed that catch and release mortality occurred only below the counting facilities. No adjustment was made for any other unrecorded mortality below the counting facilities. Counting facilities were monitored on a daily basis in 1997.

Spawning escapements were obtained by subtracting retained catches, catch and release mortality and other known removals from the total returns.

Dates of operation of counting facilities in 1997.

Counting Facility Location	Date of Operation
Lomond River Fishway	June 28 to October 20
Torrent River Fishway	June 17 to November 7
Western Arm Brook Counting Fence	May 13 to October 2

The Lomond River fishway was not monitored on a daily basis in 1989-91. Counts in those years were estimated based on the mean of the previous three years.

POTENTIAL EGG DEPOSITION

Potential egg depositions above counting facilities were calculated based on total spawning escapements and observed biological characteristics (mean weight of females, percent female) of small and large and a relative fecundity of 1,783 eggs/kg of body weight. Relative fecundity value for all three rivers was estimated from an average of 3,388 (N=264) eggs per female for Western Arm Brook in 1979-80 (Chadwick et al., 1986) based on a mean weight of 1.90 kg. Egg depositions are expressed as a percentage of the conservation egg deposition requirement.

Biological characteristics (mean weight females, proportion female) data used to estimate potential egg depositions by salmon on each of the three rivers in 1983-97 are given in Appendices 1-3. Biological information was obtained from sampling conducted at the counting facilities and in the recreational fishery. Internal and external examination at the counting facilities and internal examination in the recreational fishery determined sex composition. Because some sample sizes were small (<30), data were pooled in some years, especially since 1992 when there was a potential for increased body size due the closure of the commercial salmon fishery.

Pooling of biological characteristic information to estimate egg depositions in 1997 was as follows:

1. **Lomond River small salmon** - based on the mean weight of females and percentage female for internally sexed fish in 1992-96.
2. **Lomond River large salmon** - based on the mean weight of females in 1978-97 and percentage female for internally and externally sexed fish in 1993.
3. **Torrent River small salmon** - based on the mean weight of females and percentage female for internally sexed fish in 1992-97.
4. **Torrent River large salmon** - based on the mean weight of females and percentage female for internally and externally sexed fish in 1980-97.
5. **Western Arm Brook small salmon** - based on the mean weight of females and percentage female for internally sexed fish in 1996-97.
6. **Western Arm Brook large salmon** - based on the mean weight of females and percentage female for internally and externally sexed fish in 1992-97.

River	Small Salmon				Large Salmon			
	Whole Weight Females (kg)				Whole Weight Females (kg)			
	Mean	STD	N	Proportion Female (N)	Mean	STD	N	Proportion Female (N)
Lomond	1.57	0.39	31	0.619 (84)	3.69	0.64	16	0.857 (7)
Torrent	1.74	0.31	20	0.773 (44)	4.04	0.91	27	0.638 (213)
WAB	2.04	0.37	30	0.811 (37)	4.13	1.13	64	0.782 (87)

Conservation requirements in terms of egg deposition were calculated based on 2.4 eggs/m^2 (Elson, 1975) for fluvial habitat (Elson, 1957) on all three rivers, 368 eggs/ha for lacustrine habitat on Lomond River and 105 eggs/ha for Torrent River and Western Arm Brook (O'Connell et al., 1991). The egg deposition rate for fluvial habitat includes an adjustment for poaching and disease, whereas, the rate for lacustrine habitat does not include an adjustment.

It is important to note that for Lomond River the amount of available fluvial habitat was measured from detailed stream surveys. For Torrent River and Western Arm Brook, available fluvial habitat was based on aerial surveys (Traverse, 1971). Available lacustrine habitat on the three rivers was measured from 1:50,000 scale topographic maps using the appropriate dot grid scale.

Conservation requirements in terms of spawners were calculated based on mean weights and proportion of females for 1992-96. The means of these years were used to account for potential change in mean weight as a result of elimination of selective commercial fishing mortality since 1992 (Mullins, MS 1997). The minimum proportion

of large salmon and the maximum proportion of small salmon observed in 1992-96 were used to apportion the spawner requirements into small and large salmon.

Conservation egg deposition requirements on Lomond River, Torrent River and Western Arm Brook can be achieved by 580 (557 small and 23 large), 592 (562 small and 30 large) and 287 (284 small and 3 large) spawners, respectively.

SMOLT COUNTS, RUN-TIMING AND SEA SURVIVAL

Annual smolt production has been recorded at the counting fence on Western Arm Brook since 1971.

Run timing of the smolt and returning adult small salmon on Western Arm Brook were taken as the dates on which the 25th, 50th and 75th percentiles of the cumulative counts occurred at the counting fence.

Sea survival of smolts was taken as the percentage of the smolt production in year ***i*** that returned to the river as virgin one-sea-winter (1SW) adult salmon in year i+1.

TRENDS IN RECRUITS AND SPAWNERS

O'Connell, et al. (MS 1997) describe a technique whereby it is possible, on selected rivers with counting facilities, to retrospectively construct the total population size of small salmon (or total number of small salmon recruits) prior to any exploitation. The number of salmon recruits per spawner (R/S ratio) can then be used to estimate anticipated returns one year in advance. This technique was used to estimate the number of recruits for Lomond River, Torrent River and Western Arm Brook 1971-91. After 1991, the total returns to the river of small salmon were assumed to represent the total population size of small salmon. The equations used were the same as described by O'Connell, et al. (MS 1997) with the following exceptions: 1) the assumed exploitation rate in the commercial fishery is 0.60; and 2) the river escapements of small salmon on the three rivers were adjusted to reflect only virgin small salmon. The proportions of virgin small salmon used to adjust the total river escapements on each river in pre-moratorium and post-moratorium years are given in Appendices 4-6.

Anticipated returns in 1998 were based on the average R/S ratio in 1994-96 for each smolt age group. The smolt-age composition of small salmon on the three rivers was adjusted to reflect the predominant smolt age of adults. For example, on Western Arm Brook, the percentage of returns at smolt age 2+ was added to the 3+ group and the percentage at smolt-age 6+ was added to the 5+ group. The percentage at 2+ and 6+ was zero or minimal in most years.

The anticipated spawning escapement on Lomond River in 1998 was estimated from the anticipated returns by subtracting the recreational quota of 375 retained small salmon and 10% of the 1992-96 mean released catch of small salmon. The anticipated spawning escapement on Torrent River were estimated from anticipated returns based on an angling exploitation rate of 5% which is equivalent to the 1992-96 mean exploitation rate. The anticipated spawning escapement on Western Arm Brook in 1998 was assumed to be equivalent to the anticipated recruitment.

RESULTS

RECREATIONAL FISHERY

Recreational fisheries on all scheduled rivers in SFA 14A opened 21 June and closed 14 August 1997 due to low returns. Hook and release fisheries were permitted to the end of the season. Torrent River opened to catch and release angling only 21 June 1997 and to retention angling 8 July 1997.

Recreational catches and effort on Lomond River and Torrent River in 1953-97 are given in Tables 1-2. Catch and effort data for 1997 may not be directly comparable to previous years due to changes in the method of data collection. Based on license stub returns in 1998, the small salmon quota on Lomond River was exceeded by 32% (121 salmon) but based on reports from DFO river guardians, only 77% of the quota was reached before the river was closed due to low returns. The number of large salmon released on Lomond River was the same as in 1996 based on license stub returns but was 14% lower than in 1996 based on DFO reports. The retained catch of small salmon on Torrent River based on license stub returns in 1997 was similar to previous years, except for 1993 (Table 2).

Quotas on Lomond River, 1986-97.

Year	Quota	Open	Closed	No. Days to Reach Quota
1986	350	7 June	25 July	49
1987	350	6 June	13 July	Closed due to low water
1988	350	4 June	25 July	52
1989	350	17 June	23 July	Closed due to low water
1990	350	16 June	24 July	39
1991	350	17 June	25 July	39
1992	350	13 June	24 July	42
1993	350	12 June	20-31 Jul. & 8 Aug.-6 Sept.	SFA quota reached
1994	350	11 June		Quota not reached
1995	375	24 June	24 July	31
1996	375	22 June	13 Aug.	53
1997	375	21 June	14 Aug.	Closed due to low returns

ADULT, RETURNS, SPAWNING ESCAPEMENTS AND EGG DEPOSITIONS

RETURNS AND SPAWNING ESCAPEMENTS

Counts of small and large salmon at the three counting facilities are given in Table 3. The proportion of large salmon at the Lomond River fishway in 1997 was 37% less than in 1996 and 17% less than the 1992-96 mean (Table 4). The proportion of large salmon at the Torrent River fishway was 126% higher than in 1996 and 108% higher than the 1992-96 mean and at the Western Arm Brook counting fence it was 151% higher than 1996 and 263% higher than the 1992-96 mean (Table 4). These were the highest values recorded since 1992.

Total returns of small salmon to Lomond River in 1997 were 33% higher than in 1996 and 31% higher than the 1992-96 mean (Table 5, Fig 2A). Returns of large salmon were 21% lower than in 1996 (Table 5), but were similar to the 1992-94 mean (Fig 2B). Returns of both small and large salmon were much higher than the 1984-91 pre-moratorium mean (Fig 2A and 2B). Returns of small salmon to Torrent River were 45% lower than in 1996 and

17% lower than the 1992-96 mean (Table 5, Fig 2C). Returns of small salmon to Torrent River in 1997 did exceed the 1984-91 pre-moratorium mean (Fig 2C). Returns of large salmon to Torrent River were the highest recorded since 1971 (Fig 2D) and 32% higher than in 1996 and 82% higher than the 1992-96 mean (Table 5). Returns of small salmon to Western Arm Brook were 59% lower than in 1996 and the 43% lower than the 1992-96 mean (Table 5). Returns of small salmon to Western Arm Brook in 1997 were slightly above the 1984-91 pre-moratorium mean (Fig 2E). Returns of large salmon to Western Arm Brook in 1997 were the highest recorded since 1992 (Fig 2F), 10% higher than in 1996 and 111% higher than the 1992-96 mean (Table 5).

EGG DEPOSITIONS

Potential egg depositions by small and large salmon spawners and percentages of conservation egg deposition requirements achieved in 1984-97 are given in Table 6. The conservation requirements above the counting facilities were exceeded on all three rivers in 1997 (161%, 797% and 200%, respectively). Only on Lomond River was the percentage achieved higher than in 1996 (13% above 1996). On Torrent River, the percentage achieved was 38% lower than in 1996 and on Western Arm Brook it was 52% lower than 1996.

SMOLT COUNTS, RUN-TIMING, AND SEA SURVIVAL

The sea survival of Western Arm Brook smolts produced in 1996 to 1SW adults in 1997 was 3.0%, the lowest since 1992 and 53% less than the 1992-96 mean (Table 7). This sea survival rate was more similar to that of pre-moratorium years (1984-91) than to other moratorium years (1992-96) (Fig. 3). Run timing of smolts in 1996 was the earliest since 1992 (Fig 4A). The run timing of small salmon on Western Arm Brook in 1996 was the earliest recorded (Fig. 4B).

The smolt production on Western Arm Brook in 1997 was 23,845 fish, 39% higher than in 1996 (Table 7) and the highest on record (Fig. 5). Assuming that the sea survival of these smolts is the same as for those produced in 1996 (3.0%), then the returns of 1SW adult salmon to the river in 1998 are expected to be 39% higher than in 1997. The precision of this estimate in the previous year has been highly variable as a result of the high variability in survival of smolts at sea.

Estimates of precision of expected 1SW adult returns based on smolt counts and sea survival of smolts in the previous year.

Year	Expected	Observed	% Diff.
1992	297	480	61.8
1993	550	947	72.3
1994	826	954	15.5
1995	659	823	24.8
1996	1342	1230	-8.3
1997	1218	509	-58.3
1998	715		

TRENDS IN RECRUITS AND SPAWNERS

RECRUITS AND SPAWNERS IN 1997

The estimated numbers of small salmon recruits and corresponding spawners from each year class on Lomond River, Torrent River, and Western Arm Brook since 1971 are given in Tables 8-10.

Recruitment of small salmon in 1997 was 12% higher than expected on Lomond River but 48% lower than expected on Torrent River and 57% lower on Western Arm Brook (Table 11).

The R/S ratio has been quite variable on all three rivers but to a lesser extent on Lomond River and Torrent River than on Western Arm Brook, especially in recent years (Fig. 6A, 7A, 8A). R/S ratios in 1997 continued the decreasing trend of 1977-96 observed on Lomond River (R^2=0.3937; df=18; P<0.01) and Torrent River (R^2=0.3838; df=18; P<0.01). There was no significant trend in the recruit to spawner relationship on Western Arm Brook in 1977-96. The R/S ratio remained relatively stable on Lomond River in 1997 compared to 1996 but decreased on Torrent River and Western Arm Brook (Fig 6B, 7B, 8B) which would explain the lower than expected returns to the latter two rivers. R/S ratios since 1992 on Lomond River have been among the lowest recorded (Fig. 6B). R/S ratios on Torrent River showed a decreasing trend in the pre-moratorium years of 1987-91 (excluding 1990) but increased in 1992-96 (Fig 7B). R/S ratios on Western Arm Brook since 1992 were similar to the pre-moratorium years of 1984-88 (Fig 8B). The R/S ratios on Western Arm Brook in 1989-90 were the highest recorded since 1984 (Fig 8B).

Conservation requirements were exceeded on all three rivers in 1997. However, the number of small spawners decreased compared to 1996 on Torrent River and Western Arm Brook but not on Lomond River (Fig 6C, 7C, 8C).

Small salmon recruitment on Lomond River in 1997 was the second highest on record and above the 1992-96 and 1984-91 means (Fig 6D). In contrast, small salmon recruits on Torrent River and Western Arm Brook were below the 1992-96 and 1984-91 means (Fig 7D, 8D). On Western Arm Brook, small recruits in 1997 were the second lowest on record (Fig 8D).

ANTICIPATED RECRUITS AND SPAWNERS IN 1998.

It is anticipated that returns of small salmon in 1998 (based on the average R/S ratio in 1994-96) will be higher than in 1997 on all three rivers (Fig. 6D, 7D, 8D). Returns are expected to be only slightly higher than in 1997 on Lomond River but are expected to be higher than the 1992-96 means on all three rivers (Fig. 6D, 7D, 8D).

If the following conditions are met: 1) recreational quota on Lomond River remains at 375 small salmon; 2) the angling exploitation on Torrent remains at 5%; 3) there is no recreational fishery on Western Arm Brook; and 4) sea survival is similar to that in 1997. It is expected that spawning escapements will exceed conservation requirements on all three rivers in 1998 (Fig. 6C, 7C, 8C).

DISCUSSION

The recreational catch of small salmon on Lomond River has been restricted to a quota since 1986. Other catch and effort restrictions, such as SFA quotas, reduced bag limits and split seasons, have also been in place in some years. These restrictions, particularly since 1992, may have been responsible for preventing the quota from being reached earlier in the season, suggesting that the current river quota may not be an effective means of controlling the catch. In addition, with the improvements in the status of the stock in the six years following the commercial salmon moratorium, this stock could support some increased exploitation provided the conservation requirement is achieved.

The method used to estimate total returns of small and large salmon on Lomond River and Torrent River involves addition of retained catches to counts at the counting facilities and an allowance of 10% for hook and release mortality on small and large salmon. Catch statistics were provided by license stub returns in 1997 but were provided by DFO river guardians prior to 1997. Comparison of catch information from both methods indicated a 40% difference in retained catches of small salmon and 70% difference in released catches for Lomond River in 1997. In view of increased reliance on license stub returns for catch information, the accuracy of this system needs to be verified relative to the DFO river guardian system. Unless this verification is completed, in the future it will not be possible to compare estimates of total returns with those prior to 1997.

On the basis of the relationship between recruits and spawners in previous years, returns of small salmon to Lomond River in 1997 were within the range expected. However, returns to Torrent River and Western Arm Brook, while above those in pre-moratorium years, were much lower than expected based on this technique.

The sea survival of smolts in 1996 to 1SW adults in 1997 at Western Arm Brook (3.0%) was the lowest observed since 1992 and more comparable to pre-moratorium than to moratorium years. For reasons not well known (Dempson et al., 1998), sea survival was less than half that of the previous year. This sudden drop was unexpected, given the improvements observed since the commercial moratorium.

The run timing of smolts in 1996 was the earliest since 1992 but was not the earliest in the time series (1971-96). Of the pre-moratorium years (1971-91) for which data is available, six (1971, 1979, 1981, 1986-87, 1989) years had an earlier smolt run timing than observed in 1996. However, there was no significant correlation between early smolt run timing and low sea survival in these years. Smolts in 1979 and 1981 had a higher sea survival than smolts in 1996 while smolts in 1981, 1986-87, and 1989 had a similar sea survival to smolts in 1996. A major influence on variable sea survival in these years was the commercial salmon fishery. Sea and ice conditions would have affected the timing and exploitation in the fishery. Since the closure of the commercial fishery in 1992, years with a later smolt run timing have tended to experience higher sea survival. However, with only five data points, the relationship is not significant. This is because the 1996 data point is the only one of five data points with early smolt run timing and low sea survival. More years with earlier smolt run timing in the absence of a commercial fishery are required in order to determine whether or not a significant relationship actually exists.

The effect of the commercial moratorium on salmon populations is evident from the general increase in the total returns and spawning escapements on these three rivers since 1992. However, it must be pointed out that the total recruitment of small salmon was actually higher in many pre-moratorium years than in moratorium years on all three rivers and this trend in not expected to change in 1998 given the low R/S ratios observed since 1992.

With the commercial fishery closed, returns of salmon to rivers represent the entire recruitment. Returns of small salmon to Lomond River and Torrent River in 1997 were the progeny of spawners in 1992 and represent the first post-moratorium recruitment on these rivers. Even though these returns were the second highest on record for Lomond River and among the highest for Torrent River, they were lower than pre-moratorium recruitment levels. As seen from the unexpected decrease in smolt survival at Western Arm Brook in 1997, other factors besides commercial exploitation affect the survival of salmon at sea. The majority of small salmon returning to Western Arm Brook in 1998 will be the progeny of spawners in 1992 and will represent the first post-moratorium recruits.

We will be able to consider the commercial moratorium a success when recruitment is higher than in pre-moratorium years.

In spite of lower returns to rivers in 1997 compared to 1996, conservation egg deposition requirements were achieved on all three rivers. However, because of annual variability and the effect of atresia on fecundity (O'Connell et al., MS 1997) as well as the potential for spawner mortality upstream of counting facilities and egg losses in the river, estimates of egg deposition should be treated as potential only. The estimate of relative fecundity used to calculate egg depositions for all three rivers was based on biological characteristics of Western Arm Brook salmon in 1979-80 (Chadwick et al., 1986). This value should be revised for each river, given the potential for a change in body size of returning adults as a result of the moratorium. Additional cautions associated with parameter values used to estimate egg depositions and conservation requirements are described in detail by O'Connell and Dempson (1995). These will not be discussed further here except to point out that habitat measurements on which conservation requirements were based for these rivers are taken from aerial surveys conducted in the early 1970s. Habitat measurements on other rivers in recent years have indicated that these early habitat estimates represented minimum values.

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Table1. Recreational catches and effort of Atlantic salmon on Lomond River, 1953-97.

Year	Effort (Rod Days)	Small			Large			Total Catch			CPUE
		Retained	Released	Total	Retained	Released	Total	Retained	Released	Total	
1953	359	93	.	93	22	.	22	115	.	115	0.32
1954	423	81	.	81	27	.	27	108	.	108	0.26
1955	448	113	.	113	12	.	12	125	.	125	0.28
1956	306	130	.	130	28	.	28	158	.	158	0.52
1957	254	116	.	116	14	.	14	130	.	130	0.51
1958	359	144	.	144	32	.	32	176	.	176	0.49
1959	419	196	.	196	65	.	65	261	.	261	0.62
1960	503	124	.	124	28	.	28	152	.	152	0.30
1961	403	160	.	160	33	.	33	193	.	193	0.48
1962	778	201	.	201	32	.	32	233	.	233	0.30
1963	811	320	.	320	32	.	32	352	.	352	0.43
1964	971	349	.	349	24	.	24	373	.	373	0.38
1965	170	292	.	292	50	.	50	342	.	342	2.01
1966	347	229	.	229	61	.	61	290	.	290	0.84
1967	568	217	.	217	21	.	21	238	.	238	0.42
1968	454	202	.	202	3	.	3	205	.	205	0.45
1969	391	147	.	147	5	.	5	152	.	152	0.39
1970	457	145	.	145	29	.	29	174	.	174	0.38
1971	217	54	.	54	1	.	1	55	.	55	0.25
1972	1648	253	.	253	35	.	35	288	.	288	0.17
1973	1232	286	.	286	55	.	55	341	.	341	0.28
1974	1331	324	.	324	19	.	19	343	.	343	0.26
1975	773	258	.	258	20	.	20	278	.	278	0.36
1976	2045	650	.	650	25	.	25	675	.	675	0.33
1977	1461	495	.	495	34	.	34	529	.	529	0.36
1978	1267	345	.	345	29	.	29	374	.	374	0.30
1979	900	235	.	235	2	.	2	237	.	237	0.26
1980	1218	293	.	293	13	.	13	306	.	306	0.25
1981	1446	507	.	507	3	.	3	510	.	510	0.35
1982	1435	308	.	308	7	.	7	315	.	315	0.22
1983	1112	251	.	251	3	.	3	254	.	254	0.23
1984	1505	546	.	546	28	.	28	574	.	574	0.38
1985	1075	203	.	203	.	2	2	203	2	205	0.19
1986	1164	371	.	371	.	46	46	371	46	417	0.36
1987	1186	297	.	297	.	13	13	297	13	310	0.26
1988	1545	404	.	404	.	25	25	404	25	429	0.28
1989	1714	270	.	270	.	5	5	270	5	275	0.16
1990	1938	386	.	386	.	17	17	386	17	403	0.21
1991	1519	328	.	328	.	10	10	328	10	338	0.22
1992	1612	357	24	381	.	56	56	357	80	437	0.27
1993	2190	281	85	366	.	40	40	281	125	406	0.19
1994	2017	325	116	441	.	58	58	325	174	406	0.20
1995	2043	343	190	533	.	62	62	343	252	595	0.29
1996	2700	371	99	470	.	49	49	371	148	519	0.19
1997*	**1436**	**496**	**279**	**775**		**49**	**49**	**496**	**328**	**824**	**0.57**
1997	2102	290	80	370		42	42	290	122	412	0.20
Mean (92-96)	2112	335	103	438	.	53	53	335	156	473	0.23
95% CL=+/-	248	43	74	84	.	11	11	43	179	103	0.06
N	5	5	5	5	.	5	5	5	5	5	5
Mean(84-91)	1456	351	.	351	.	17	18	354	17	369	0.26
95% CL=+-	248	86	.	86	.	14	12	93	14	94	0.07
N	8	8	.	8	.	7	8	8	7	8	8
Mean(78-83)	1230	323	.	323	10	.	10	333	.	333	0.27
95% CL=+-	217	103	.	103	11	.	11	104	.	104	0.05
N	6	6	.	6	6	.	6	6	.	6	6

*Catches and effort for 1997 were based on license stub returns (bold type). Values in normal type were collected by the DFO river guardians.

Table 2. Recreational catches and effort of Atlantic salmon on Torrent River, 1953-97.

Year	Effort (Rod-days)	Small			Large			Total Catch			CPUE
		Retained	Released	Total	Retained	Released	Total	Retained	Released	Total	
1953	169	4	.	4	9	.	9	13	.	13	0.08
1954	187	15	.	15	3	.	3	18	.	18	0.10
1955	184	22	.	22	15	.	15	37	.	37	0.20
1956	464	51	.	51	29	.	29	80	.	80	0.17
1957	377	73	.	73	21	.	21	94	.	94	0.25
1958	594	24	.	24	34	.	34	58	.	58	0.10
1959	585	31	.	31	54	.	54	85	.	85	0.15
1960	401	54	.	54	32	.	32	86	.	86	0.21
1961	569	37	.	37	43	.	43	80	.	80	0.14
1962	893	107	.	107	37	.	37	144	.	144	0.16
1963	1286	107	.	107	64	.	64	171	.	171	0.13
1964	593	66	.	66	40	.	40	106	.	106	0.18
1965	455	62	.	62	36	.	36	98	.	98	0.22
1966	794	43	.	43	13	.	13	56	.	56	0.07
1967	598	36	.	36	11	.	11	47	.	47	0.08
1968	998	70	.	70	7	.	7	77	.	77	0.08
1969	315	41	.	41	4	.	4	45	.	45	0.14
1970	277	52	.	52	9	.	9	61	.	61	0.22
1971	333	53	.	53	5	.	5	58	.	58	0.17
1972	306	22	.	22	3	.	3	25	.	25	0.08
1973	413	88	.	88	3	.	3	91	.	91	0.22
1974	400	58	.	58	4	.	4	62	.	62	0.16
1975	364	123	.	123	6	.	6	129	.	129	0.35
1976		.	.	0	.	.	0	0	.	0	.
1977		.	.	0	.	.	0	0	.	0	.
1978	183	31	.	31	4	.	4	35	.	35	0.19
1979	238	65	.	65	3	.	3	68	.	68	0.29
1980		.	.	0	.	.	0	0	.	0	.
1981	656	167	.	167	18	.	18	185	.	185	0.28
1982	535	187	.	187	2	.	2	189	.	189	0.35
1983	354	82	.	82	1	.	1	83	.	83	0.23
1984	.	.	.	.	.	.		.	.	.	.
1985	251	70	.	70	.	0	0	70	0	70	0.28
1986	767	340	.	340	.	5	5	340	5	345	0.45
1987	576	165	.	165	.	0	0	165	0	165	0.29
1988	803	313	.	313	.	0	0	313	0	313	0.39
1989	559	143	.	143	.	0	0	143	0	143	0.26
1990	629	222	.	222	.	4	4	222	4	226	0.36
1991	438	150	.	150	.	1	1	150	1	151	0.34
1992	727	477	75	552	.	6	6	477	81	558	0.77
1993	619	179	266	445	.	15	15	179	281	460	0.74
1994	992	227	82	309	.	9	9	227	91	318	0.32
1995	1816	331	369	700	.	36	36	331	405	736	0.41
1996	2027	421	270	691	.	20	20	421	290	711	0.35
1997*	**966**	**328**	**471**	**799**		**76**	**76**	**328**	**547**	**875**	**0.91**
Mean (92-96)	1236	327	212	539	.	17	17	327	230	557	0.52
95% CL=+/-	800	156	160	207	.	15	15	156	174	217	0.27
N	5	5	5	5	.	5	5	5	5	5	5
Mean(84-91)	503	175	.	175	.	1	1	175	1	177	0.30
95% CL=+-	225	96	.	96	.	2	2	96	2	97	0.11
N	8	8	.	8	.	7	8	8	7	8	8
Mean(78-83)	393	89	.	89	5	.	5	93	.	93	0.22
95% CL=+-	209	78	.	78	7	.	7	82	.	82	0.13
N	6	6	.	6	6	.	6	6	.	6	6

* Catches and effort for 1997 were based on license stub returns.

Table 3. Counts of small and large Atlantic salmon at Lomond River and Torrent River fishways and Western Arm Brook counting fence (SFA 14A), 1974-97. Numbers in bold are partial counts.

	Lomond River		Torrent River		Western Arm Brook		
					Unadjusted	Adjusted	
Year	Small	Large	Small	Large	Small	Small	Large
1971	6	0	54	4	427	.	305
1972	30	15	64	3	309	.	9
1973	108	110	96	12	554	.	30
1974	41	33	38	3	382	.	4
1975	**1**	**0**	191	25	631	.	1
1976	132	11	341	47	520	.	0
1977	192	11	789	33	362	.	3
1978	117	12	971	21	293	.	1
1979	195	1	1984	39	1578	.	0
1980	301	19	792	63	435	.	3
1981	110	50	2101	97	451	.	1
1982	275	16	2112	523	394	.	3
1983	220	7	2007	442	1141	.	4
1984	440	47	1805	288	120	.	0
1985	190	14	1553	30	**165**	416	1
1986	354	32	2815	92	**252**	525	0
1987	355	11	2505	68	378	.	1
1988	437	21	2075	44	**102**	251	1
1989	**382**	**21**	1369	60	**414**	455	0
1990	**391**	**18**	2296	82	**124**	444	0
1991	**403**	**20**	1441	71	233	.	1
1992	435	80	2347	169	480	.	8
1993	526	34	4009	222	947	.	8
1994	701	50	3592	331	954	.	31
1995	1003	95	5800	611	823	.	33
1996	601	93	6923	507	1230	.	50
1997	783	72	3659	666	509	.	55
Mean (92-96)	653	70	4534	368	887	.	26
95% CL=+/-	271	34	2260	233	337	.	22
CV	33.5	38.6	40.1	51.0	30.6	.	69.3
N	5	5	5	5	5	.	5
Mean (84-91)	369	23	1982	92	224	.	1
95% CL=+/-	66	10	442	68	100	.	0
CV	21.5	49.9	26.7	88.9	53.4	.	106.9
N	8	8	8	8	8	.	8

Note: Western Arm Brook small salmon counts in some years were adjusted to account for fish that did not move upstream until after the counting fence was removed:

1. small salmon counts in 1985-86 were adjusted based on the ratio of marked to unmarked small at the counting fence (Claytor and Mullins, 1988).
2. small salmon count in 1988 was adjusted based on kelt counts in 1989.
3. small salmon count in 1989 was adjusted based on the proportion of marked kelts (131/144) recaptured in 1990.
4. small salmon count in 1990 was adjusted based on the proportion of marked kelts (43/154) recaptured in 1991.

Table 4. Proportion of small and large Atlantic salmon observed at counting facilities.

	Lomond River		Torrent River		Western Arm Brook	
Year	Small	Large	Small	Large	Small	Large
1971	1.000	0.000	0.931	0.069	0.583	0.417
1972	0.667	0.333	0.955	0.045	0.972	0.028
1973	0.495	0.505	0.889	0.111	0.949	0.051
1974	0.554	0.446	0.927	0.073	0.990	0.010
1975	1.000	0.000	0.884	0.116	0.998	0.002
1976	0.923	0.077	0.879	0.121	1.000	0.000
1977	0.946	0.054	0.960	0.040	0.992	0.008
1978	0.907	0.093	0.979	0.021	0.997	0.003
1979	0.995	0.005	0.981	0.019	1.000	0.000
1980	0.941	0.059	0.926	0.074	0.993	0.007
1981	0.688	0.313	0.956	0.044	0.998	0.002
1982	0.945	0.055	0.802	0.198	0.992	0.008
1983	0.969	0.031	0.820	0.180	0.997	0.003
1984	0.903	0.097	0.862	0.138	1.000	0.000
1985	0.931	0.069	0.981	0.019	0.998	0.002
1986	0.917	0.083	0.968	0.032	1.000	0.000
1987	0.970	0.030	0.974	0.026	0.997	0.003
1988	0.954	0.046	0.979	0.021	0.996	0.004
1989	**0.947**	**0.053**	0.958	0.042	1.000	0.000
1990	**0.957**	**0.043**	0.966	0.034	1.000	0.000
1991	**0.953**	**0.047**	0.953	0.047	0.996	0.004
1992	0.845	0.155	0.933	0.067	0.984	0.016
1993	0.939	0.061	0.948	0.052	0.992	0.008
1994	0.933	0.067	0.916	0.084	0.969	0.031
1995	0.913	0.087	0.905	0.095	0.961	0.039
1996	0.866	0.134	0.932	0.068	0.961	0.039
1997	0.916	0.084	0.846	0.154	0.902	0.098
Mean (92-96)	0.899	0.101	0.926	0.074	0.973	0.027
95% CL=+/-	0.052	0.052	0.021	0.021	0.017	0.017
CV	4.7	41.7	1.8	22.6	1.4	51.4
N	5	5	5	5	5	5
Mean (84-91)	0.942	0.058	0.955	0.045	0.998	0.002
95% CL=+/-	0.019	0.019	0.032	0.032	0.002	0.002
CV	2.4	38.2	4.1	86.3	0.2	113.1
N	8	8	8	8	8	8

Table 5. Total returns of small and large Atlantic salmon to Lomond River, Torrent River and Western Arm Brook, 1971-97.

	Lomond River		Torrent River		Western Arm Brook	
Year	Small	Large	Small	Large	Small	Large
1971	60	1	107	9	632	305
1972	283	50	86	6	406	9
1973	394	165	184	15	797	30
1974	365	52	96	7	506	4
1975	**259**	**20**	314	31	639	1
1976	782	36	341	47	552	0
1977	687	45	789	33	373	3
1978	462	41	1002	25	315	2
1979	430	3	2049	42	1578	0
1980	594	32	792	63	465	5
1981	617	53	2268	115	492	1
1982	583	23	2299	525	467	3
1983	471	10	2089	443	1141	4
1984	986	75	1805	288	235	0
1985	393	14	1623	30	**467**	1
1986	725	37	3155	93	**527**	0
1987	652	12	2670	68	437	1
1988	841	24	2388	44	**422**	1
1989	**652**	**22**	1512	60	**455**	0
1990	**777**	**19**	2518	82	**444**	0
1991	**731**	**21**	1591	71	233	1
1992	794	86	2832	170	480	8
1993	816	38	4215	224	947	8
1994	1038	56	3827	332	954	31
1995	1365	101	6168	615	823	33
1996	982	98	7371	509	1230	50
1997	1307	77	4034	674	509	55
Mean (92-96)	999	76	4882	370	887	26
95% CL=+/-	285	34	2290	234	337	22
CV	23.0	36.5	37.8	51.0	30.6	69.3
N	5	5	5	5	5	5
Mean (84-91)	720	28	2158	92	403	1
95% CL=+/-	143	17	508	68	91	0
CV	23.8	72.7	28.2	88.8	27.0	107.5
N	8	8	8	8	8	8

Table 6. Total returns, spawning escapement, potential egg deposition and percentage of egg deposition requirement achieved in Lomond River, Torrent River, and Western Arm Brook in SFA 14(A), 1984-97. Numbers in bold type were estimated based on partial counts.

Year	Total Returns		Spawning Escapement		No. Eggs x 10^6		% Eggs Achieved
	Small	Large	Small	Large	Small	Large	
Lomond River							
1984	986	75	440	47	0.7356	0.0758	74
1985	393	14	189	14	0.3160	0.0226	31
1986	725	37	353	32	0.5901	0.0516	59
1987	652	12	355	11	0.5935	0.0177	56
1988	841	24	437	21	0.7306	0.0339	70
1989	**652**	**22**	382	21	0.6386	0.0339	61
1990	**777**	**19**	391	18	0.6537	0.0290	62
1991	**731**	**21**	403	20	0.6737	0.0323	64
1992	794	86	419	80	0.9495	0.3728	121
1993	816	38	504	33	1.1421	0.1538	118
1994	1038	56	695	49	1.2714	0.2793	142
1995	1365	101	983	95	1.5115	0.5415	187
1996	982	98	601	93	1.0414	0.5244	143
1997	1307	77	783	72	1.3568	0.4060	161
Torrent River							
1984	1805	288	1,805	288	3.0902	0.9118	270
1985	1623	30	1,551	30	2.3022	0.0909	161
1986	3155	93	2,815	92	4.9539	0.3913	360
1987	2670	68	2,482	68	2.7027	0.2486	199
1988	2388	44	2,075	44	3.8292	0.1130	266
1989	1512	60	1,367	60	3.1478	0.1874	225
1990	2518	82	2,296	82	3.0851	0.1993	221
1991	1591	71	1,440	71	2.4155	0.2295	178
1992	2832	170	2,344	169	4.1125	0.5364	313
1993	4215	224	4,009	222	7.2739	0.7046	538
1994	3827	332	3,592	331	6.2796	1.5815	530
1995	6168	615	5,800	611	12.4117	2.9193	1033
1996	7371	509	6,923	507	16.4851	2.4955	1279
1997	4034	674	3,659	666	8.7749	3.0607	797
Western Arm Brook							
1984	235	0	117	0	0.2746	0.0000	30
1985	**467**	1	416	1	0.7202	0.0017	80
1986	**527**	0	525	0	1.4194	0.0000	156
1987	437	1	378	1	0.9297	0.0025	103
1988	**422**	1	251	1	0.6051	0.0024	67
1989	**455**	0	455	0	1.2907	0.0000	142
1990	**444**	0	444	0	1.4276	0.0000	157
1991	233	1	233	1	0.6129	0.0026	68
1992	480	8	480	8	1.3454	0.0224	151
1993	947	8	947	8	2.5943	0.0219	288
1994	954	31	954	31	2.5321	0.1187	292
1995	823	33	796	30	2.3844	0.2122	286
1996	1230	50	1,189	48	3.4858	0.2839	415
1997	509	55	508	55	1.4985	0.3167	200

Notes:

1. Lomond egg depositions in 1984-88 is based on 1983-93 mean biological characteristics and 1992-93 based on 1993 values.
2. Torrent egg depositions in 1990-93 based on 1985-89 mean biological characteristics for 1985-89 foe small and large salmon.
3. Western Arm Brook egg depositions in 1984 based on 1974-93 mean biological characteristics for small and large salmon combined.

Table 7. Sea-survival of Atlantic salmon smolts from Western Arm Brook, 1971-97.

Year (i)	Smolts Year (i)	Small Returns Year (i+1)	% Virgin 1SW	V. 1SW Returns Year (i+1)	% Sea-Survival
1971	5735	406	95.9	389	6.8
1972	11905	797	99.6	794	6.7
1973	8484	506	100.0	506	6.0
1974	11854	639	100.0	639	5.4
1975	9600	552	100.0	552	5.8
1976	6232	373	100.0	373	6.0
1977	9899	315	97.7	308	3.1
1978	13071	1578	99.6	1572	12.0
1979	8349	465	100.0	465	5.6
1980	15665	492	97.0	477	3.0
1981	13981	467	100.0	467	3.3
1982	12477	1141	99.5	1135	9.1
1983	10552	235	100.0	235	2.2
1984	20653	467	98.8	462	2.2
1985	13417	527	100.0	527	3.9
1986	17719	437	100.0	437	2.5
1987	17029	422	84.1	355	2.1
1988	15321	455	100.0	455	3.0
1989	11407	444	97.9	435	3.8
1990	10563	233	100.0	233	2.2
1991	13453	480	99.8	479	3.6
1992	15405	947	86.3	817	5.3
1993	13435	954	96.3	919	6.8
1994	9283	823	100.0	823	8.9
1995	15144	1230	100.0	1230	8.1
1996	14502	**509**	84.3	**429**	**3.0**
1997	**23845**				
Mean (92-96)	13554	893	93	844	6.4
95% CI +/-	3110	324	9	355	2.9
C.V.	18.5	29.2	8.1	33.9	36.8
N	5	5	5	5	5
Mean (84-91)	14945	433	98	423	2.9
95% CI +/-	2845	73	5	76	0.6
C.V.	22.8	20.1	5.6	21.4	26.3
N	8	8	8	8	8

Table 8. Estimation of small salmon recruits and spawners for the Lomond River stock. Note: values in bold/italics are estimated based on the previous three-year mean.

Spawning	Recruit Years			River Escapement	Adj. Escapement	Total Recruits	Spawning Escapement	Recruits at Smolt Age				Recruits/spawners (R/S ratio)					Smolt Distribution		
Year (i)	(i+4)	(i+5)	(i+6)	Year i	Year i	Year i	Small	2+ (I+4)	3+ (I+5)	4+ (I+6)	Total	2+	3+	4+	Total	R/S ratio Rec. Yr.	2+	3+	4+
71	75	76	77	60	58	146	6	192	1542	100	1834	31.9364	257.0629	16.7284	305.7278	63.9089	13.0	81.0	6.0
72	76	77	78	283	276	689	30	248	1355	67	1670	8.2514	45.1668	2.2499	55.6682	14.2542	13.0	81.0	6.0
73	77	78	79	394	384	959	108	217	911	63	1192	2.0136	8.4373	0.5817	11.0326	21.492	13.0	81.0	6.0
74	78	79	80	365	356	889	41	146	848	87	1081	3.5670	20.6856	2.1167	26.3693	5.4766	13.0	81.0	6.0
75	79	80	81	605	590	1474	605	136	1172	90	1398	0.2249	1.9354	0.1489	2.3092	10.3854	13.0	81.0	6.0
76	80	81	82	782	762	1904	132	188	1217	85	1490	1.4245	9.2192	0.6453	11.2890	8.2116	13.0	81.0	6.0
77	81	82	83	687	669	1673	192	195	1150	101	1446	1.0172	5.9890	0.5258	7.5320	13.2962	13.0	81.0	6.0
78	82	83	84	462	450	1125	117	185	1363	144	1691	1.5773	11.6487	1.2312	14.4572	12.2412	13.0	81.0	6.0
79	83	84	85	430	419	1047	195	219	1945	57	2221	1.1217	9.9730	0.2944	11.3892	4.0006	13.0	81.0	6.0
80	84	85	86	594	579	1446	301	312	775	106	1193	1.0369	2.5752	0.3519	3.9640	14.1860	13.0	81.0	6.0
81	85	86	87	617	601	1502	110	124	1430	95	1650	1.1309	12.9996	0.8660	14.9965	6.4804	13.0	81.0	6.0
82	86	87	88	583	568	1420	275	229	1286	123	1638	0.8345	4.6763	0.4468	5.9576	8.5916	13.0	81.0	6.0
83	87	88	89	691	673	1683	220	206	1659	95	1960	0.9381	7.5398	0.4330	8.9109	4.4419	13.0	81.0	6.0
84	88	89	90	986	960	2401	440	266	1286	114	1666	0.6050	2.9227	0.2580	3.7857	9.0187	13.0	81.0	6.0
85	89	90	91	393	383	957	190	206	1533	107	1846	1.0863	8.0659	0.5621	9.7142	5.2868	13.0	81.0	6.0
86	90	91	92	725	706	1765	354	246	1442	46	1734	0.6948	4.0728	0.1305	4.8982	2.1170	13.0	81.0	6.0
87	91	92	93	652	635	1588	355	231	624	47	903	0.6518	1.7573	0.1338	2.5429	1.7587	13.0	81.0	6.0
88	92	93	94	841	819	2048	437	100	641	60	802	0.2291	1.4671	0.1382	1.8345	1.5576	13.0	81.0	6.0
89	93	94	95	652	635	1588	652	103	816	79	998	0.1578	1.2509	0.1218	1.5304	1.7363	13.0	81.0	6.0
90	94	95	96	777	757	1892	777	131	1072	57	1260	0.1685	1.3793	0.0736	1.6214	1.4260	13.0	81.0	6.0
91	95	96	97	731	712	1780	731	172	772			0.2353	1.0566				13.0	81.0	6.0
92	96	97	98	794	770	770	419	124				0.2958					13.0	81.0	6.0
93	97	98	99	816	792	792	504												
94				1038	1007	1007	701												
95				1364	1323	1323	982												
96				983	954	954	602												

Anticipated Returns in 1997 (based on the average R/S in 1994-96)

	R/S Ratio			No. of Small			
	2+	3+	4+	2+	3+	4+	Total
Mean	1.576	1.573	13.000	1152	1222	8476	10850
Hi	1.621	1.736	13.000	1185	1349	8476	11010
Low	1.530	1.426	13.000	1119	1108	8476	10703

Estimate of Precision: Observed-Expected returns in 1992-96.
Comparison in 92-95 based on R/S ratio in 1992-1994.

Recruit Year	Expected No. Small	Difference (Obs-Exp.)	(%)
92	1036	-266	-26
93	1112	-321	-29
94	1387	-380	-27
95	1975	-652	-33
96	1382	-428	-31
Mean			-29

Table 9. Estimation of small salmon recruits and spawners for the Torrent River stock.

Note: Spawning escapements for 1972-76 include fish transferred from Western Arm Brook (104, 204, 100, 238, 100).

Spawning Year (i)	Recruit Years (i+5)	(i+6)	River Escapement Year i	Adj. Escapement Year i	Total Recruits Year i	Spawning Escapement Small	Recruits at Smolt Age 3+ (I+5)	4+ (I+6)	Total	Recruits/spawners (R/S ratio) 3+	4+	Total	R/S ratio Rec. Yr.	3+	4+
71	76	77	107	100	249	54	811	386	1197	15.0163	7.1415	22.1578	9.0565	79	21
72	77	78	190	177	442	168	1451	490	1941	8.6354	2.9152	11.5506	30.6394	79	21
73	78	79	388	361	903	300	1842	1001	2844	6.1413	3.3383	9.4797	6.1997	79	21
74	79	80	196	182	456	138	3768	387	4155	27.3011	2.8051	30.1062	12.0403	79	21
75	80	81	552	514	1285	429	1456	1109	2565	3.3946	2.5840	5.9786	7.9058	79	21
76	81	82	441	411	1026	441	4170	1124	5294	9.4563	2.5481	12.0044	5.2499	79	21
77	82	83	789	735	1836	789	4227	1021	5248	5.3577	1.2941	6.6518	2.5814	79	21
78	83	84	1002	933	2332	971	3841	882	4723	3.9558	0.9086	4.8644	4.1678	79	21
79	84	85	2049	1908	4769	1984	3319	793	4112	1.6728	0.3998	2.0727	4.7082	79	21
80	85	86	792	737	1843	792	2984	1542	4526	3.7680	1.9471	5.7151	2.9457	79	21
81	86	87	2268	2112	5279	2101	5801	1305	7106	2.7612	0.6211	3.3823	2.7404	79	21
82	87	88	2299	2140	5351	2112	4909	1167	6077	2.3245	0.5526	2.8772	1.9085	79	21
83	88	89	2089	1945	4862	2007	4391	739	5130	2.1878	0.3682	2.5560	3.6631	79	21
84	89	90	1805	1680	4201	1805	2780	1231	4011	1.5403	0.6818	2.2221	1.5148	79	21
85	90	91	1623	1511	3778	1553	4630	765	5395	2.9813	0.4926	3.4738	0.9851	79	21
86	91	92	3155	2937	7343	2815	2878	530	3408	1.0222	0.1885	1.2107	1.7466	79	21
87	92	93	2670	2486	6214	2505	1996	790	2785	0.7967	0.3152	1.1119	2.3541	79	21
88	93	94	2388	2223	5558	2075	2970	729	3699	1.4314	0.3513	1.7827	2.7366	79	21
89	94	95	1512	1408	3519	1369	2742	1155	3897	2.0029	**0.8438**	2.8467	4.2722	79	21
90	95	**96**	2518	2344	5861	2296	4346	1381	5726	**1.8928**	**0.6014**			79	21
91	**96**	**97**	1565	1457	3643	1415	5194		5194	**3.6708**				79	21
92	**97**	98	2832	2526	2526	2347									
93			4215	3760	3760	4009									
94			3891	3471	3471	3592									
95			6167	5501	5501	5799									
96			7371	6575	6575	6923									

Anticipated Returns in 1997 (based on the average R/S in 1994-96)

	R/S Ratio 3+	4+	3+	4+	Total
Mean	1.776	0.503	2513	1156	3668
Hi	2.003	0.844	2834	1937	4771
Low	1.431	0.315	2025	724	2749

Estimate of Precision: Observed-Expected returns in 1992-96.

Comparison in 92-95 based on R/S ratio in 1992-94.

Recruit Year	No. Small Obs.	Exp.	Obs-Exp	(%)
92	2526	4335	-1809	-42
93	3760	3640	120	3
94	3471	2522	949	38
95	5501	3628	1873	52
96	6575	3668	2906	79
Mean				13

Table 10. Estimation of small salmon recruits and spawners for the Western Arm Brook stock.

Spawning	Recruit Years			River Escapement	Adj. Escapement	Total Recruits	Spawning Escapement	Recruits at Smolt Age				Recruits/spawners (R/S ratio)					Smolt Distribution		
Year (i)	(i+5)	(i+6)	(i+7)	Year i	Year i	Year i	Small	3+ (I+5)	4+ (I+6)	5+ (I+7)	Total	3+	4+	5+	Total	R/S ratio Rec. Yr.	3+	4+	5+
71	76	77	78	632	621	1553	427	543	476	38	1056	1.2708	1.1142	0.0883	2.4733	2.3221	40.0	55.0	5.0
72	77	78	79	406	399	998	302	346	415	194	955	1.1457	1.3740	0.6420	3.1618	11.9065	40.0	55.0	5.0
73	78	79	80	798	784	1961	351	302	2133	57	2491	0.8598	6.0765	0.1610	7.0973	3.3910	40.0	55.0	5.0
74	79	80	81	523	514	1285	299	1551	622	60	2233	5.1879	2.0794	0.2005	7.4678	3.0211	40.0	55.0	5.0
75	80	81	82	639	628	1570	393	452	660	57	1168	1.1506	1.6784	0.1438	2.9728	2.9502	40.0	55.0	5.0
76	81	82	83	552	543	1357	420	480	622	140	1242	1.1422	1.4804	0.3338	2.9563	8.7919	40.0	55.0	5.0
77	82	83	84	352	346	865	341	452	1542	29	2023	1.3260	4.5226	0.0847	5.9333	1.3456	40.0	55.0	5.0
78	83	84	85	307	302	754	285	1122	318	57	1496	3.9354	1.1145	0.2009	5.2509	1.6654	40.0	55.0	5.0
79	84	85	86	1578	1551	3878	1578	231	630	65	926	0.1464	0.3991	0.0410	0.5866	2.8565	40.0	55.0	5.0
80	85	86	87	460	452	1130	430	458	712	54	1224	1.0653	1.6565	0.1249	2.8467	2.5563	40.0	55.0	5.0
81	86	87	88	488	480	1199	447	518	591	52	1161	1.1589	1.3214	0.1160	2.5963	1.9534	40.0	55.0	5.0
82	87	88	89	460	452	1130	387	430	570	56	1056	1.1100	1.4739	0.1445	2.7283	4.4107	40.0	55.0	5.0
83	88	89	90	1141	1122	2804	1141	415	615	40	1069	0.3636	0.5390	0.0347	0.9372	4.4224	40.0	55.0	5.0
84	89	90	91	235	231	578	120	447	435	29	911	3.7272	3.6269	0.2386	7.5927	1.4319	40.0	55.0	5.0
85	90	91	92	466	458	1145	416	317	315	23	654	0.7609	0.7570	0.0550	1.5730	1.0193	40.0	55.0	5.0
86	91	92	93	527	518	1295	525	229	252	45	526	0.4363	0.4797	0.0860	1.0020	2.8403	40.0	55.0	5.0
87	92	93	94	437	430	1074	378	183	497	46	726	0.4846	1.3145	0.1204	1.9195	2.9148	40.0	55.0	5.0
88	93	94	95	422	415	1037	251	361	501	39	901	1.4397	1.9943	**0.1564**	3.5904	**2.0808**	40.0	55.0	5.0
89	94	95	96	455	447	1118	455	364	432	61	857	0.8001	**0.9491**	**0.1334**	1.8825	**4.2893**	40.0	55.0	5.0
90	95	96	**97**	322	317	791	322	314	667			**0.9753**	**2.0727**				40.0	55.0	5.0
91	96	**97**	98	233	229	573	233	485				**2.0832**					40.0	55.0	5.0
92	**97**	98	99	480	458	458	480												
93				947	903	903	947												
94				954	910	910	954												
95				823	785	785	789												
96				1272	1213	1213	1187												

Anticipated Returns in 1997 (based on the average R/S in 1994-96)

	R/S Ratio			No. of Small			
	3+	4+	5+	3+	4+	5+	Total
Mean	1.072	1.419	0.121	250	457	55	762
Hi	1.440	1.994	0.156	335	642	71	1049
Low	0.800	0.949	0.086	186	306	39	531

Estimate of Precision: Observed-Expected returns in 1992-96.

Comparison in 92-95 based on R/S ratio in 1992-1994.

Recruit	No. Small			
Year	Obs.	Exp.	Obs-Exp	(%)
92	458	1043	-585	-56
93	903	751	152	20
94	910	763	147	19
95	785	889	-104	-12
96	1213	762	452	59
Mean				-7

Table 11. Precision of expectations of returns based on recruit/spawner relationships on Lomond River, Torrent River, and Western Arm Brook, 1992-97.

	No. Small 1SW											
	Lomond River				Torrent River				Western Arm Brook			
Recruit Year	Obs.	Exp.	Obs-Exp.	(%)	Obs.	Exp.	Obs-Exp.	(%)	Obs.	Exp.	Obs-Exp.	(%)
92	729	742	-13	-2	2526	4281	-1755	-41	479	1014	-535	-53
93	791	789	2	0	3759	3615	144	4	817	731	87	12
94	1006	918	88	10	3414	2507	907	36	919	739	179	24
95	1324	835	489	59	5502	3609	1893	52	823	971	-148	-15
96	952	1027	-74	-7	6575	3697	2878	78	1230	898	332	37
97	1260	1125	135	12	3457	6699	-3242	-48	429	1000	-571	-57
Mean				12				13				-8

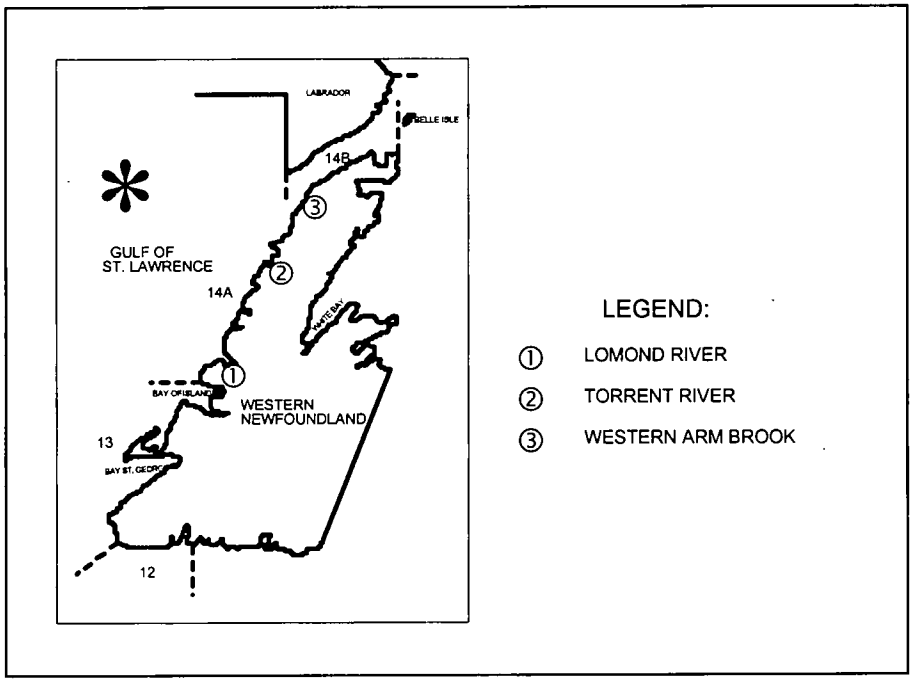


Figure 1. Location of Salmon Fishing Areas (SFAs) and selected rivers in SFA 14A.

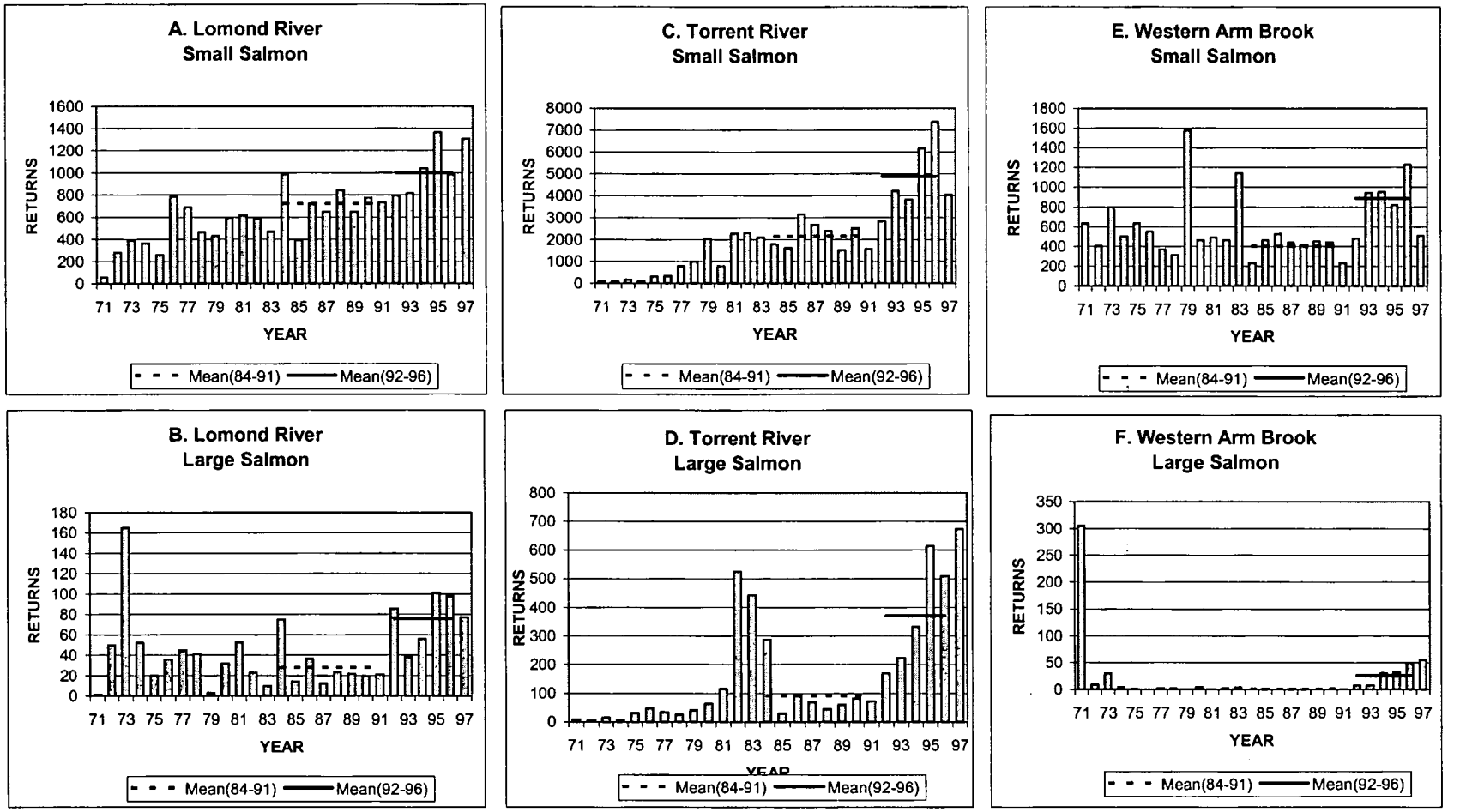


Figure 2. Small and large salmon returns to Lomond River, Torrent River and Western Arm Brook, 1971-97.

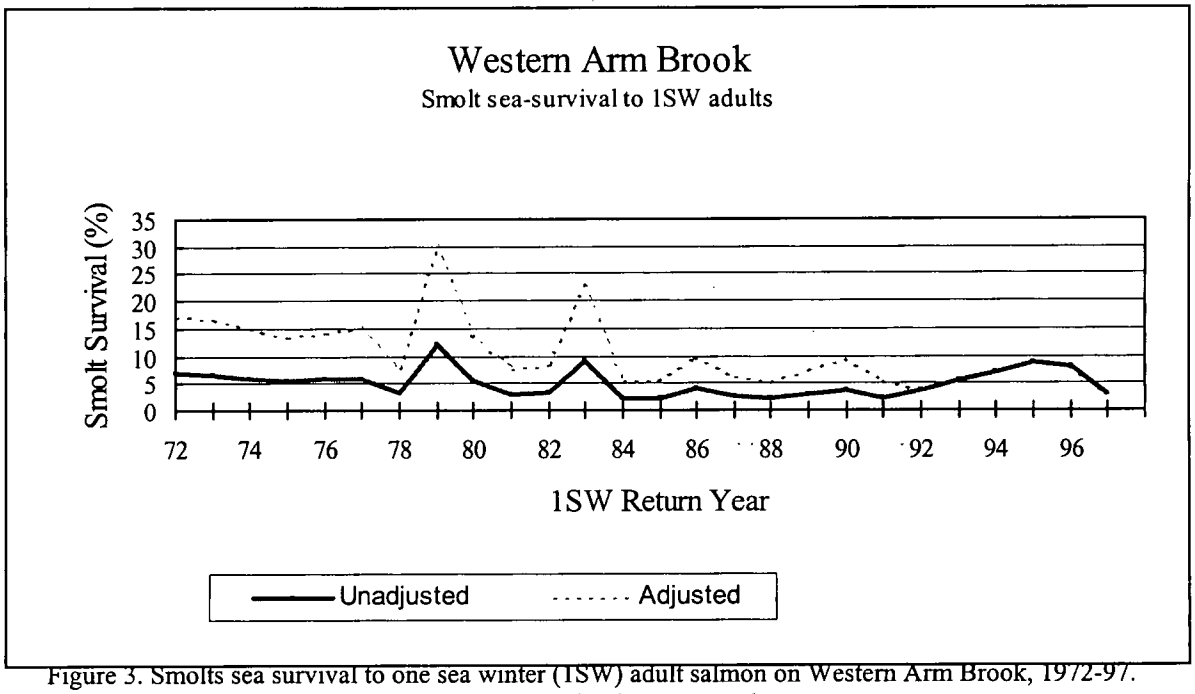
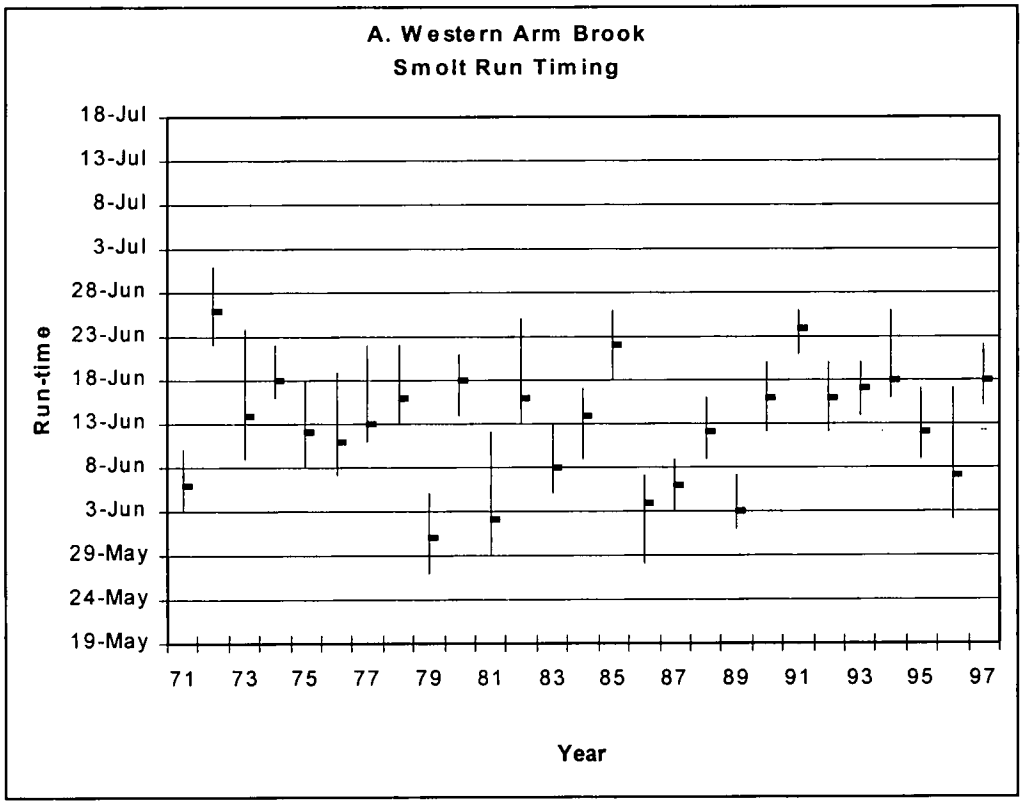


Figure 3. Smolts sea survival to one sea winter (1SW) adult salmon on Western Arm Brook, 1972-97. Dashed line represents adjustment for commercial fishery removals.



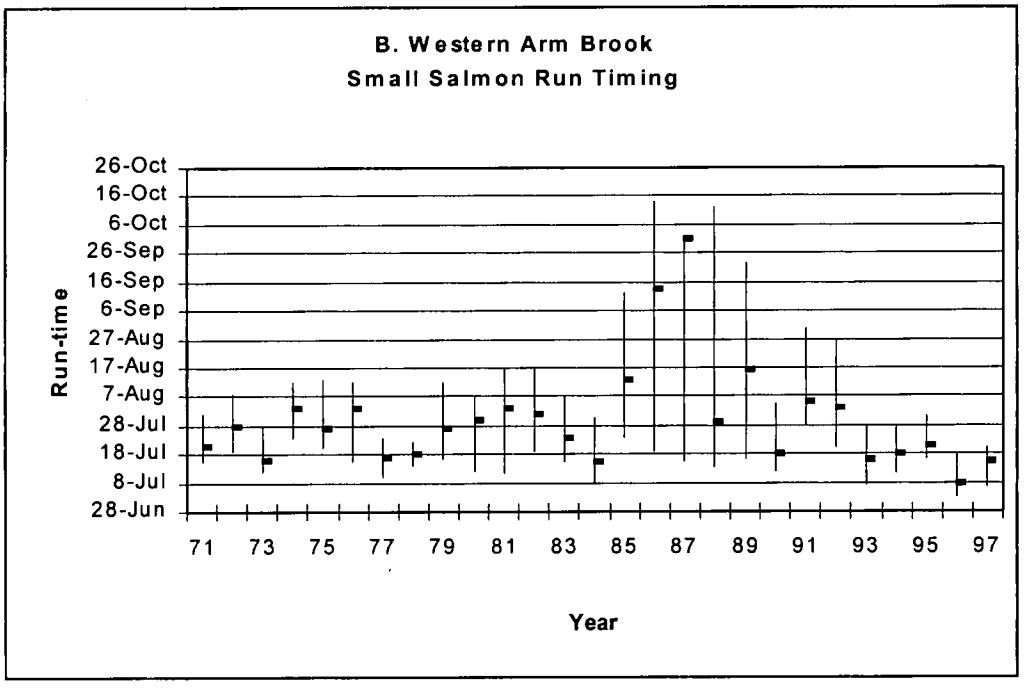


Figure 4. Run timing of smolts and small salmon on Western Arm Brook, 1971-97.

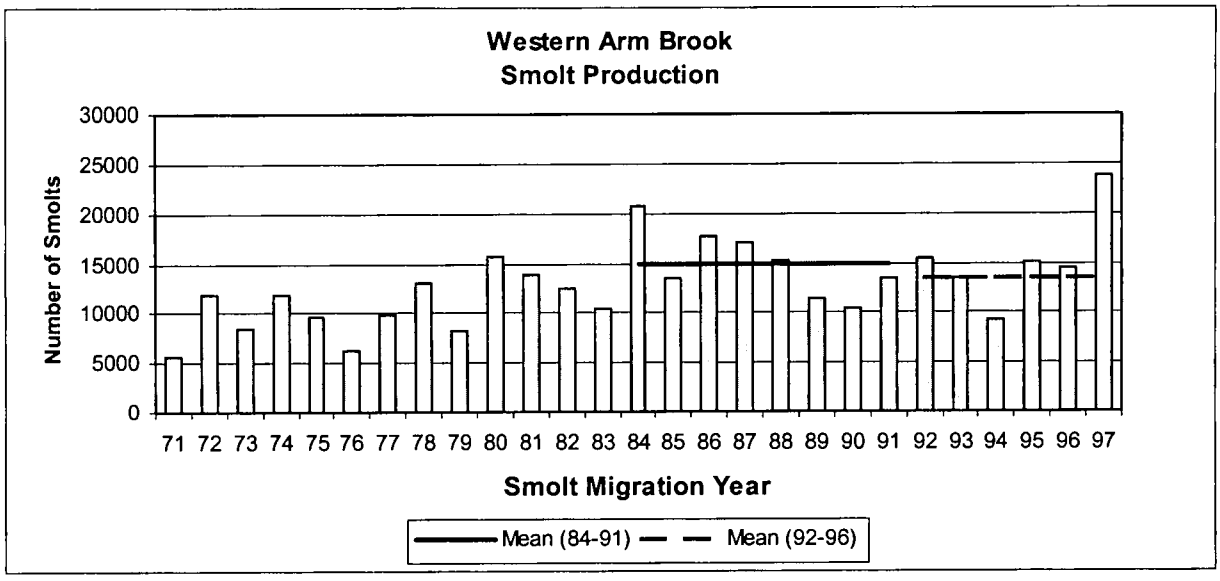


Figure 5. Smolt production at Western Arm Brook, 1971-97.

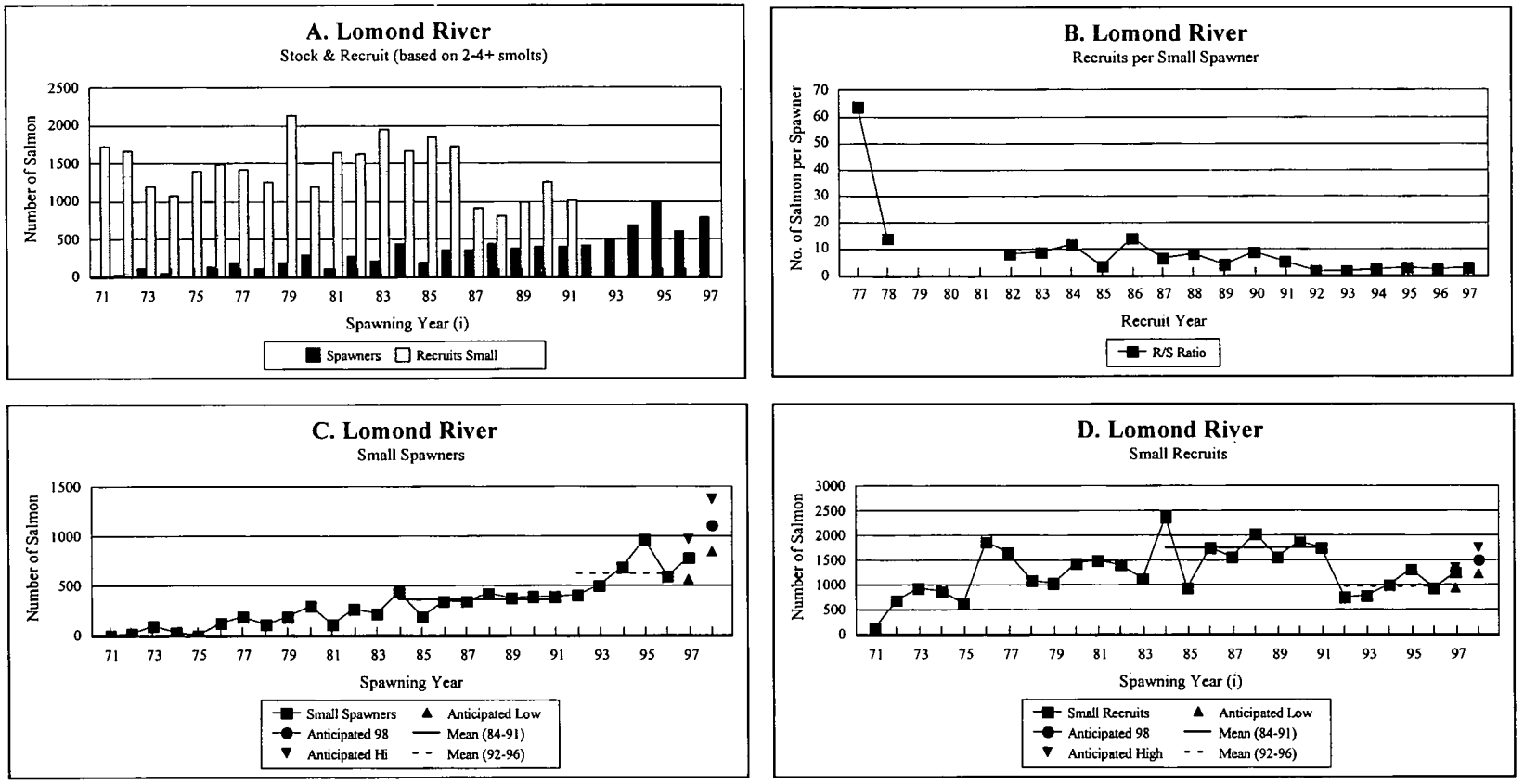


Figure 6. Reconstructed recruitment and spawning escapements of small salmon on Lomond River, 1971-97 and anticipated recruitment in 1998.

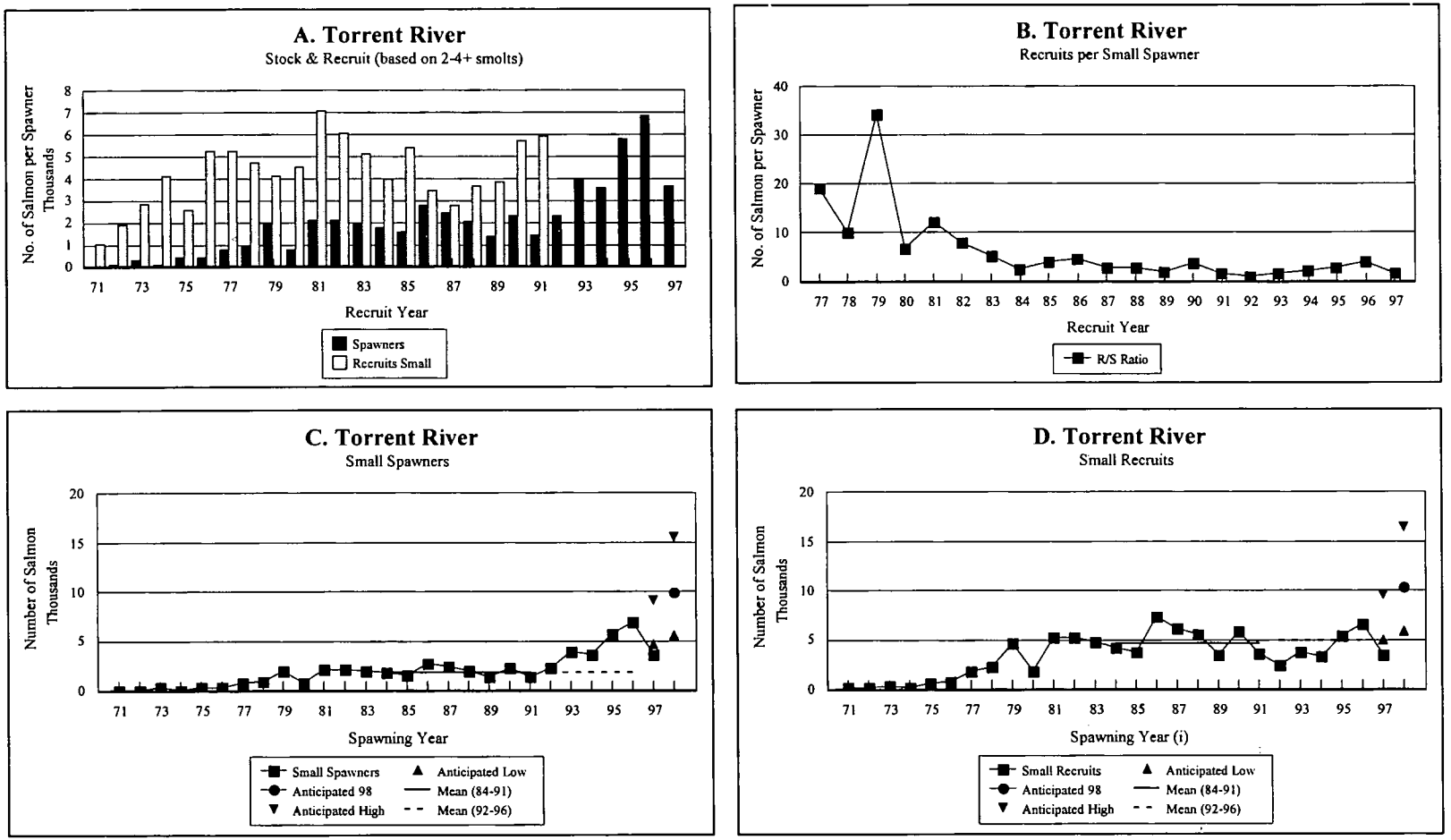


Figure 7. Reconstructed recruitment and spawning escapements of small salmon on Torrent River, 1971-97 and anticipated recruitment in 1998.

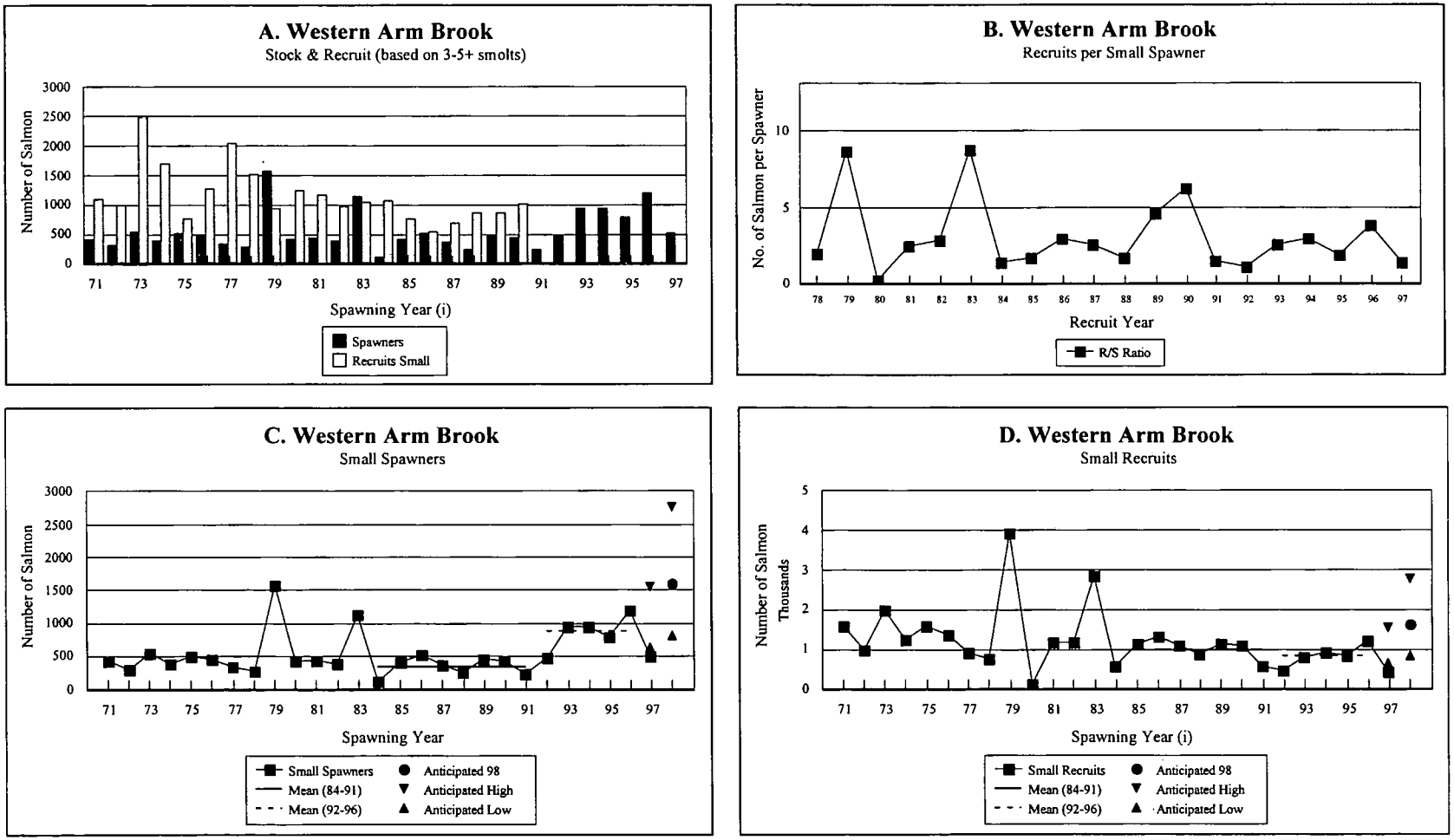


Figure 8. Reconstructed recruitment and spawning escapements of small salmon on Western Arm Brook, 1971-97 and anticipated recruitment in 1998.

Appendix 1. Mean fork length, weight and sex composition of small and large Atlantic salmon.
Note: Sex is determined internally for small salmon and internally and externally for large salmon.
Note: Samples are from recreational fishery and counting fence.
Note: The whole weight given for 1996 id for males and females combined.

LOMOND RIVER

		FORK LENGTH (cm)					WHOLE WEIGHT (kg)					WHOLE WEIGHT FEMALES (kg)					NO.	PERCENT FEMALE	
		N	MEAN	MIN	MAX	STD	N	MEAN	MIN	MAX	STD	N	MEAN	MIN	MAX	STD	SEXED	N	%
LARGE	YY																		
	78	3	69.17	68.0	70.0	1.04	3	3.33	3.2	3.6	0.23	2	3.40	3.2	3.6	0.28	3	2	66.7
	79	1	69.90	69.9	69.9	.	1	3.50	3.5	3.5	.	1	3.50	3.5	3.5	.	1	1	100.0
	80	3	67.90	64.0	71.1	3.60	3	3.74	2.9	4.2	0.69	3	3.74	2.9	4.2	0.69	3	3	100.0
	81	1	75.80	75.8	75.8	.	1	4.80	4.8	4.8	.	0	.	.	.	.	1	0	.
	82	2	70.00	70.0	70.0	0.00	2	3.86	3.6	4.1	0.32	2	3.86	3.6	4.1	0.32	2	2	100.0
	84	4	70.88	66.0	74.0	3.57	4	3.78	3.2	4.2	0.46	2	3.70	3.2	4.2	0.71	2	2	100.0
	92	26	70.51	63.0	77.0	3.36	0	.	.	.	.	0	.	.	.	.	26	1	3.8
	93	7	69.71	66.0	74.0	2.98	6	3.54	2.8	4.3	0.62	5	3.45	2.8	4.3	0.65	7	6	85.7
	94	1	76.80	76.8	76.8	.	1	5.20	5.2	5.2	.	1	5.20	5.2	5.2	.	1	1	100.0
	97	1	66.50	66.5	66.5	.	1	3.50	3.5	3.5	.	0	.	.	.	.	1	0	.
	1984-91	4	70.88	66.0	74.0	3.57	4	3.78	3.2	4.2	0.46	2	3.70	3.2	4.2	0.71	2	2	100.0
	1992-97	35	70.41	63.0	77.0	3.41	8	3.74	2.8	5.2	0.79	6	3.74	2.8	5.2	0.92	35	8	22.9
	Total	49	70.30	63.0	77.0	3.28	22	3.74	2.8	5.2	0.61	16	3.69	2.8	5.2	0.64	47	18	38.3
SMALL	YY																		
	75	1	50.80	50.8	50.8	.	1	1.40	1.4	1.4	.	0	.	.	.	.	0	0	.
	78	21	51.25	45.5	60.0	3.26	21	1.47	1.0	2.3	0.27	0	.	.	.	.	0	0	.
	79	30	51.97	41.9	57.2	2.81	39	1.47	1.0	2.0	0.22	0	.	.	.	.	0	0	.
	80	15	51.53	46.0	56.0	3.02	13	1.54	1.1	1.8	0.24	0	.	.	.	.	0	0	.
	81	39	51.50	41.0	62.4	3.50	38	1.70	1.3	2.8	0.32	0	.	.	.	.	0	0	.
	82	5	48.80	45.0	52.0	2.77	35	1.56	1.0	3.6	0.42	0	.	.	.	.	0	0	.
	83	15	52.63	44.0	56.0	3.18	11	1.47	1.3	1.7	0.11	8	1.46	1.3	1.6	0.09	12	9	75.0
	84	53	51.09	46.0	58.0	2.80	49	1.45	1.1	1.8	0.20	31	1.43	1.1	1.8	0.16	52	32	61.5
	85	33	51.81	44.0	60.0	3.69	23	1.54	1.1	2.1	0.25	6	1.43	1.2	2.0	0.29	11	9	81.8
	86	40	52.86	45.0	60.0	3.20	54	1.88	0.5	5.3	0.98	9	1.71	1.3	2.2	0.30	37	15	40.5
	88	6	52.92	50.5	56.0	1.80	6	1.50	1.3	1.6	0.15	1	1.36	1.4	1.4	.	6	1	16.7
	90	1	50.80	50.8	50.8	.	1	1.10	1.1	1.1	.	1	1.10	1.1	1.1	.	1	1	100.0
	91	1	54.60	54.6	54.6	.	1	1.30	1.3	1.3	.	1	1.30	1.3	1.3	.	1	1	100.0
	92	52	53.95	37.0	62.5	4.46	4	1.53	1.3	1.8	0.22	3	1.60	1.4	1.8	0.20	6	5	83.3
	93	79	52.86	40.0	61.2	3.89	58	1.61	0.6	3.0	0.48	8	1.46	0.7	2.0	0.40	35	24	68.6
	94	24	52.97	40.6	57.2	3.77	24	1.49	0.5	2.4	0.36	12	1.50	0.5	2.4	0.46	26	14	53.8
	95	21	53.95	48.2	59.0	2.47	34	1.62	0.8	2.5	0.37	5	1.89	1.5	2.1	0.24	9	5	55.6
	96	64	52.43	40.0	61.0	3.45	22	1.50	1.0	2.0	0.35	3	1.63	1.4	2.0	0.32	8	4	50.0
	97	27	52.56	41.5	59.5	3.64	27	1.84	0.8	2.9	0.42	0	.	.	.	.	0	0	.
	1984-91	134	51.90	44.0	60.0	3.18	134	1.64	0.5	5.3	0.67	49	1.47	1.1	2.2	0.24	108	59	54.6
	1992-97	267	53.03	37.0	62.5	3.80	169	1.62	0.5	3.0	0.42	31	1.57	0.5	2.4	0.39	84	52	61.9
	Total	527	52.40	37.0	62.5	3.56	461	1.60	0.5	5.3	0.48	88	1.50	0.5	2.4	0.30	204	120	58.8

Appendix 2. Mean fork length, weight and sex composition of small and large Atlantic salmon.
Note: Sex is determined internally for small salmon and internally and externally for large salmon.
Note: Samples are from recreational fishery and counting fence.
Note: The whole weight given for 1996 id for males and females combined.
TORRENT RIVER

		FORK LENGTH (cm)					WHOLE WEIGHT (kg)					WHOLE WEIGHT FEMALES (kg)					NO.	PERCENT FEMALE	
		N	MEAN	MIN	MAX	STD	N	MEAN	MIN	MAX	STD	N	MEAN	MIN	MAX	STD	SEXED	N	%
LARGE	YY																		
	80	1	73.60	73.6	73.6	.	0	.	.	.	.	0	.	.	.	.	1	0	.
	85	5	73.80	71.0	76.0	2.17	1	4.25	4.3	4.3	.	1	4.25	4.3	4.3	.	5	2	40.0
	86	9	72.02	64.0	76.0	3.44	9	4.31	2.2	5.5	0.93	5	3.86	2.2	4.7	1.00	9	5	55.6
	87	8	75.18	63.0	87.0	7.85	8	4.10	3.0	5.5	0.96	4	4.45	3.8	5.0	0.64	8	4	50.0
	88	10	70.06	63.0	77.8	5.92	10	3.60	2.3	5.0	1.06	4	4.44	3.5	5.0	0.72	10	4	40.0
	89	15	73.02	65.6	82.4	5.77	8	3.76	2.8	5.3	1.00	4	4.40	3.1	5.3	1.01	15	6	40.0
	90	2	63.50	63.0	64.0	0.71	0	.	.	.	.	0	.	.	.	.	2	1	50.0
	92	1	78.00	78.0	78.0	.	0	.	.	.	.	0	.	.	.	.	1	1	100.0
	93	146	69.51	63.0	81.5	4.77	0	.	.	.	.	0	.	.	.	.	146	104	71.2
	94	3	71.00	70.0	72.0	1.00	2	3.65	3.5	3.8	0.21	1	3.80	3.8	3.8	.	3	1	33.3
	96	2	77.00	72.0	82.0	7.07	2	4.75	3.5	6.0	1.77	2	4.75	3.5	6.0	1.77	2	2	100.0
	97	11	65.92	63.0	73.0	2.95	11	3.45	2.5	5.0	0.76	6	3.20	2.7	4.0	0.44	11	6	54.5
	1984-91	49	72.28	63.0	87.0	5.81	36	3.94	2.2	5.5	0.98	18	4.26	2.2	5.3	0.81	49	22	44.9
	1992-97	163	69.44	63.0	82.0	4.82	15	3.65	2.5	6.0	0.92	9	3.61	2.7	6.0	0.98	163	114	69.9
	Total	213	70.11	63.0	87.0	5.19	51	3.86	2.2	6.0	0.96	27	4.04	2.2	6.0	0.91	213	136	63.8
SMALL	YY																		
	75	0	.	.	.	.	16	1.70	1.1	4.1	0.69	0	.	.	.	.	0	0	.
	79	4	56.38	47.0	62.0	6.57	3	1.82	1.2	2.2	0.58	0	.	.	.	.	0	0	.
	80	58	53.15	32.4	61.0	4.24	0	.	.	.	.	0	.	.	.	.	0	0	.
	81	0	.	.	.	.	10	1.53	1.0	2.0	0.34	0	.	.	.	.	0	0	.
	83	16	53.01	48.5	56.0	2.38	16	1.43	1.0	1.8	0.25	8	1.43	1.0	1.6	0.27	12	8	66.7
	85	154	52.49	44.0	61.5	3.16	6	1.46	1.0	2.3	0.46	0	.	.	.	.	7	3	42.9
	86	305	52.39	40.5	61.5	3.30	303	1.76	0.5	3.0	0.43	16	1.52	1.2	2.0	0.22	24	18	75.0
	87	301	51.96	42.7	60.5	2.86	301	1.57	0.7	2.8	0.38	19	1.44	1.0	2.0	0.25	21	19	90.5
	88	220	53.67	47.0	62.7	3.37	220	1.52	1.0	2.5	0.36	12	1.56	1.0	2.3	0.34	14	12	85.7
	89	108	54.12	45.9	62.0	3.47	101	1.67	0.2	2.6	0.32	0	.	.	.	.	0	0	.
	90	40	53.93	47.0	62.5	3.84	0	.	.	.	.	0	.	.	.	.	5	3	60.0
	91	43	52.61	47.0	59.0	3.10	4	1.78	1.5	2.2	0.31	2	1.90	1.6	2.2	0.42	4	2	50.0
	92	17	53.43	46.7	59.0	3.03	0	.	.	.	.	0	.	.	.	.	4	3	75.0
	93	254	53.18	30.0	62.0	4.20	2	2.10	1.9	2.3	0.28	2	2.10	1.9	2.3	0.28	2	2	100.0
	94	22	54.25	48.0	60.5	3.38	17	1.43	0.9	3.0	0.50	2	1.50	1.4	1.6	0.14	2	2	100.0
	95	19	54.07	48.3	58.4	2.58	17	1.68	1.1	2.1	0.32	10	1.68	1.4	2.0	0.21	17	12	70.6
	96	37	54.22	48.0	60.8	3.09	34	1.57	1.0	2.8	0.37	4	1.71	1.3	2.3	0.45	7	6	85.7
	97	53	56.65	47.0	62.8	3.36	46	2.13	1.0	3.5	0.55	2	2.00	1.8	2.3	0.35	12	9	75.0
	1984-91	1171	52.75	40.5	62.7	3.30	935	1.63	0.2	3.0	0.40	49	1.51	1.0	2.3	0.28	75	57	76.0
	1992-97	402	53.84	30.0	62.8	4.01	116	1.80	0.9	3.5	0.54	20	1.74	1.3	2.3	0.31	44	34	77.3
	Total	1651	53.04	30.0	62.8	3.55	1096	1.65	0.2	4.1	0.42	77	1.56	1.0	2.3	0.30	131	99	75.6

Appendix 3 Mean fork length, weight and sex composition of small and large Atlantic salmon.
Note: Sex is determined internally for small salmon and internally and externally for large salmon.
Note: Samples are from recreational fishery and counting fence.
Note: The whole weight given for 1996 id for males and females combined.

WESTERN ARM BROOK

		FORK LENGTH (cm)					WHOLE WEIGHT (kg)					WHOLE WEIGHT FEMALES (kg)					NO.	PERCENT FEMALE	
		N	MEAN	MIN	MAX	STD	N	MEAN	MIN	MAX	STD	N	MEAN	MIN	MAX	STD	SEXED	N	%
LARGE	YY																		
	73	1	72.00	72.0	72.0	.	1	3.85	3.9	3.9	.	0	.	.	.	.	1	0	.
	77	2	74.50	74.0	75.0	0.71	2	3.94	3.9	4.0	0.08	1	3.88	3.9	3.9	.	2	1	50.0
	80	2	75.00	73.0	77.0	2.83	2	4.55	4.2	4.9	0.49	2	4.55	4.2	4.9	0.49	2	2	100.0
	81	2	69.00	68.5	69.5	0.71	2	2.95	2.3	3.6	0.92	2	2.95	2.3	3.6	0.92	2	2	100.0
	85	1	71.00	71.0	71.0	.	1	3.50	3.5	3.5	.	0	.	.	.	.	1	0	.
	87	1	64.00	64.0	64.0	.	1	2.40	2.4	2.4	.	1	2.40	2.4	2.4	.	1	1	100.0
	88	2	76.00	72.0	80.0	5.66	2	3.40	2.8	4.0	0.85	2	3.40	2.8	4.0	0.85	2	2	100.0
	89	1	63.50	63.5	63.5	.	1	1.60	1.6	1.6	.	0	.	.	.	.	1	0	.
	90	1	64.80	64.8	64.8	.	1	3.00	3.0	3.0	.	1	3.00	3.0	3.0	.	1	1	100.0
	91	1	76.20	76.2	76.2	.	1	4.00	4.0	4.0	.	1	4.00	4.0	4.0	.	1	1	100.0
	92	8	70.85	63.0	79.0	5.73	1	4.50	4.5	4.5	.	1	4.50	4.5	4.5	.	8	5	62.5
	93	4	69.58	67.8	71.5	1.95	4	3.48	2.0	4.2	1.00	4	3.48	2.0	4.2	1.00	4	4	100.0
	94	7	70.11	63.9	78.1	4.68	7	3.67	2.2	5.0	1.00	3	3.83	2.2	5.0	1.46	7	3	42.9
	95	35	73.88	64.8	83.5	3.95	35	4.73	3.0	6.3	0.84	29	4.72	3.0	6.0	0.80	35	29	82.9
	96	26	72.35	63.0	77.4	4.09	26	3.94	1.2	6.0	1.54	21	3.89	1.2	6.0	1.52	26	21	80.8
	97	7	70.16	63.0	74.9	4.05	7	2.84	2.4	4.0	0.63	6	2.65	2.4	3.4	0.40	7	6	85.7
	1984-91	7	70.21	63.5	80.0	6.43	7	3.04	1.6	4.0	0.88	5	3.24	2.4	4.0	0.73	7	5	71.4
	1992-97	87	72.34	63.0	83.5	4.34	80	4.15	1.2	6.3	1.25	64	4.13	1.2	6.0	1.25	87	68	78.2
	Total	101	72.22	63.0	83.5	4.42	94	4.04	1.2	6.3	1.23	74	4.05	1.2	6.0	1.22	101	78	77.2
SMALL	YY																		
	71	78	52.76	36.6	61.2	3.12	13	1.51	1.0	1.8	0.21	0	.	.	.	.	0	0	.
	72	67	52.58	37.2	62.5	3.72	76	1.60	0.6	2.6	0.40	0	.	.	.	.	0	0	.
	73	137	53.13	43.8	62.1	2.98	136	1.60	0.8	2.8	0.29	0	.	.	.	.	0	0	.
	74	80	53.10	45.9	59.8	2.56	79	1.62	1.1	2.2	0.23	0	.	.	.	.	0	0	.
	75	24	52.26	33.0	58.5	5.24	24	1.52	0.7	2.3	0.36	0	.	.	.	.	0	0	.
	76	205	53.12	41.0	59.0	2.75	11	1.68	1.4	3.0	0.45	0	.	.	.	.	0	0	.
	77	75	52.90	40.9	60.3	3.58	71	1.37	0.5	2.6	0.39	0	.	.	.	.	0	0	.
	78	73	52.06	45.0	58.0	2.72	28	1.39	0.6	2.1	0.43	0	.	.	.	.	0	0	.
	79	226	51.39	27.5	62.0	3.07	226	1.51	0.5	2.9	0.30	0	.	.	.	.	0	0	.
	80	765	52.55	39.0	59.5	2.40	758	0.96	0.1	7.0	0.38	0	.	.	.	.	0	0	.
	81	73	52.28	43.0	60.0	3.20	73	1.51	0.8	2.5	0.36	0	.	.	.	.	0	0	.
	82	76	53.11	48.0	59.5	2.12	76	1.79	0.7	3.0	0.36	0	.	.	.	.	0	0	.
	83	205	51.42	35.9	60.0	2.90	203	1.52	0.7	2.7	0.31	1	1.80	1.8	1.8	.	1	1	100.0
	84	41	51.14	45.0	59.5	2.71	39	1.27	0.8	2.0	0.33	2	1.30	1.2	1.4	0.14	2	2	100.0
	85	80	52.27	37.5	59.0	3.04	80	1.56	0.9	2.2	0.30	45	1.58	0.9	2.1	0.30	52	45	86.5
	86	38	52.93	46.0	58.5	2.95	38	1.65	1.1	2.2	0.29	0	.	.	.	.	0	0	.
	87	85	53.79	47.0	59.4	2.69	85	1.63	0.5	2.7	0.34	17	1.91	1.5	2.7	0.41	22	18	81.8
	88	66	53.65	36.5	61.0	3.83	64	1.56	0.5	2.4	0.48	16	1.61	0.9	2.0	0.27	24	18	75.0
	89	155	53.51	42.0	60.5	3.17	58	1.60	0.0	2.5	0.51	7	1.89	1.5	2.3	0.28	8	7	87.5
	90	49	55.45	50.8	62.2	3.16	36	1.82	1.0	2.4	0.41	2	1.40	1.4	1.4	0.00	3	2	66.7
	91	228	53.26	46.4	62.2	2.50	81	1.71	0.0	2.1	0.25	0	.	.	.	.	0	0	.
	92	415	53.65	34.0	61.6	2.91	7	1.61	0.7	2.2	0.64	0	.	.	.	.	0	0	.
	93	292	54.02	46.6	62.0	2.74	271	1.82	0.6	4.1	0.53	0	.	.	.	.	0	0	.
	94	111	53.74	36.5	60.9	3.37	109	1.79	0.9	2.8	0.35	11	1.80	1.3	2.3	0.29	11	11	100.0
	95	99	54.50	45.8	62.0	2.78	94	2.10	1.3	3.3	0.36	18	1.99	1.5	2.5	0.28	25	24	96.0
	96	82	54.70	45.0	61.7	3.42	78	1.95	0.8	3.0	0.48	29	2.04	1.3	2.7	0.37	36	29	80.6
	97	57	55.17	42.4	62.0	3.25	38	1.91	0.9	2.9	0.51	1	1.90	1.9	1.9	.	1	1	100.0
	1984-91	742	53.31	36.5	62.2	3.05	481	1.61	0.0	2.7	0.38	89	1.66	0.9	2.7	0.34	111	92	82.9
	1992-97	1056	54.01	34.0	62.0	2.99	597	1.88	0.6	4.1	0.48	59	1.98	1.3	2.7	0.33	73	65	89.0
	Total	3882	53.03	27.5	62.5	3.01	2852	1.47	0.0	7.0	0.51	149	1.79	0.9	2.7	0.37	185	158	85.4

Appendix 4. Sea-age distribution of small and large Atlantic salmon.
LOMOND RIVER

		SEA-AGE									
		1SW		CS 1SW		AS 1SW		2SW		Total	
		N	%	N	%	N	%	N	%	N	%
LARGE	YY										
	78	.	.	1	33.3	.	.	2	66.7	3	100.0
	79	1	100.0	.	.	.	.	.	.	1	100.0
	80	.	.	1	33.3	.	.	2	66.7	3	100.0
	81	.	.	.	.	.	.	1	100.0	1	100.0
	82	.	.	.	.	.	.	2	100.0	2	100.0
	84	.	.	.	.	.	.	4	100.0	4	100.0
	92	1	4.0	2	8.0	7	28.0	15	60.0	25	100.0
	93	.	.	.	.	1	14.3	6	85.7	7	100.0
	94	.	.	.	.	.	.	1	100.0	1	100.0
	97	.	.	.	.	1	100.0	.	.	1	100.0
	1984-91	.	.	.	.	.	.	4	100.0	4	100.0
	1992-97	1	2.9	2	5.9	9	26.5	22	64.7	34	100.0
	Total	2	4.2	4	8.3	9	18.8	33	68.8	48	100.0
SMALL	YY										
	75	1	100.0	.	.	.	.	.	.	1	100.0
	78	20	90.9	2	9.1	.	.	.	.	22	100.0
	79	39	100.0	.	.	.	.	.	.	39	100.0
	80	15	100.0	.	.	.	.	.	.	15	100.0
	81	37	94.9	2	5.1	.	.	.	.	39	100.0
	82	36	97.3	.	.	.	.	1	2.7	37	100.0
	83	15	100.0	.	.	.	.	.	.	15	100.0
	84	55	100.0	.	.	.	.	.	.	55	100.0
	85	32	97.0	1	3.0	.	.	.	.	33	100.0
	86	57	87.7	1	1.5	2	3.1	5	7.7	65	100.0
	88	6	100.0	.	.	.	.	.	.	6	100.0
	90	1	100.0	.	.	.	.	.	.	1	100.0
	91	1	100.0	.	.	.	.	.	.	1	100.0
	92	50	96.2	1	1.9	1	1.9	.	.	52	100.0
	93	75	93.8	5	6.3	.	.	.	.	80	100.0
	94	24	100.0	.	.	.	.	.	.	24	100.0
	95	43	100.0	.	.	.	.	.	.	43	100.0
	96	65	98.5	1	1.5	.	.	.	.	66	100.0
	97	27	93.1	1	3.4	.	.	1	3.4	29	100.0
	1984-91	152	94.4	2	1.2	2	1.2	5	3.1	161	100.0
	1992-97	284	96.6	8	2.7	1	0.3	1	0.3	294	100.0
	Total	599	96.1	14	2.2	3	0.5	7	1.1	623	100.0

Appendix 5. Sea-age distribution of small and large Atlantic salmon.
TORRENT RIVER

		SEA-AGE												Total	
		1SW		CS 1SW		AS 1SW		CS 2SW		2SW		3SW			
		N	%	N	%	N	%	N	%	N	%	N	%	N	%
LARGE	YY														
	80	.	.	1	100.0	.	.	.	.	.	.	.	.	1	100.0
	85	.	.	.	.	3	60.0	.	.	2	40.0	.	.	5	100.0
	86	.	.	1	11.1	4	44.4	.	.	4	44.4	.	.	9	100.0
	87	.	.	1	12.5	6	75.0	.	.	1	12.5	.	.	8	100.0
	88	.	.	5	50.0	4	40.0	.	.	1	10.0	.	.	10	100.0
	89	.	.	5	33.3	9	60.0	.	.	1	6.7	.	.	15	100.0
	90	1	100.0	.	.	.	.	.	.	.	.	.	.	1	100.0
	92	.	.	.	.	1	100.0	.	.	.	.	.	.	1	100.0
	93	2	1.4	41	28.7	1	0.7	44	30.8	54	37.8	1	0.7	143	100.0
	94	.	.	1	33.3	.	.	.	.	2	66.7	.	.	3	100.0
	96	.	.	.	.	.	.	1	50.0	1	50.0	.	.	2	100.0
	97	.	.	10	100.0	.	.	.	.	.	.	.	.	10	100.0
	1984-91	1	2.1	12	25.0	26	54.2	.	.	9	18.8	.	.	48	100.0
	1992-97	2	1.3	52	32.7	2	1.3	45	28.3	57	35.8	1	0.6	159	100.0
	Total	3	1.4	65	31.3	28	13.5	45	21.6	66	31.7	1	0.5	208	100.0
SMALL	YY														
	75	15	93.8	.	.	.	.	.	.	1	6.3	.	.	16	100.0
	79	4	100.0	.	.	.	.	.	.	.	.	.	.	4	100.0
	80	55	94.8	3	5.2	.	.	.	.	.	.	.	.	58	100.0
	81	9	90.0	1	10.0	.	.	.	.	.	.	.	.	10	100.0
	83	16	100.0	.	.	.	.	.	.	.	.	.	.	16	100.0
	85	147	95.5	7	4.5	.	.	.	.	.	.	.	.	154	100.0
	86	290	95.1	15	4.9	.	.	.	.	.	.	.	.	305	100.0
	87	288	95.7	11	3.7	1	0.3	.	.	1	0.3	.	.	301	100.0
	88	196	89.1	24	10.9	.	.	.	.	.	.	.	.	220	100.0
	89	92	85.2	15	13.9	.	.	.	.	1	0.9	.	.	108	100.0
	90	36	92.3	3	7.7	.	.	.	.	.	.	.	.	39	100.0
	91	38	92.7	3	7.3	.	.	.	.	.	.	.	.	41	100.0
	92	17	100.0	.	.	.	.	.	.	.	.	.	.	17	100.0
	93	223	87.5	29	11.4	.	.	1	0.4	2	0.8	.	.	255	100.0
	94	20	90.9	2	9.1	.	.	.	.	.	.	.	.	22	100.0
	95	20	90.9	2	9.1	.	.	.	.	.	.	.	.	22	100.0
	96	34	94.4	2	5.6	.	.	.	.	.	.	.	.	36	100.0
	97	48	85.7	8	14.3	.	.	.	.	.	.	.	.	56	100.0
	1984-91	1087	93.1	78	6.7	1	0.1	.	.	2	0.2	.	.	1168	100.0
	1992-97	362	88.7	43	10.5	.	.	1	0.2	2	0.5	.	.	408	100.0
	Total	1548	92.1	125	7.4	1	0.1	1	0.1	5	0.3	.	.	1680	100.0

Appendix 6. Sea-age distribution of small and large Atlantic salmon.
WESTERN ARM BROOK

		SEA-AGE													
		1SW		CS 1SW		AS 1SW		CS 2SW		AS 2SW		2SW		Total	
		N	%	N	%	N	%	N	%	N	%	N	%	N	%
LARGE	YY														
	73	.	.	.	.	.	.	1	100.0	.	.	.	.	1	100.0
	77	.	.	.	.	2	100.0	.	.	.	.	.	.	2	100.0
	80	.	.	2	100.0	.	.	.	.	.	.	.	.	2	100.0
	81	.	.	1	50.0	.	.	1	50.0	.	.	.	.	2	100.0
	85	.	.	.	.	.	.	.	.	.	.	1	100.0	1	100.0
	87	1	100.0	.	.	.	.	.	.	.	.	.	.	1	100.0
	88	.	.	.	.	1	50.0	1	50.0	.	.	.	.	2	100.0
	89	.	.	1	100.0	.	.	.	.	.	.	.	.	1	100.0
	90	1	100.0	.	.	.	.	.	.	.	.	.	.	1	100.0
	91	1	100.0	.	.	.	.	.	.	.	.	.	.	1	100.0
	92	2	25.0	.	.	5	62.5	.	.	.	.	1	12.5	8	100.0
	93	1	25.0	.	.	.	.	1	25.0	.	.	2	50.0	4	100.0
	94	2	33.3	1	16.7	.	.	1	16.7	.	.	2	33.3	6	100.0
	95	.	.	.	.	31	91.2	.	.	.	.	3	8.8	34	100.0
	96	2	8.7	1	4.3	13	56.5	6	26.1	1	4.3	.	.	23	100.0
	97	.	.	.	.	.	.	7	100.0	.	.	.	.	7	100.0
	1984-91	3	42.9	1	14.3	1	14.3	1	14.3	.	.	1	14.3	7	100.0
	1992-97	7	8.5	2	2.4	49	59.8	15	18.3	1	1.2	8	9.8	82	100.0
	Total	10	10.4	6	6.3	52	54.2	18	18.8	1	1.0	9	9.4	96	100.0
SMALL	YY														
	71	77	100.0	.	.	.	.	.	.	.	.	.	.	77	100.0
	72	71	93.4	.	.	.	.	5	6.6	.	.	.	.	76	100.0
	73	136	99.3	.	.	.	.	.	.	.	.	1	0.7	137	100.0
	74	81	100.0	.	.	.	.	.	.	.	.	.	.	81	100.0
	75	18	100.0	.	.	.	.	.	.	.	.	.	.	18	100.0
	76	6	100.0	.	.	.	.	.	.	.	.	.	.	6	100.0
	77	53	100.0	.	.	.	.	.	.	.	.	.	.	53	100.0
	78	64	98.5	.	.	.	.	.	.	.	.	1	1.5	65	100.0
	79	226	100.0	.	.	.	.	.	.	.	.	.	.	226	100.0
	80	58	100.0	.	.	.	.	.	.	.	.	.	.	58	100.0
	81	63	96.9	2	3.1	.	.	.	.	.	.	.	.	65	100.0
	82	73	100.0	.	.	.	.	.	.	.	.	.	.	73	100.0
	83	189	99.5	1	0.5	.	.	.	.	.	.	.	.	190	100.0
	84	24	100.0	.	.	.	.	.	.	.	.	.	.	24	100.0
	85	79	98.8	.	.	.	.	.	.	.	.	1	1.3	80	100.0
	86	38	100.0	.	.	.	.	.	.	.	.	.	.	38	100.0
	87	81	100.0	.	.	.	.	.	.	.	.	.	.	81	100.0
	88	53	88.3	5	8.3	1	1.7	1	1.7	.	.	.	.	60	100.0
	89	140	100.0	.	.	.	.	.	.	.	.	.	.	140	100.0
	90	46	97.9	1	2.1	.	.	.	.	.	.	.	.	47	100.0
	91	224	100.0	.	.	.	.	.	.	.	.	.	.	224	100.0
	92	407	99.8	.	.	.	.	.	.	.	.	1	0.2	408	100.0
	93	251	86.3	38	13.1	.	.	1	0.3	.	.	1	0.3	291	100.0
	94	103	96.3	4	3.7	.	.	.	.	.	.	.	.	107	100.0
	95	97	100.0	.	.	.	.	.	.	.	.	.	.	97	100.0
	96	76	100.0	.	.	.	.	.	.	.	.	.	.	76	100.0
	97	43	84.3	6	11.8	.	.	2	3.9	.	.	.	.	51	100.0
	1984-91	685	98.7	6	0.9	1	0.1	1	0.1	.	.	1	0.1	694	100.0
	1992-97	977	94.9	48	4.7	.	.	3	0.3	.	.	2	0.2	1030	100.0
	Total	2777	97.5	57	2.0	1	0.0	9	0.3	.	.	5	0.2	2849	100.0

Appendix 7 . Recreational catch and effort of Atlantic salmon on Western Arm Brook, 1960-88.

Year	Effort (Rod-days)	Small			Large			Total Catch			CPUE
		Retained	Released	Total	Retained	Released	Total	Retained	Released	Total	
1960											
1961	3	1	.	1	0	.	0	1	.	1	0.33
1962	44	38	.	38	0	.	0	38	.	38	0.86
1963	97	86	.	86	0	.	0	86	.	86	0.89
1964	171	130	.	130	0	.	0	130	.	130	0.76
1965	214	123	.	123	0	.	0	123	.	123	0.57
1966	273	219	.	219	0	.	0	219	.	219	0.80
1967	261	192	.	192	0	.	0	192	.	192	0.74
1968	298	176	.	176	0	.	0	176	.	176	0.59
1969	296	323	.	323	13	.	13	336	.	336	1.14
1970	420	294	.	294	42	.	42	336	.	336	0.80
1971	128	205	.	205	0	.	0	205	.	205	1.60
1972	100	97	.	97	0	.	0	97	.	97	0.97
1973	409	243	.	243	0	.	0	243	.	243	0.59
1974	361	124	.	124	0	.	0	124	.	124	0.34
1975	155	8	.	8	0	.	0	8	.	8	0.05
1976	115	32	.	32	0	.	0	32	.	32	0.28
1977	107	11	.	11	0	.	0	11	.	11	0.10
1978	168	22	.	22	1	.	1	23	.	23	0.14
1979	5	0	.	0	0	.	0	0	.	0	0.00
1980	175	30	.	30	2	.	2	32	.	32	0.18
1981	209	41	.	41	0	.	0	41	.	41	0.20
1982	379	73	.	73	0	.	0	73	.	73	0.19
1983	15	0	.	0	0	.	0	0	.	0	0.00
1984	432	115	.	115	0	.	0	115	.	115	0.27
1985	204	46	52	98	.	1	1	46	53	99	0.49
1986	83	.	17	17	.	0	0	0	17	17	0.20
1987	269	59	.	59	.	2	2	59	2	61	0.23
1988	701	171	.	171	.	0	0	171	0	171	0.24
Mean(84-88)	338	78	.	92	.	1	1	78	18	93	0.29
95% CL=+-	297	82	.	72	.	1	1	82	25	72	0.14
N	5	5	.	5	.	4	5	5	4	5	5
Mean(78-83)	159	28	.	28	1	.	1	28	.	28	0.12
95% CL=+-	145	29	.	29	1	.	1	29	.	29	0.10
N	6	6	.	6	6	.	6	6	.	6	6