Department of Fisheries and Oceans
Canadian Stock Assessment Secretariat
Research Document 97/33

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Ministère des pêches et océans
Secrétariat canadien pour l'évaluation des stocks
Document de recherche 97/33

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# Status of three enhanced Atlantic salmon (*Salmon salar* L.) stocks of the Newfoundland Region in 1996

by

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## Abstract

The status of Atlantic salmon in three systems, namely Rocky River, Little River and Flat Bay Brook which are presently undergoing salmon enhancement activities are assessed. The systems are located in Salmon Fishing Areas (SFA) 9, 11 and 13 respectively. Egg deposition for each watershed was 34%, 298% and 65% respectively of the required conservation egg deposition. Of these systems, only the Little River would have had salmon returning in 1996 from previous stocking activities. Romaines River in SFA 13 and Piper's Hole River in SFA 10 are updated in terms of stocking activities.



## Résumé

L'état du saumon atlantique dans trois bassins versants, ceux des rivières Rocky et Little et du ruisseau Flat Bay, qui font l'objet de travaux de mise en valeur, a été évalué. Les bassins sont situés dans, respectivement, les zones de pêche du saumon (ZPS) 9, 11 et 13. La ponte dans ces bassins a été de, respectivement, 34 %, 298 % et 65 % des besoins de conservation. Des remontées dans ces bassins en 1996, seule celle de la Little pouvait comporter des saumons ayant fait l'objet d'un ensemencement. On trouve aussi une mise à jour des travaux d'ensemencement réalisés dans la rivière Romaines, dans la ZPS 13 et la rivière Piper's Hole, de la ZPS 10.

## Introduction

Rocky River is the largest watershed on the Avalon Peninsula, encompassing a drainage area of 296 $km^2$ (Porter et al. 1974) flowing to the sea in salmon Fishing Area (SFA 9) (Fig. 1). A natural falls at the mouth of this river, made this watershed inaccessible to anadromous Atlantic salmon, prior to fishway construction in 1987. The Rocky River requires 3.4 million eggs to meet the required conservation egg deposition (Table1).

The Little River flows into the Bay d'Espoir in SFA 11(Fig. 1) approximately 4 km south of the Conne River. The watershed encompasses 183 $km^2$ with a complete obstruction at kilometre 4.8 on the main stem of the river which results in anadromous Atlantic salmon having access to less than 30% of the watershed. Little River requires 313,920 eggs and 976,072 eggs for the accessible and inaccessible portions of the watershed respectively for conservation (Table 1).

Romaines River and Flat Bay Brook are situated in St. Georges Bay in SFA 13. Flat Bay Brook encompasses a watershed area of 635 $km^2$. Due to natural obstructions anadromous Atlantic salmon have access to 89% of the riverine habitat and very little standing water habitat (Porter et. al., 1974). Porter et. al. (1974) record 16,012 ($100m^2$) rearing units accessible to anadromous Atlantic salmon. Romaines River encompasses a watershed area of 98 $km^2$ and has 4,572 rearing units of riverine habitat with no standing water accessible to anadromous Atlantic salmon (Table 1).

The Piper's Hole River flows into the western side of Placentia Bay in SFA10 (Fig. 1) and requires an egg deposition of $3.159 \times 10^6$ eggs for conservation (Table 1).

The intent of this document is to review the status of Atlantic salmon stocks in these watersheds in 1996 and to discuss any possible changes in stock status due to management changes affecting marine exploitation.

## Background

For details of the stocking conducted on these watersheds refer to Tables 4, 9, 11, 15 and 16. Atlantic salmon was introduced into Rocky River by means of fry stocking and an adult transfer from 1984-87. Little River is the site of a ranching project which began in 1989. Romaines River, Flat Bay Brook and Piper's Hole River are the sites of stock augmentation projects which began in 1993 (Romaines) and 1995 (Flat Bay Brook and Piper's Hole River).

Rocky River, since the introduction of anadromous Atlantic salmon, has not been open for a recreational salmon fishery. Little River downstream of the obstruction has been closed to angling since 1989. Flat Bay Brook has been under a special management regime (quota) since 1986 (Table 10) and was closed to angling in 1995 and 1996. The Romaines River is an unscheduled watershed.

Management restrictions implemented in 1992 which were in place through 1995 that impacted marine exploitation of salmon are as follows:

1. Moratorium on commercial salmon fishing along the coast of insular Newfoundland.

2. Moratorium on the cod fishery in areas 2J, 3K and 3L implemented on July 15, 1992. This reduced the by-catch of Atlantic salmon.

3. Moratorium on the cod fishery in 4R implemented in August of 1993, further reduced the by-catch of Atlantic salmon.

## Methods

The conservation egg requirement was calculated based on 2.40 egg/$m^2$ of fluvial habitat and 368 eggs/ha of standing water. Smolt production of 7 smolt/ha was divided by 1.9% to convert this to eggs, (O'Connell et al., 1991).

Spawning escapements were calculated from fishway/fence counts less known removals without inclusion of an estimate for poaching and disease.

Fecundity

Numbers of female fish examined in fecundity studies conducted on Rocky River, Flat Bay Brook and Piper's Hole River are detailed in the following table;

| River | Number of females examined (No. Of females sacrificed for egg retention) | | |
|---|---|---|---|
| | 1994 | 1995 | 1996 |
| Rocky River | 19(19) | 30(5) | N/A |
| Flat Bay Brook | N/A | 33(7) | 26(8) |
| Piper's Hole River | N/A | 21(5) | 28(9) |

Female salmon examined for fecundity were sampled for fork length, whole weight and sacle sampled. Fish were manually stripped of their eggs, fertilized and then counted manually. Fish examined for egg retention were sacrificed any remaining eggs removed, kept separate, fertilized and then counted manually. Percentage of eggs retained were used to adjust the egg counts of fish that were released alive.

The Rocky River and Flat Bay Brook egg depositions are calculated based on average number of eggs/cm of fish fork length while egg depositions for other stocks are based on average number of eggs per kilogram of female weight for the respective years. Percentage females in the population was calculated using the sex ratio of broodstock for the particular year and mean weight of females collected from broodstock. Rocky River egg deposition in 1996 was based on the combined fecundity data for 1994 and 1995. Flat Bay Brook and Piper's Hole River egg depositions for 1995 and 1996 utilized fecundity data from the respective year(s).

Egg Depositions

Egg depositions were calacuated as follows;

I) For length based relationships the appropriate regression equation was solved using mean length of female for large and small seperately then multiplied by the respective number of females and the two totals summed.

2)For weight based the mean weight of female for large and small was multiplied by the number of eggs per kg. and then multiplied by the respective number of females and the two totals summed.

In order to calculate the egg deposition in areas where stocking occurred, an estimate of egg-to-fry survival of 20% (Sturge, 1968) was used to back-calculate the number of fry released to equivalent naturally spawned eggs. Sturge (1968), in his work, gave a range of 10-30% for egg-to-fry survival and indicated that a figure of 20% appeared to be a reasonable value. Parr were back calculated to eggs by dividing the number of parr stocked by 0.125( V. Pepper, pers. comm.) based on parr stocking data obtained from Black Brook. Assumptions are that natural egg to fry survival is 20% and that 40% of the wild fry survive to their first fall. Inherent in this calculation is that 80% of fry placed in grow out cages survive to 90 day fingerlings.

Smolt Operations

In 1996 a smolt fence was operated on the Rocky River for the seventh year with dates of operation and dates of first and last smolt listed below.

| Year | Dates of Operation | Date of First Smolt | Date of Last Smolt |
|---|---|---|---|
| 1990 | Apr. 26 - June 8 | Apr. 27 | June 8 |
| 1991 | Apr. 23 - June 19 | May 1 | June 19 |
| 1992 | Apr. 27 - June 16 | Apr. 29 | June 15 |
| 1993 | Apr. 28 - June 14 | May 4 | June 11 |
| 1994 | Apr. 29 - June 16 | May 1 | June 16 |
| 1995 | May 2 - June 14 | May 2 | June 14 |
| 1996 | Apr. 25 - May 22 | Apr. 26 | May 22 |

The counting fence was in partial operation on April 25 with complete installation by April 26 and operated untill it washed out on May 16 at 0200 hours. During this high water 4 sections of fence were partially collapsed approximately 10 sections from the trap and water flowed over the trap and fence making it impossible for staff to reach the trap. Prior to the washout 10,053 smolt were enumerated. On May 17 the trap was checked and 1,070 smolt were enumerated with 1,000 of these being dead. Attendants started removing the near shore sections of fence at this time. The trap was left closed and reopened on May 20. On May 21 and 22 two-hundred and fiftyeight smolt were enumerated.

A smolt fence operated on the Little River from May 2 - June 5 in 1997.

Smolt that were sampled had the following data collected;fork length, whole weight, scale sample and sex.

Smolt condition was calculated as weight/length$^3$.

Adult Counts

A counting fence operated on Flat Bay Brook from June 12 - Sept. 24 with the exception of the following time periods when rods were pulled for high water and subsequent debris; July 3 at 1830 hours for 17 hours, July 6 at 2030 hours for 50 hours, July 9 at 2030 hours for 18.5 hours, July 14 at 1000 hours for 107 hours and July 20 at 1400 hours for 21.5 hours.

A snorkelling/walking survey to count adults was conducted from August 27 - August 30 on Flat Bay Brook. Water conditions were low during this time period (see Figure 5 which displays the water levels as recorded at the trap). A total of 1,051 adults (950 small and 101 large) were enumerated on this survey (Table 17) with an additional 89 small salmon visually estimated (these fish were estimated as it was too difficult to

count them accurately in the pool they were observed). To accomodate these 89 estimated fish 45 fish were added to the small total making the count 1,096. Addition of known removals prior to August 27 for broodstock, mortalities (holding mortalities and fence mortalities) and poaching removals increased the total by 190 small and 20 large. The counts in sections III - IV had there counts adjusted upwards by 15%(due to width and depth of pools in these sections and the opinion of personell that counts were incomplete) for unobserved fish while Section I -II and VI had no adjustment. River escapement is estimated to be 1,247 and 132 small and large respectively. Spawning escapement is estimated to be 1,057 and 112 small and large respectively.

## Results and Discussion

The use of fixed parameters, such as 2.4 eggs $m^2$ and 7 smolts/ha of standing water, has certain limitations (see O'Connell & Dempson, 1991 for discussion on this topic).

Rocky River

Tables 1 - 4 detail the accessible rearing area, the required conservation egg deposition and biological characteristics for the Rocky River stock.

The authors have chosen to utilize a length based relationship to determine egg deposition as fish length records are likely more accurate than fish weight records. An analysis of covariance revealed a significant relationship between the length of female fish and number of eggs ($p < 0.05$ ) however no significant relationship was found with year. As a result of this analysis of covariance, fecundity data from the two years were combined. Regression analysis of raw, and log transformed data revealed significant relationships for both and provided $R^2$ values of .57 and .56 respectively. Figure 2 displays the regression line and equation for the linear regression of total number of eggs on fish length.

The 1996 escapement of 401 (356 small and 45 large) adults to Rocky River was the third highest on record and was 164% of the 1987-1991 mean and 122% of the 1992-1996 mean. In 1996 Rocky River achieved 34 % of it's conservation egg deposition based on total returns.

Reconstruction of the 1996 smolt run was complicated by the earliest run timing encountered, annual bimodal peaks in all previous years and by low water conditions throughout the run. Estimates of smolt loss for May 16, 18, 19 and 20 were achieved by plotting daily counts in a histogram plot and joining the catch on May 15 to the May 17 catch and the catch on the 17 to the catch on May 22. Daily estimated totals are as follows; May 16 - 840; May 18 - 960; May 19 - 640 and May 20 - 440. No efforts were

made to reconstruct smolt not counted prior to April 26 or after May 22. As such the 1996 smolt count is conservative and totals 14,261 fish with 1,203 removals. This count (see Table 5) is the highest smolt count enumerated to date on the Rocky River by 146 % and is 184% of the 1990 - 1995 mean count. The 1996 smolt run was comprised of 82% age $3^{+}$ smolt from the 1992 egg deposition (Table 3).

Figure 3 displays smolt to adult survival from 1990-1995 which averaged 2.9% and ranged from 2.3% to 3.5%. For the Rocky River stock in 1996 smolt to adult survival increased to 3.8% and is the highest of the six years where data is available. Table 5 details enumeration of the 1990-1995 smolt escapement. The 1996 adult returns were all resultant from natural spawning. Smolt to adult survival is calculated based on the portion of virgin fish in the escapement. The increase in sea survival from 1990 and 1991 to 1992 can, in part, be attributed to the closure of the comercial fishery. The decrease in the 1993 smolt survival is most likely due to a decrease in natural marine survival.

Figure 3 also displays the relative condition factor of the outmigrating smolt with the 1996 smolt having the highest relative condition factor measured to date. A linear regression of relative smolt condition (in year x) on adult returns (in year x+1) was significant at the 5% level. Using the equation in Figure 4 the predicted 1997 escapement would be 503 adults.

Table 6 provides insight into the egg/fry-to-smolt survival on the Rocky River. The egg-to-smolt figures compare favourably to other watersheds. At present it appears that egg-to-smolt survival has been improving since 1990.

Repeat spawners accounted for 14%(n=59), 9%(n=20), 17%(n=48) , 13%(n=49), 31%(n=55), 22%(n=93) and 17%(n=67) of the returns to Rocky River for the years 1990 - 1996 respectively.

The 1997 return to Rocky River is expected to be in the order of 300 - 496 virgin grilse plus repeat spawners based on the range of smolt to adult survival data collected to date multiplied by the 1996 smolt output.

## Flat Bay

The required conservation egg deposition for Flat Bay River is estimated to be 3,842,880 eggs. At present the percentage of the required egg deposition that should come from large salmon has not been determined due to lack of understanding of the biology of the Flat Bay stock.

Biological characteristics used in 1996 are those collected from Flat Bay stock and are listed in Table 14 ;percent female small and large salmon is 61.2%and 62.5% respectively. Table 15 details the egg deposition for Flat Bay Brook for the 1994-1996 period.

A counting fence operated from June 12- Sept. 24 enumerating 645 adults).

The fence enumerated 645 (615 small and 30 large) adults as compared to the snorkelling survey which accounted for 1,379 adults (including removals) or 47% of the escapement. Of the 235 ( 204 plus 15% adjustment) fish observed below the fence on August 28 only 73 were enumerated by September 24 when the fence ceased operation leaving 162 downstream of the fence. The 645 plus the 162 account for 59% of the river escapement.

Figure 5 displays daily fence counts and water levels which suggest water levels did not delay upstream migration leading one to believe that this may be the normal migrational time frame for these fish. Additionally the larger number of large fish enumarated on the snorkelling is suggestive that fish may have been missed prior to the installation of the fence on June 12.

Egg deposition of adults is calculated from fecundity studies conducted in 1995 and 1996. The 1995 fecundity is based on the equation Total eggs = 182.12* fish length - 6826.8 ($R^2$ = 0.836) and 1996 is based on the equation Total eggs = 151.21*Fish Length - 4948.8 ($R^2$ = 0.7107). These linear regression relationships include large and small fish.

Egg deposition in 1995 is believed to be 45% of the conservation egg requirement due to fry stocking conducted in the spring of 1996. Listed egg depositions for 1994 and 1995 are suspect due to the data revealed by the snorkelling survey in 1996 and likely only represent 50% of egg deposition. Of note is that the 1996 fence count is the highest recorded.

Egg deposition in 1996 based on results of the snorkelling survey accounted for 65 percent of conservation requirement and based on the stocking of 150,000 fry in the spring of 1997 the egg deposition equivalent for 1996 would be 85% of requirement.

Little River

Table 1 details the available habitat and the required egg deposition for the Little River watershed. The data is presented for the area above and below the obstruction since fry stocking occurred above the falls. Table 9 details the egg deposition rates for the

watershed with a 1996 fence count of 801 adults. The 1996 returns are 994% of the 1987-89 mean , 841% of the 1987-1991 mean and 611% of the 1992-1995 mean.

Table 10 details the dates of counting fence operation and the number of smolt and parr enumerated for 1992 - 1996. Of interest is the large number of parr enumerated at the fence each year. The fence site is located approximately 1 km upstream of the river mouth but is under tidal influence. This is suggestive that these parr are smoltifying downstream of the fence site.

Smolt to adult survival figures are not calculated as they are not likely indicative of the entire smolt output prior to 1995.

There were 23,132 and 69,396 fry were stocked above and below the falls respectively into Little River in 1996.

A total of 52 Conne River orign tagged salmon were enumerated through the counting fence on Little River.

Romaines River

The Romaines River with 4,572 units of habitat (based on a stream survey conducted in 1993 and 1994) requires an egg deposition of 1,097,280 eggs. A counting fence operation was conducted on the river from 1993-1995 however no complete counts were obtained. Egg incubation commenced in 1994 and the first fry were stocked in 1995. Table 11 details the information available on egg deposition within the watershed during this time frame. Table 12 details the biological characteristics that are available for this stock.

On September 18 a total of 6 pools were snorkled and 142 adults were counted. Twenty seven fish were obtained by seining on October 3, 1996 forbroodstock. The 1996 snorkelling count must be considered a minimun escapement. These 27 fish led to 68,299 eggs being incubated.

Piper's Hole River

The Piper's Hole River has 8,877 units of riverine habitat and 1,184 ha. of lacustrine accessible to anadromous Atlantic salmon and a conservation egg deposition 2,566,192 eggs. This is a revised egg deposition for the watershed and it differs from the one presented in O'Connell et. al. (1991).

A counting fence operated from July 7 - Sept. 23 collect broodstock. There were 78 small and 10 large Atlantic salmon enumerated in1996.

A total of 176 salmon were angled (retained) within the watershed in 1996 with 85% (119 fish) of these angled below the fence (pers. Comm. M. Eddy, local fishery officer).

Preliminary fecundity figures for Piper's Hole river suggest that the stock produces approximately 1,767 eggs/kg. Additional biological characteristics are those of O'Connell and Dempson (1991). Table 16 details the egg deposition for the watershed for the 1989 and 1995 years.

A total of 104,623 Atalntic salmon eggs, were stripped from 37 females and 14 males, are being incubated for fry distribution in 1997.

Eleven adult brown trout, which is believed to the first record of brown trout in Piper's Hole River, were enumerated at the counting fence in 1996.

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Table 1: Rearing area and conservation egg deposition for watersheds examined in present study.

| | Riverine habitat ($m^2$) | Lacustrine habitat (ha) | Conservation egg deposition |
|---|---|---|---|
| Rocky River | 10,823 | 2,191 | 3,404,730 |
| Little River | 5,221 | 989 | 1,253,040 |
| accessible | 1,308 | 0 | 313,920 |
| inaccessible | 3,913 | 989 | 939,120 |
| Flat Bay Brook | 16,012 | 0 | 3,842,880 |
| Romaines River | 4,572 | 0 | 1,097,280 |
| Piper"s Hole River | 8,877 | 1,184 | 2,566,192 |

Table2 . Biological characteristics of Rocky River adults.

| | Year | No. Sampled(aged) | % Female | No. 2 Sea Winter Virgin | Mean Length(cm) | Mean Weight(kg) | % Repeat Spawners | Percentage at various Freshwater Ages | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | $2^+$ | $3^+$ | $4^+$ | $5^+$ |
| Rocky River | 1990 | 21 | N/A | 0 | 57.1 | 2.2 | 14 | 6 | 72 | 16 | 6 |
| | 1991 | 32 | N/A | 0 | 56.9 | 2.2 | 9 | 15 | 58 | 27 | 0 |
| | 1992 | 24 | N/A | 0 | 58 | 2.4 | 17 | 18 | 55 | 27 | 0 |
| | 1993 | 32 | N/A | 0 | 56.5 | 2.2 | 13 | 3 | 69 | 24 | 3 |
| | 1994 | 68 | 79 | 0 | 56.9 | 2 | 31 | 16 | 72 | 12 | 0 |
| | 1995 | 111 | 86 | 1 | 56 | 2 | 22 | 14 | 77 | 9 | 0 |
| | 1996 | 18 | N/A | 0 | 54.9 | 2 | 17 | 6 | 61 | 33 | 0 |

Table 3 . Biological characteristics of Rocky River smolt.

| | | | | | | Percent at various freshwater ages | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Year | No. Sampled | % Female | Mean Length(cm) | Mean Weight(g) | $2^+$ | $3^+$ | $4^+$ | $5^+$ | $6^+$ |
| Rocky River | 1988 | 28 | 57.1 | 17.5 | 54.5 | 0 | 64 | 36 | 0 | 0 |
| | 1989 | 28 | N/A | 14.9 | 32.4 | 18 | 67 | 11 | 4 | 0 |
| | 1990 | 101 | 84.2 | 17.3 | 46.5 | 1 | 66 | 29 | 4 | 0 |
| | 1991 | 146 | 86.3 | 17.0 | 43.2 | 16 | 70 | 13 | 1 | 0 |
| | 1992 | 71 | 78.9 | 17.0 | 44.5 | 1 | 76 | 21 | 2 | 0 |
| | 1993 | 88 | 71.6 | 18.9 | 58.2 | 13 | 57 | 24 | 6 | 0 |
| | 1994 | 160 | 83.8 | 17.0 | 45.1 | 2 | 66 | 29 | 3 | 0 |
| | 1995 | 124 | 77.4 | 17.0 | 44.8 | 16 | 77 | 7 | 0 | 0 |
| | 1996 | 203 | 83.4 | 16.6 | 44.1 | 6 | 82 | 10 | 0 | 1 |

Table 4. Details of egg deposition Rocky River 1983-1994.

| Year | Fry Stocked | Parr Stocked | Adults Stocked | Fishway Count small | Fishway Count large | Fishway Count total | Broodstock | Total Eggs | % Conservation Egg |
|---|---|---|---|---|---|---|---|---|---|
| 1983 | 0 | | 0 | | | | 0 | 1,538,875 | 45 |
| 1984 | 307775 | | 0 | | | | 0 | 2,172,500 | 64 |
| 1985 | 434500 | | 0 | | | | 0 | 970,000 | 28 |
| 1986 | 194000 | | 0 | | | | 0 | 1,998,225 | 59 |
| 1987 | 399645 | | 140 | 80 | 1 | 81 | 0 | 743,595 | 22 |
| 1988 | 0 | | 0 | 313 | 6 | 319 | 0 | 1,011,527 | 30 |
| 1989 | 0 | | 0 | 168 | 9 | 177 | 0 | 561,255 | 17 |
| 1990 | 0 | | 0 | 401 | 17 | 418 | 0 | 1,359,420 | 40 |
| 1991 | 0 | | 0 | 211 | 16 | 227 | 0 | 730,874 | 22 |
| 1992 | 0 | | 0 | 237 | 46 | 283 | 0 | 961,811 | 28 |
| 1993 | 0 | | 0 | 292 | 72 | 364 | 0 | 1,148,320 | 34 |
| 1994 | 0 | | 0 | 158 | 19 | 177 | 62 | 857,862 | 25 |
| 1995 | 50,000 | 31,983 | 0 | 385 | 39 | 424 | 76 | 1,918,012 | 56 |
| 1996 | 162,231 | 0 | 0 | 356 | 45 | 401 | 0 | 1,163,295 | 34 |

Table 5. Details of smolt enumeration Rocky River 1990-1995.

| Year | Smolt Count | % Smolt-to-Adult Survival |
|---|---|---|
| 1990 | 8,287 | 2.3 |
| 1991 | 7,732 | 2.9 |
| 1992 | 7,813 | 3.5 |
| 1993 | 5,115* | 2.3 |
| 1994 | 9,781 | 3.4 |
| 1995 | 7,786 | 3.8 |
| 1996 | 14,261+ | |

* Smolt count is an estimate due to fence washout Rocky River 1985 - 1990.
+ No. Of smolt released is 13,057

Table 6. Details of egg/fry to smolt survival for Rocky River.

| Year | egg to smolt survival (%) | fry to smolt survival (%) | smolt classes |
|---|---|---|---|
| 1985 | | 0.08 | $5^+$ |
| 1986 | | 1.3 | $4^+$, $5^+$ |
| 1987 | | 1.6 | $3^+$, $4^+$, $5^+$ |
| 1987 | 1.00 | | $2^+$, $3^+$, $4^+$, $5^+$ |
| 1988 | 0.86 | | $2^+$, $3^+$, $4^+$, $5^+$ |
| 1989 | 1.04 | | $2^+$, $3^+$, $4^+$, $5^+$ |
| 1990 | 0.56 | | $2^+$, $3^+$, $4^+$, $5^+$ |
| 1991 | 1.05 | | $2^+$, $3^+$, $4^+$ |
| 1992 | 1.35 | | $2^+$, $3^+$ |
| 1993 | 0.08 | | $2^+$ |

Table 7. Biological characteristics Little River adults 1990, 1992 - 1996.

| | | Fork Length | | | Weight | | | River Age | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | Life Stage | Mean (No.) | S.D. | Range | Mean (No.) | S.D. | Range | Mean (No.) | S.D. | Range |
| 1990 | 1SW | 51.41 (73) | 3.79 | 44.00-62.80 | 1.34 (73) | .32 | .700-2.500 | 3.02 (62) | .50 | 2-4 |
| | Repeat | 57.40 (4) | 1.19 | 56.20-59.00 | 1.85 (4) | .15 | 1.700-2.000 | 3.00 (4) | .00 | 3 |
| 1992 | 1SW | 51.51 (89) | 2.53 | 46.50-59.00 | 1.41 (88) | .22 | 1.100-2.200 | 3.00 (68) | .42 | 2-4 |
| | Repeat | 63.85 (12) | 6.45 | 53.50-73.00 | 3.05 (11) | 1.20 | 1.700-5.900 | 2.80 (10) | .42 | 2-3 |
| 1993 | 1SW | 51.68 (154) | 2.81 | 40.90-59.10 | 1.48 (154) | .29 | 1.000-2.700 | 3.05 (144) | .38 | 2-4 |
| | Repeat | 60.55 (13) | 5.62 | 53.70-72.70 | 2.29 (12) | .65 | 1.400-3.800 | 2.92 (12) | .29 | 2-3 |
| 1994 | 1SW | 51.33 (62) | 2.93 | 41.80-60.20 | 1.33 (62) | .25 | .800-2.200 | 2.95 (58) | .35 | 2-4 |
| | Repeat | 58.19 (8) | 7.42 | 48.70-71.00 | 1.97 (8) | .81 | 1.300-3.600 | 3.14 (7) | .69 | 2-4 |
| 1995 | 1SW | 51.17 (111) | 3.34 | 44.70-67.60 | 1.25 (111) | .25 | .800-2.900 | 2.86 (108) | .50 | 2-4 |
| | 2SW | 68.00 (1) | | | 3.00 (1) | | | | | |
| | Repeat | 61.81 (7) | 5.49 | 55.50-70.80 | 2.24 (7) | .70 | 1.500-3.300 | 3.00 (7) | .58 | 2-4 |
| 1996 | 1SW | 53.12 (113) | 2.23 | 46.00-58.70 | 1.41 (131) | .21 | .960-2.120 | 2.60 (110) | .58 | 2-4 |
| | Repeat | 66.50 (1) | - | - | 1.58 (1) | - | - | - | - | - |

Table 8. Biological characteristics of Little River smolt.

| Year | No. Sampled | % Female | Mean Length(cm) | Mean Weight(g) | Percent at various freshwater ages $2^+$ | $3^+$ | $4^+$ |
|---|---|---|---|---|---|---|---|
| 1993 | 43 | 97.7 | 17.58 | 50.73 | 32.6 | 58.1 | 9.3 |
| 1995 | 31 | 87.1 | 14.86 | 28.87 | 90.3 | 9.7 | 0 |
| 1996 | 51 | 94.1 | 16.16 | 39.40 | 5.9 | 90.2 | 3.9 |

Note: 1993 & 1995 smolt samples were collected on a single day.
1996 samples collected over 5 days.

Table 9. Egg deposition rates for Little River 1987-1995.

| Year | Fence Count | | Spawning escapement | Fry stocked | Fry Stocked | Egg Equiv. | Egg Equiv. | Natural Egg | % Conservation | Total | % Conservation | % Conservation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | large | small | | Below Falls | Above Falls | Below Falls | Above Falls | Deposition | Wild | Eggs | Below Falls | Above Falls |
| 1987 | 64 | 3 | 67 | 0 | 0 | 0 | 0 | 91,410 | 29.12% | 91,410 | 29.12% | 0.00 |
| 1988 | 65 | 3 | 68 | 0 | 0 | 0 | 0 | 92,774 | 29.55% | 92,774 | 29.55% | 0.00 |
| 1989 | 102 | 5 | 66 | 0 | 0 | 100350 | 0 | 90,046 | 28.68% | 190,396 | 60.65% | 0.00 |
| 1990 | 158 | 15 | 91 | 20,070 | 0 | 204835 | 0 | 124,154 | 39.55% | 328,989 | 104.80% | 0.00 |
| 1991 | 55 | 6 | 31 | 40,967 | 0 | 103715 | 0 | 42,294 | 13.47% | 146,009 | 46.51% | 0.00 |
| 1992 | 104 | 21 | 28 | 20,743 | 0 | 102835 | 553380 | 38,201 | 12.17% | 694,416 | 44.93% | 56.69 |
| 1993 | 169 | 11 | 80 | 20,567 | 110,676 | 148,090 | 444,270* | 109,146 | 34.77% | 701,506 | 81.94% | 45.52 |
| 1994 | 73 | 11 | 88 | 29,618 | 88,854 | 0 | 0 | 120,061 | 38.25% | 120,061 | 38.25% | 0.0 |
| 1995 | 118 | 17 | 50 | 0 | 0 | 115,660 | 346,980 | 68,217 | 21.73% | 68,217+ | 21.73% | 0.0 |
| 1996 | 674 | 127 | 686 | 23,132 | 69,396 | 0 | 0 | 935,930 | 298.14% | 935,930 | 298.14% | 0.0 |

+ data available post fry distribution 1996

Table 10 . Details of smolt and parr enumeration Little River.

| Year | Dates of Operation | Number of Smolt | Number of Parr |
|---|---|---|---|
| 1992 | May 11-July 5 | 382 | 1,404 |
| 1993 | May 11-July 5 | 324 | 1,500 |
| 1994 | May 6- June 13 | 495 | 4,018 |
| 1995 | May 2 - June 22 | 2,712 | 1,586 |
| 1996 | May 2 - June 5 | 4,449 | 585 |

Table 11. Details of egg depositions for Romaines River.

| Year | Fence Count | Snorkelling Survey | Angling | Total Returns | Brood Removal | Fry Stocked |
|---|---|---|---|---|---|---|
| 1993 | 93 | | 5 | 117+ | 0 | 0 |
| 1994 | 14 | | 2 | unknown | 12 | 0 |
| 1995 | 49 | | 0 | unknown | 37 | 39,577 |
| 1996 | | 142 | ? | unknown | 27 | 56,965 |

+ includes fish observed by fishery officer prior to fence installation
Note: Total returns could not be assessed due to fence washouts in 1993-95.

Table 12. Biological characteristics Romaines River.

| Year | Life Stage | Fork Length | | Weight | |
|---|---|---|---|---|---|
| | | Mean | No. | Mean | No. |
| 1994 | 1 SW | 54.1 | 12 | 1.63 | 8 |
| | 2 SW | 70.2 | 1 | 3.30 | 1 |
| | Repeat | 66.1 | 3 | 2.55 | 3 |
| 1995 | 1 SW | 50.8 | 39 | 1.31 | 39 |
| | 2 SW | 73.2 | 2 | 4.10 | 2 |
| | Repeat | 73.0 | 1 | 3.90 | 1 |
| 1996 | 1SW | 53.1 | 24 | 1.54 | 24 |
| | 2SW | 70.8 | 1 | 4.00 | 1 |
| | Repeat | 61.3 | 2 | 2.38 | 2 |

Table 13. Angling restrictions Flay Bay Brook 1986-1994.

| Year | Quota | Effort | Small Retained | Small Released | Large Released |
|---|---|---|---|---|---|
| 1986 | 400 | 684 | 174 | 0 | 2 |
| 1987 | 300 | 815 | 219 | 0 | 0 |
| 1988 | 300 | 871 | 249 | 0 | 5 |
| 1989 | 250 | 612 | 130 | 0 | 1 |
| 1990 | 250 | 939 | 277 | 0 | 6 |
| 1991 | 250 | 977 | 251 | 0 | 2 |
| 1992 | 250 | 665 | 223 | 0 | 20 |
| 1993 | 250 | 678 | 173 | 0 | 17 |
| 1994 | 250 | 615 | 128 | 8 | 32 |

Table 14 . Biological characteristics Flat Bay Brook stock.

| Year | Life Stage | Fork Length | | Weight | |
|---|---|---|---|---|---|
| | | Mean | No. | Mean | No. |
| 1994 | 1 SW | 52.6 | 39 | 1.32 | 39 |
| | 2 SW | 67.1 | 3 | 3.21 | 3 |
| 1995 | 1 SW | 51.7 | 81 | 1.30 | 81 |
| | Repeat | 66.0 | 3 | 3.07 | 3 |
| | 2 SW | 70.6 | 2 | 3.0 | 2 |
| | Repeat | 79.8 | 1 | 4.90 | 1 |
| 1996 | 1SW | 53.0 | 102 | 1.38 | 102 |
| | Repeat | 60.0 | 64 | 1.95 | 64 |
| | 2SW | 68.5 | 7 | 3.13 | 7 |
| | Repeat | 75.3 | 3 | 3.63 | 3 |

Table 15 . Egg deposition Flat Bay Brook 1994-1995.

| Year | Fence Count Small | Fence Count Large | Adjusted Count | Snorkelling Survey | Angling Retained | River Escapement | Broodstock Removals | Spawning Escapement | % of Conservation |
|---|---|---|---|---|---|---|---|---|---|
| 1994 | 403 | 67 | 490 | N/A | 128 | 554 | 43 | 383 | 19.6 |
| 1995 | 557 | 41 | 698 | N/A | 0 | 698 | 83 | 611 | 45.0 |
| 1996 | 615 | 30 | N/A | 1,096 | 0 | 1,397 | 87 | 1169 | 65.1+ |

+ preliminary figure due to egg incubation

Table 16. Egg deposition Piper's Hole River 1989 and 1995.

| Year | Fence Count | Angling Retained | River Escapement | Brood stock Removals | Spawning Escapement | Fry Stocking | % of Conservation |
|---|---|---|---|---|---|---|---|
| 1989 | 285 | 112 | 386 | 0 | 274 | 0 | 24.3 |
| 1995 | 498 | 176 | 648 | 50 | 399 | 0 | 35.4+ |
| 1996 | N/A | 119 | ? | 51 | ? | 88,767 | ? |

+ preliminary figure due to egg incubation

Table 17. Details of snorkelling survey Flat Bay Brook.

| Date | Section | No. Fish Observed | | No. Fish Estimated | | Total Fish on Survey | | Known Removals Prior to Aug. 28 | | Adjustment | | Total Fish | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Small | Large | Small | Large | Small | Large | Small | Large | Small | Large | Small | Large |
| Aug. 27 | I | 158 | 7 | 89 | 0 | 203 | 7 | | | | | 203 | 7 |
| Aug. 27 | II | 389 | 15 | 0 | 0 | 389 | 15 | | | | | 389 | 15 |
| Aug. 27 | III | 113 | 7 | 0 | 0 | 113 | 7 | | | 17 | 1 | 130 | 8 |
| Aug. 28 | IV | 118 | 39 | 0 | 0 | 118 | 39 | | | 18 | 6 | 136 | 45 |
| Aug. 28 | V | 172 | 32 | 0 | 0 | 172 | 32 | | | 26 | 5 | 198 | 37 |
| Aug. 30 | VI | 0 | 1 | 0 | 0 | 0 | 1 | 27+ | | | | 28 | 0 |
| | | | | | | | | 163* | 20* | | | 63 | 20 |
| Total | | 950 | 101 | 89 | 0 | 995 | 101 | | | | | 1,247 | 132 |
| + known poaching mortalities<br>* includes broodstock & holding mortalities | | | | | | | | | | | | | |

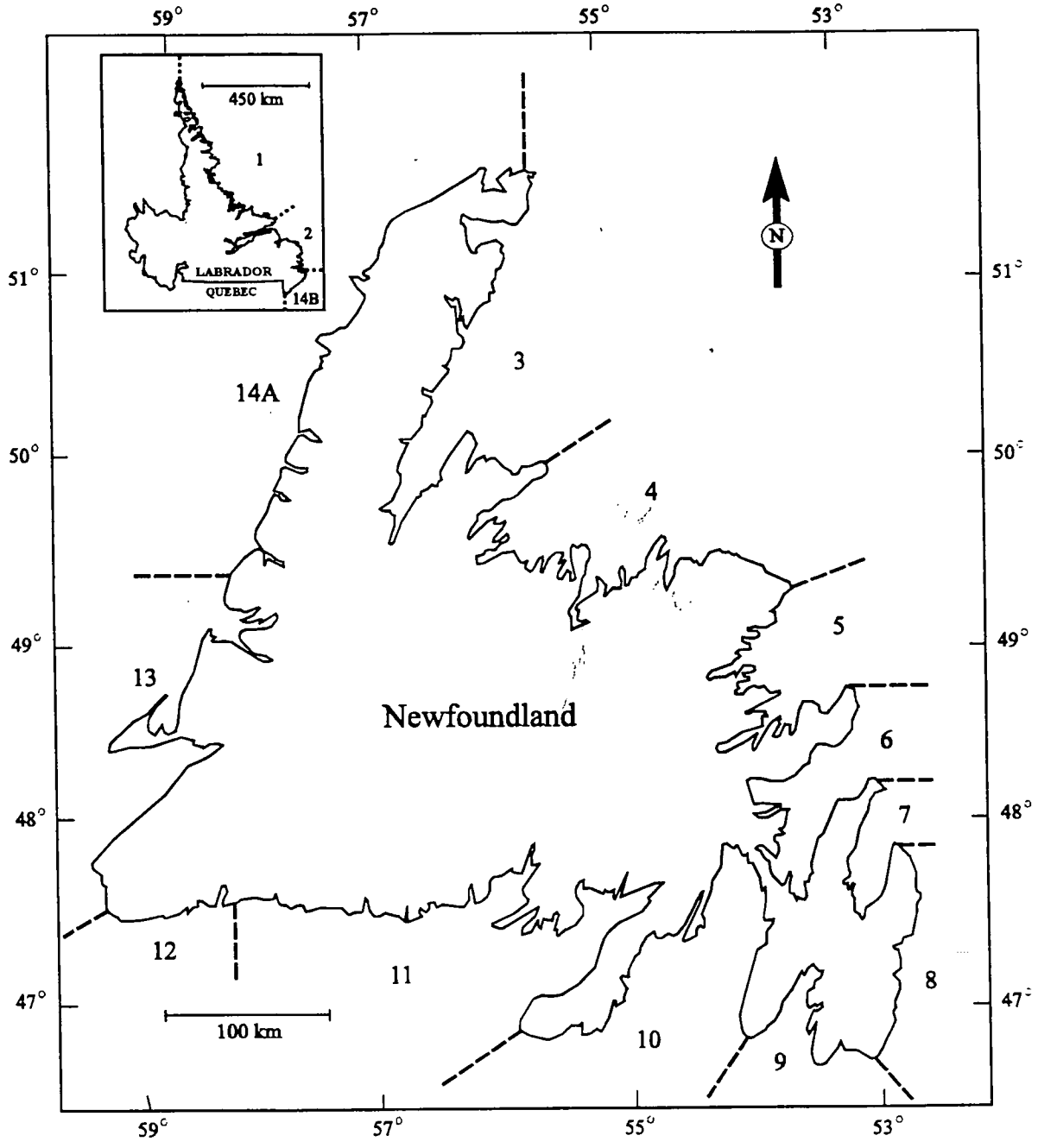


Fig. 1. Map showing the 14 Salmon Fishing Areas of the Newfoundland Region.

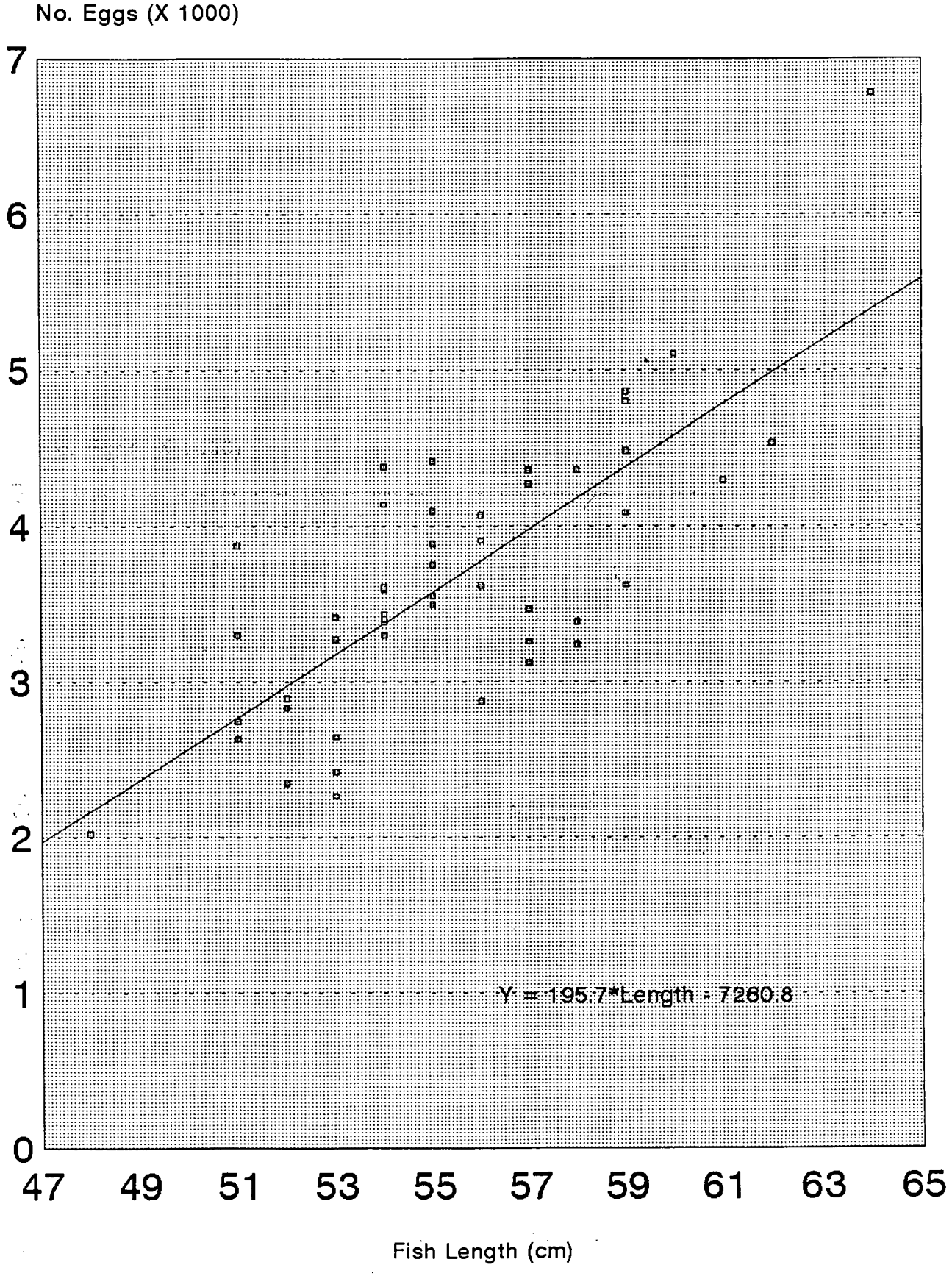


Figure 2. Fecundity relationship Rocky River salmon.

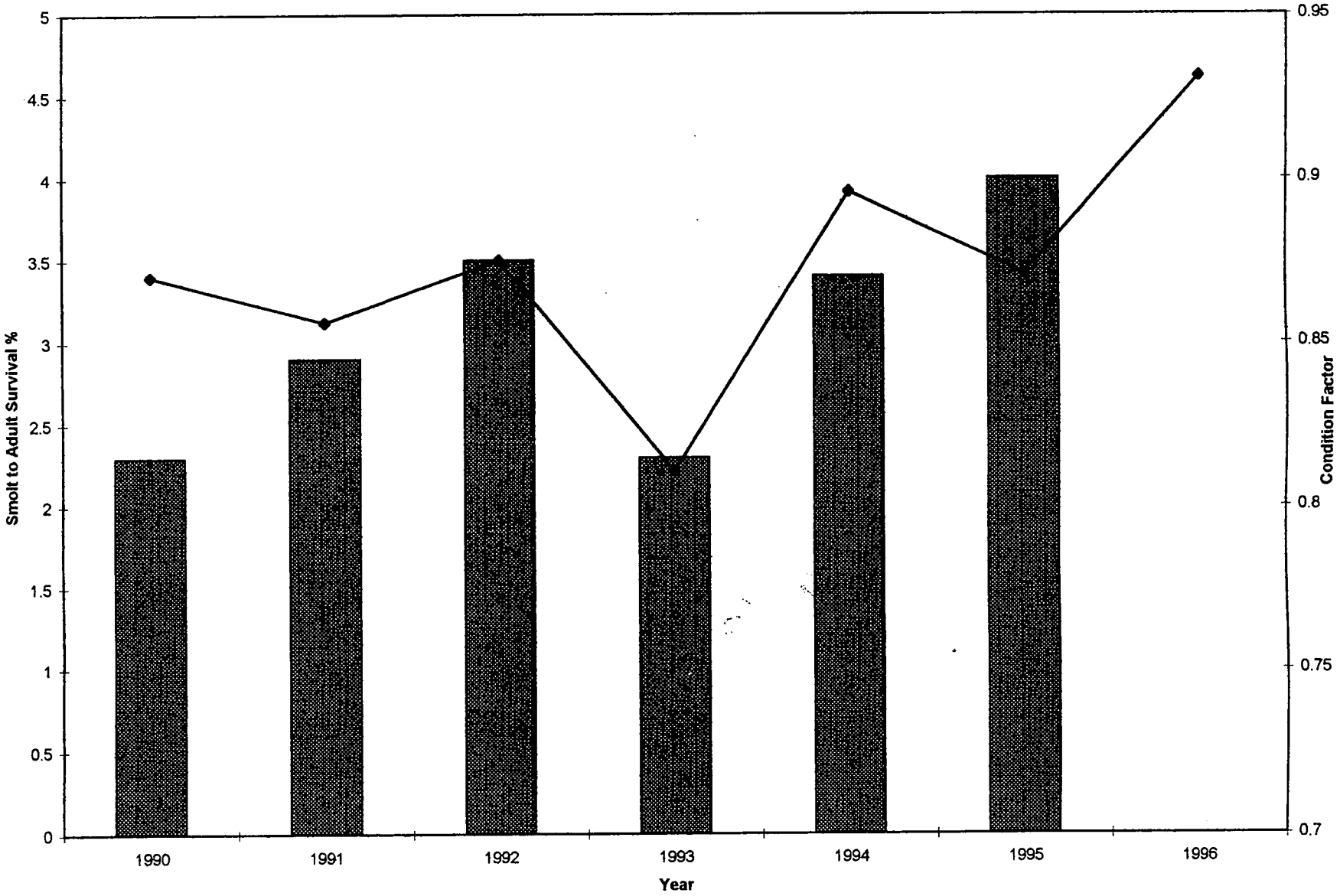


Figure 3. Smolt condition in year x and smolt to adult survival in year x + 1 for Rocky River salmon.

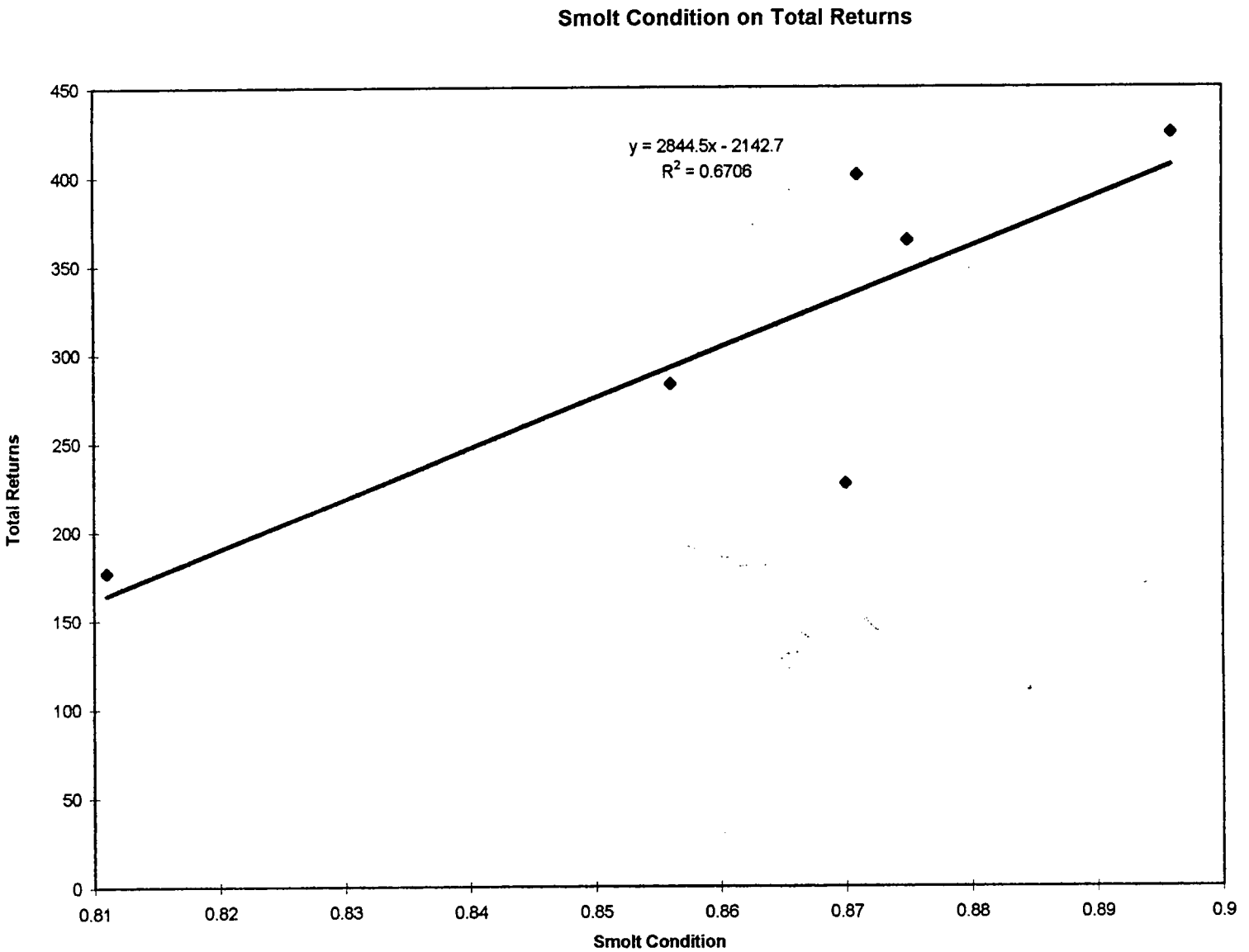


Figure 4. Regression relationship of smolt condition on total adult returns for Rocky River salmon.

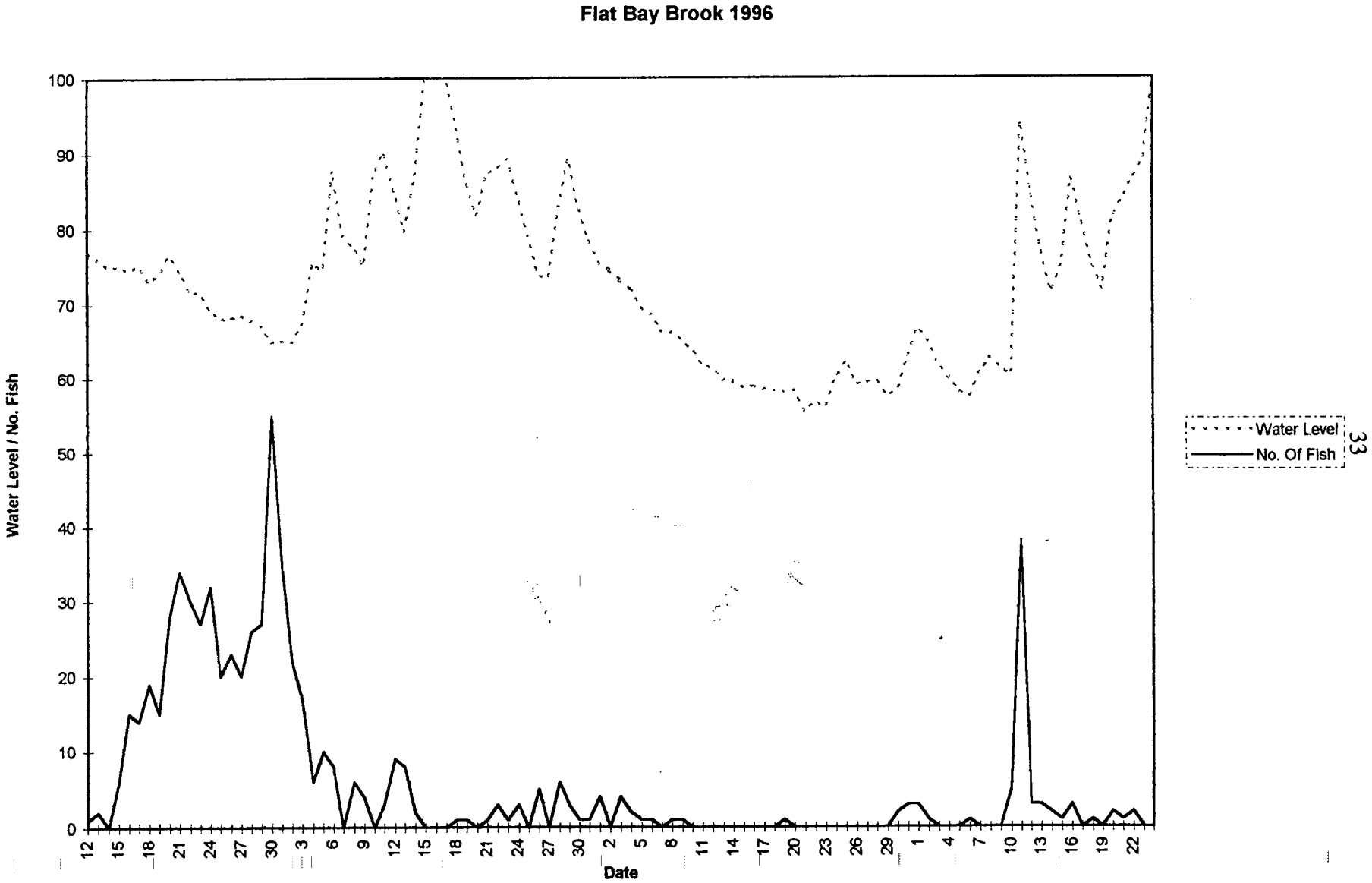


Figure 5. Daily water levels and adult counts Flat Bay Brook 1996.