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Status of juvenile Atlantic salmon stocks of the Stewiacke River in 1984 and 1985 and forecasts of recruits to fisheries in 1986 and 1987

by

P.G. Amiro and A.J. McNeill
Freshwater & Anadromous Division
Fisheries Research Branch
Department of Fisheries and Oceans
P.O. Box 550
Halifax, Nova Scotia
B3J 2S7

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ABSTRACT

The Atlantic salmon stock composition of the Stewiacke River, Nova Scotia, consists of virgin and consecutive-spawning grilse. The available salmon production area of $25{,}988 \cdot 10^2$ m^2 includes $13{,}287 \cdot 10^2$ m^2 where orthophoto map measured gradient is less than 0.12%. Egg requirement to seed the entire area at 2.4 eggs$\cdot m^{-2}$ is $6.24 \cdot 10^6$ eggs and 50% less when areas less than 0.12% ortho-gradient were excluded. Required spawning escapement based on Big Salmon River salmon, a stock with similar characteristics, is 1,878 fish for the entire production area and 939 fish for habitats greater than 0.12 ortho-gradient. Typical spawning stock composition indicated contribution to egg deposition of : 25% 1SW maidens; 7% 2SW maidens; and 68% previous spawners. Parr densities, 1984 and 1985, were two to four times Elson's "normal" abundance in lower tributaries and were less than the norm in other areas. A stock-recruitment relationship modified by precipitation occurring in the summer previous to smoltification indicated replacement by maiden grilse occurred only 20% of the years studied. The importance of achieving a target number of recruits was concluded. Forecast recruits to the fisheries were 435 fish in 1986 and 280 fish in 1987. Both forecasts are below the mean total grilse harvest for the years 1970 to 1982.

RESUME

Les stocks de saumon atlantique de la rivière Stewiacke en Nouvelle-Ecosse sont composés de castillon vierge et de castillon ayant eu plusieurs périodes consécutives de frai. La superficie disponible de production du saumon, qui représente $25\,988 \cdot 10^2$ m^2 inclut $13\,287 \cdot 10^2$ m^2 dans lesquels le gradient mesuré sur orthophoto est inférieur à 0,12 %. Pour ensemencer toute la zone au taux de 2,4 oeufs$\cdot m^{-2}$, il faut disposer de $6{,}24 \times 10^6$ oeufs, et de 50 % de moins si l'on exclut les zones d'orthogradient inférieur à 0,12 %. Les taux requis de survie au frai, basés sur l'étude du saumon de la rivière Big Salmon, qui constitue un peuplement de caractéristiques similaires, sont de 1 878 poissons pour toute la zone de production et de 939 poissons pour des habitats d'orthogradient supérieur à 0,12. La composition typique d'un stock géniteur indiquait les contributions suivantes à la ponte : 25 % de géniteurs vierges 1HM; 7 % de géniteurs vierges 2 HM et 68 % de géniteurs répétitifs. En 1984 et 1985, les densités de populations de tacons représentaient deux à quatre fois l'abondance "normale", telle que définie par Elson, dans les affluents inférieurs, mais moins que la norme dans d'autres secteurs. Une relation établie entre le stock existant et le recrutement, modifiée par les précipitations estivales qui précèdent l'époque du passage au stade de smolt, a indiqué que le remplacement par les castillons vierges ne survenait qu'une fois sur cinq au cours des années de l'étude. On en a conclu l'importance d'atteindre un nombre cible de recrues. Les nombres prévue de recrues sont de 435 poissons en 1986 et de 280 poissons en 1987. Ces deux valeurs se situent au-dessous du nombre total de castillon récoltées de 1970 à 1982.

INTRODUCTION

This document provides data and analysis for assessment of the status of Atlantic salmon (Salmo salar) production in the Stewiacke River, 1984 and 1985, and forecasts of fisheries in 1986 and 1987.

DESCRIPTION OF THE STEWIACKE SYSTEM

The Stewiacke River basin is an area of approximately 619 km^2 in Colchester Co., Nova Scotia, (Fig. 1). The main river originates at an elevation of 150 meters and flows some 88 km to confluence with the Shubenacadie River. Tides of up to 9 m influence the lower 13.3 km of the main stem.

The geology of the lower 60 km of the river consists mainly of sedimentary rocks overlain with deep soils rich in calcium carbonate resulting in relatively productive and acid tolerant water. The upper portion of the system is also sedimentary but without the extensive overburden of soil. Water quality is generally favorable for Atlantic salmon with conductivities ranging from 10-30 $Mhos \cdot cm^{-3}$ and summer maxima temperatures generally less than 28°C.

Invertebrates are diverse and abundant throughout the system (Carey unpublished).

Atlantic salmon are the most abundant and by far the dominant species particularly in faster-moving waters of the tributaries and upper river. Competitor species in these areas consist of brook trout (Salvelinus fontinalis) and brown trout (Salmo trutta). The lower portions of the drainage where gradient is less than 0.03% contain significant populations of American eel (Anguilla rostrata), common sucker (Catostomus commersoni) and adult salmon and brown trout.

MATERIALS AND METHODS

A longitudinal profile description of the system was derived from digital measurement of distances between 5-m contour intervals on 1:10,000 orthophotographic maps. Area of accessible juvenile salmon habitat was estimated from 1:10,000 color aerial photographs in a manner similar to Amiro (MS 1983). Detailed physical descriptions of juvenile sampling areas were gathered using standard survey leveling techniques and taped measurements of ecological units similar to Amiro (MS 1984).

Age-1+ and older parr densities were estimated by adjusted Petersen mark-recapture estimates (Ricker 1975) while age-0+ parr were estimated using the first capture efficiency of age 1+ and counts of age 0+ for detailed survey areas during July and August, 1984 and 1985. Age, length and sex characteristics were derived from: 98 salmon taken in the Stewiacke sport fishery, 1968; 238 fish angled in the Stewiacke River 1983 and 1984 (S.F. O'Neil, pers. comm.); 28 fish collected by electrofishing October 12-18, 1983 as part of a broodstock collection; and 86 fish from the commercial fishery in the Shubenacadie River, Fishery Statistical District 42, 1984.

S.F. O'Neil, Fisheries and Oceans, Freshwater and Anadromous Div., P.O. Box 550, Halifax, N.S.

T.G. Carey, Fisheries and Oceans, Aquaculture and Resources Dev. Br., 200 Kent St., Ottawa, Ont.

Length-fecundity was determined by water volume displacement of the eggs in a manner similiar to Burrows (1951) for 12 female fish collected in October 1983.

Commercial harvests for FSD 42, 1970-1985, were reported by Cutting (MS 1984). Sport fishery statistics, 1970-1985 were summarized from Redbooks[a] from 1970 to 1983. Duration of seasons, effort and opening and closing dates were provided by S.F. O'Neil (pers. comm.).

RESULTS

SALMON PRODUCTION AREA

The production area available to salmon was estimated at $25{,}988 \cdot 10^2$ m^2. Stream area was classified by distance from tidal influence and by gradient interval in Table 1 and illustrated in Fig. 2. Areas where gradient was greater than 5.0%, as determined by measurements made from orthophotographic maps, were excluded from potential production. This upper limit was suggested by extensive parr sampling. Production area where gradient was less than 0.12% was estimated at $13{,}287 \cdot 10^2$ m^2 which included $12{,}153 \cdot 10^2 m^2$ on the main river with gradient less than 0.03 percent.

SPORT FISHERY

The sport fishery season traditionally opened June 15 and closed October 15 with extensions to October 31 occurring in 1975 to 1977 and 1980. In 1981, the opening was delayed until August 1, and since 1984 only fish less than 63 cm were permitted to be retained.

Catches (Table 2, Fig. 3) were highly variable for both grilse (less than 2.3 kg) and salmon (greater than or equal to 2.3 kg). Effort has increased since the mid-70's and has tended to follow catch. Catch per unit effort has been relatively low in recent years, the lowest values occurring in 1980 and 1982. Run timing, as indicated by monthly angling totals (Table 3), is late summer and fall. No difference is apparent in timing of grilse and salmon.

Sampling of catches in the sport fishery in 1968 indicated that 13% were age two seawinters (2SW) at first spawning (Table 4) compared with only 0.01% in 1983 (Table 5). Samples collected in 1984 (Table 6) are not representative of the stock since retention, and therefore sampling, was restricted to fish less than 63 cm. The 1984 sample provides additional information such as length, smolt age and proportion of female for fish less than 63 cm or less than 2.3 kg.

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[a] Atlantic Salmon Sport Catch Statistics, Maritime Provinces, annual series beginning 1970. DFO, Halifax, N.S.

COMMERCIAL FISHERY

The commercial salmon fishery of FSD 42 (Table 7) consisted in 1984 of 12 drift gill nets of 127 mm stretched mesh fished July 23 to August 10. Nets were fished during the incoming tide from near Maitland Bridge on the Shubenacadie estuary to the highway bridge on the Stewiacke River at the Town of Stewiacke. While the production of salmon on the Shubenacadie system is not limited to the Stewiacke (Semple 1970), the commercial fishery is likely comprised mainly of Stewiacke-destined fish. This conclusion is inferred from sport harvest data wherein Stewiacke landings in 1984 accounted for 86% of landings from the total Shubenacadie drainage (O'Neil et al. 1985).

In 1984, 33.6% of the commercial harvest was maiden 1SW fish; most (all but 1) were less than 2.3 kg (Table 8).

STOCK DESCRIPTION

Atlantic salmon stocks of the Stewiacke River are primarily composed of consecutive-spawning grilse; there are few maiden 2SW fish and/or alternate spawning grilse (Tables 4,5,6). A sample of the population collected by boat-mounted electrofishing in October 1983 (Table 9) after removal of 1,300 "grilse" and release of 223 "salmon" suggested that 43% were repeat-spawning grilse.

Weighted proportions of females for maiden grilse were 71.7% for 1968 and 1983 data combined (Table 10) and 67.7% for the 1984 sport sample (Table 6). Proportion of female increased with age in all samples.

Age at smoltification for 364 samples (excluding the commercial fishery) was 87.5% 2-year and 12.5% 3-year. Accounting for an additional year in freshwater for 3-year smolts and over-winter survival of 40%, relative contribution of eggs to smolts could be 0.74 for 2-year and 0.26 for 3-year smolts.

BIOLOGICAL RELATIONSHIPS

Biological relationships required for assessment of Atlantic salmon stocks on the Stewiacke were, length-fecundity and length-weight.

Length-fecundity was determined (by the volume displacement method after stripping) for 12 fish collected in October 1983 (Table 11). The equation was:

$$Y_F=431.3e^{0.0368X_L},\ r^2=0.90.$$

Length-weight (Fig. 4) was determined for 324 fish sampled but not necessarily aged or sexed in the 1984 Stewiacke sport and FSD 42 commercial fisheries. The equation was:

$$Y_W=.000011\ X_L^{2.99174},\ r^2=0.88.$$

EGG REQUIREMENTS

The number of eggs required to seed the Stewiacke River and its tributaries at 240 eggs $m^{-2}\cdot 10^2$ (Elson 1975) for all accessible salmon production area is $6.24\cdot 10^6$ eggs. On the main Stewiacke below km 57, orthogradient is less than or equal to 0.03% and the area is $12,153 \cdot 10^2 m^2$. Area less than 0.12% orthogradient for the total system comprises $13,287 \cdot 10^2 m^2$, or 50% of the total water surface area accessible to Atlantic salmon. Excluding these low-gradient areas from the required egg deposition, the requirement would be $3.12 \cdot 10^6$ eggs.

SPAWNING REQUIREMENTS

The stock composition indicated by all Stewiacke samples, the uncertainty of bias in the samplings, and the complexity of setting a target composition for stocks dependent on repeat spawners indicated the desirability of utilizing a more complete data set of similar stock composition. To that end the stock composition derived from 3,334 adult salmon counted into the Big Salmon River, 1965 to 1973 (Appendix I) on the north shore of the Bay of Fundy, was used to calculate the percent contribution to required egg depositions for maiden and repeat-spawning 1SW and 2SW fish for the Stewiacke River.

Required spawners at that composition for all accessible areas are:

Postsmolt age	% Contribution	Number of fish
1SW		
1	25	943
2	17	380
3	22	262
4	15	115
5	3	17
6	0.7	4
7	0.1	1
		1,722
2SW		
2	7	77
3	7	59
4	3	19
5	0.2	1
		156
	Total	1,878

Spawning requirements for only areas greater than 0.12% ortho grade would be 50 percent or 939 fish of the same percent composition.

STOCK STATUS

Age-1+ parr

The stock status of the Stewiacke salmon population for 1984 and 1985 was evaluated by comparing the mean density of age-1+ parr for areas greater than

0.12% orthogradient to a "normal" abundance of 24 small (less than 10.0 cm) parr $m^{-2} \cdot 10^2$ (Elson 1967).

In 1984, 44 sites were electrofished that were above 0.12% orthogradient and below barriers to migration (Table 12). The age-1+ parr mean density was 16.3 $\pm$ 12.8 $m^{-2} \cdot 10^2$ (Table 13). The high standard deviation required the data be examined for values contributing to this condition. Nine sites were noted to exceed the upper bounds of the 99% confidence interval of the mean (11.1 to 21.5). Two values, for the Little River, 52.3 and 67.0 $m^{-2} \cdot 10^2$, appeared several orders of magnitude above the remaining seven outliers. Without these sites the mean age-1+ parr density was 14.2+8.5 $m^{-2} \cdot 10^2$. This value was 59% of a "normal" abundance. The average density for Little River was 251% of the "norm".

In 1985 29 sites were electrofished, 15 of which were new locations and 26 had greater than 0.12% orthogradient (Tables 12, 14). The mean age-1+ parr density was 29.8 $\pm$ 26.2 $m^{-2} \cdot 10^2$ (Table 15). Again, the high standard deviation, required the data be examined for outliers. Five values exceeded the upper limit of the 99% confidence interval of the mean (15.4 to 44.1), and these consisted of two sites on Little River (107.0 and 105.0 $m^{-2} \cdot 10^2$) and three on Putnam Brook (57.9, 56.2 and 49.3 $m^{-2} \cdot 10^2$). Without these five sites, the age-1+ parr mean density for the remaining 21 sites throughout the system was 19.0 $\pm$ 7.9 $m^{-2} \cdot 10^2$. This value was 79% of a "normal" abundance while that of Little River was 442% of the "norm" and that of Putnam Brook was 227% of the "norm".

STOCK AND RECRUITMENT

Maiden Grilse

No simple relationship was found between stock and recruits. Stock and recruitment were found to be functionally related to be precipitation during the last year a recruit spent in freshwater. Estimates of stock and recruits (Table 16) were expressed in eggs and were calculated as follows:

1) Stock size (spawners); the numbers of eggs were derived from the numbers of grilse and salmon angled in years i-4 and i-5. Eggs were partitioned as contributing to recruits in year i according to the relative contribution to age-2 (74% of eggs) and age-3 (26% of eggs) smolts. Numbers of eggs were derived from the average $weight \cdot fish^{-1}$ for salmon and grilse converted to length by the length-weight relationship. Proportions of females for salmon (77%) and grilse (72%) were derived as the weighted mean from the 1968 and 1983 samples.

2) Recruits (maiden grilse); the numbers of eggs were derived from grilse in the sport fishery in year i converted to eggs using a value of 2,174 $eggs \cdot fish^{-1}$ determined from the 1968 and 1983 combined data (Table 10) and grilse in the commercial fishery in year i converted to eggs using a weighted average of 2,432 $eggs \cdot fish^{-1}$ determined for fish less than 2.3 kg in the 1984 commercial samples (Table 17).

3) Precipitation; at Upper Stewiacke was averaged for the months of July to October in year i-2 (Table 18).

The natural log of the ratio of recruits· $spawner^{-1}$ on precipitation best fitted a second order polynominial (Fig. 5). The equation used was:

$$Ln\ R/S = -8.2083 + 0.14023\ X - 0.00059\ X^2;\ r^2=0.78$$

where X = average July to October precipitation for recruit years 1975 to 1984.

Analysis of variance for this function was:

Source	Df	Sum of squares	Mean square	F value	Probability
Total	9	15.56			
Regression	2	12.09	6.04	12.18	.005
X1	1	7.71	7.71	15.54	.006
X2	1	4.37	4.38	8.82	.021
Residual	7	3.47	.50		

Salmon (Post Spawners)

While no significant ($p \leq 0.05$) correlations were found between grilse and salmon, the strong positive ($p=0.08$) relationship between sport-caught grilse of year i and sport-caught salmon of year i+1 suggests stock strength of repeat-spawning salmon is positively related to the level of angled grilse the previous year. Inclusion of the commercial landings of grilse or salmon from FSD 42 did not improve the relationship.

Forecasts

Forecasts of recruits are 1,011 x 10^3 eggs for 1986 and 652 x 10^3 eggs for 1987. At an average length of 56.6 cm, and 67.2% females (the weighted average of 66 samples in the 1984 sport fishery), yield to the angling and commercial fisheries (provided traditional seasons were in effect) would be 435 fish in 1986 and 280 fish in 1987. Both of these values are below the mean (623 ± 364) total grilse harvest for years 1970 to 1982.

Hatchery Stocking

Hatchery rearing of Stewiacke stocks began in 1983 for the purpose of documenting the marine distribution and fisheries exploitations. To that end 1,770 tagged one-year-old smolts were released in 1985. An additional 22,000 finclipped age-1+ parr or small smolts were also released into upriver areas. The contribution these releases may make to returns in 1986 and 1987 is unquantified.

DISCUSSION

The foregoing assessment relied on several assumptions. Discussion of the three more important ones and their probable impacts follows:

1) Assumed absence of parr production for orthogradients less than 0.12%. Population densities for the 15 streams contributing to "normal" abundance (Elson 1967) are known to have come from "suitable habitat", i.e., intermittent riffle and pool and therefore had gradients greater than 0.12%. However, since low populations of age-1+ parr were observed in orthogradients of less than 0.12%, an improved method for calculating required egg deposition might be to prorate egg deposition to habitat, i.e. gradient.

Development of such a technique is a topic of current research.

2) Assumed Stewiacke stock composition equivalent to Big Salmon River. While the BSR stock approximates a desirable composition for the Stewiacke, recent sampling of stocks in the Stewiacke River indicate a decreased presence of 2SW fish.

Fecundity for BSR was developed from total ovary counts following dissection. Therefore the fecundity-on-length relationship developed by Jessop (1986) estimates greater numbers of eggs for fish larger than 68 cm than that of the Stewiacke. The Stewiacke relationship, which approximates those for the Saint John (Marshall and Penney, MS 1983), Medway (T. Goff, pers. comm.) and LaHave (Cutting and Jefferson, MS 1986) river stocks, was derived after hatchery stripping of eggs. Combination of the above factors may underestimate the recruit requirements for the Stewiacke River. Hence, postulated minimum requirements for recruits were rounded up to reflect conservation of stocks.

3) Assumed constant exploitation rates in the sport fishery for estimates of stock and a combined constant exploitation in the commercial and sport fisheries for estimates of recruits. Attempts to adjust the sport catch by accounting for variable exploitation according to precipitation at Upper Stewiacke did not improve the relationship. The sequential nature and therefore mutual exclusiveness of the commercial and sport fisheries acting on recruits may have tended to stabilize the total exploitation rate and therefore provided reasonable indices of recruits. It follows that a substantial amount of the variation in catch is explained by stock abundance and thus catch is an indicator of stock abundance.

The model presented in Fig. 5 has two important adjuncts: 1) A stock-recruitment function must underlie the model and, since precipitation is the only variable affecting the ratio of recruits per spawner, spawning levels must be less than the maximum value of the function. If spawners were greater than the maximum of a stock-recruitment curve, then a more complex function accounting for density dependance in the recruit$\cdot$ spawner^{-1} ratio would have to be incorporated in a new model. 2) There is an optimum environmental condition associated with

T. Goff, Fisheries and Oceans, Freshwater and Anadromous Div., Mersey Fish Culture Station, Milton, Queens Co., N.S.

precipitation the summer previous to smoltification which influences potential returns. This observation implies an environmental mechanism which acts on growth, condition or numbers of smolts.

Forecasts of recruits in 1986 and 1987 to all fisheries were relatively low. The 1986 forecast was low mainly because of low spawning escapement in 1982 and is supported by the reduced age-1+ parr densities observed in 1984. Fish mortalities including parr, concurrent with low and warm water conditions were observed and reported in 1984 and indicate perhaps an even greater negative environmental effect on the 1986 returns. The 1987 forecast, although derived from much higher escapements in 1983 (supported by the higher age-1+ parr densities observed in 1985) was greatly impacted by the low water conditions in 1985. However, because the extremely low precipitation occurred in September in 1985, after the growing season, the negative impact may not be as great as that estimated by the model.

The importance of forecasting poor returns of recruits is indicated by the low incidence (20%) of recruits achieving stock replacement (Fig. 5) and the dependency of achieving about 58% of the required egg deposition from repeat-spawning grilse (Appendix 1). This requirement conflicts with certain Newfoundland grilse stocks with similar proportions of female spawner recruits which are viable without significant contribution by previous spawners. Smolt-to-grilse survival for Western Arm Brook (WAB) was 6.3% (Chadwick et al. 1978) while smolt-to-grilse survival of Big Salmon River averaged 4.2% (Jessop 1986). Adding the FSD 42 commercial catch of grilse to a similiar return rate (4.2%) on the Stewiacke would not approach the 17 to 20% marine survival estimated for WAB, (this assumes distant exploitation of Stewiacke fish is negligible) since the sport fishery is on average (1970 to 1983) 3.13 times the commercial fishery for grilse. Therefore, potential surplus yield of grilse is particularly sensitive to factors affecting marine survival. Stock stability becomes dependent on previous spawners when smolt marine survival drops or exploitation on grilse increases. Therefore a minimum escapement of about 500 maiden grilse with the balance in repeat spawners is required to maintain stock stability. If exploitation rates in the commercial and sport fisheries are highly variable and targeted on smaller size-classes, then the possibility for long-term decreased production is a reality.

Age-1+ parr densities suggest that escapements are more than adequate on the lower tributaries where habitat is suitable. Suitable habitat on the main river and tributaries above the 0.12% ortho grade point is perhaps 20 to 40% under-utilized. If sport catch were 30% of river escapement, then adequate spawning escapements should be achieved when sport catches are about 400 fish. However, the 1983 run, when sport catch was at least 1,144, produced 1985 age-1+ parr densities for the majority of the system less than the Elson (1967) norm. Total escapement in 1983 may have reached target levels but distribution of spawning fish was less than desirable. Therefore, decreased exploitation of up-river stocks and perhaps increased exploitation of downriver stocks is indicated.

While stocks with surplus spawners, like those of the lower tributaries, may tolerate increased exploitation, upriver stocks cannot be sustained by repeat spawners if maiden grilse are harvested at the same rate as those from the lower tributaries. The adult sample collected in 1983 after the angling season and above the confluence of most lower river tributaries indicated a disproportionate presence of repeat spawners (Table 9).

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REFERENCES

Amiro, P.G. MS 1983. Aerial photographic measurement of Atlantic salmon habitat of the Miramichi River, New Brunswick. CAFSAC Res. Doc. 83/74, 31p.

Amiro, P.G. MS 1984. Stream gradients and Atlantic salmon parr densities. CAFSAC Res. Doc. 84/89, 22p.

Burrows, Roger E. 1951 . A method for enumeration of salmon and trout eggs by displacement. Prog. Fish-Cult. Vol. 13, No. 1, pp. 25-30.

Chadwick, E.M.P., T.R. Porter, and P. Downton. 1978. Analysis of growth of Atlantic salmon (Salmo salar) in a small Newfoundland river. J. Fish. Res. Board Can. 35:60-68.

Cutting, R.E. MS 1984. Summary of tables of recreational and commercial Atlantic salmon harvests of the Scotia-Fundy Region, 1967-1983. CAFSAC Res. Doc. 84/53, 27p.

Cutting, R.E. and E.M. Jefferson. MS 1986. Status of the Atlantic salmon of the LaHave River, Nova Scotia, in 1985 and Forecasts of Returns in 1986. CAFSAC Res. Doc. 86/17, 21p.

Elson, P.F. 1967. Effects on wild young salmon of spraying DDT over New Brunswick Forests. J. Fish. Res. Bd. Canada, 24(4): 731-767

Elson, P.F. 1975. Atlantic salmon rivers. Smolt production and optimal spawning-an overview of natural production. Int. Atlantic Sal. Found. Spec. Public. Ser. 6: 96-119.

Marshall, T.L., and G.H. Penney. MS 1983. Spawning and river escapement requirements for Atlantic salmon of the Saint John River, New Brunswick. CAFSAC Res. Doc. 83/66, 17p+App.

O'Neil, S.F., M. Bernard, and J. Singer. 1985. Atlantic salmon sport catch statistics, Maritime provinces (Redbook) Can. Data. Rep. Fish. Aquat. Sci. No. 530, v+98p.

Jessop, B.M. 1986 (In press). Analysis of the run of Atlantic salmon (Salmo salar) to the Big Salmon River, N.B. Can. Tech. Rep. Fish. Aquat. Sci., 1415:50p.

Ricker, W.E. 1975. Computation and interpertation of biological statistics of fish populations. Fish. Res. Board Can. Bull. 191: 382p.

Semple, J.R. 1970. Shubenacadie and Stewiacke River, Nova Scotia, Fisheries Survey, 1969 MS, DFO, 66p+App.

TABLE 1. Area ($m^2 \cdot 10^2$) by percent orthogradient and distance above the 10 m contour for the Stewiacke River and tributaries.

	Area ($100 m^2$) by percent orthogradient intervals and distance												
Dist. Interval (km)	0-.12	.121-.249	.25-.49	.5-.99	1-1.49	1.5-1.99	2-2.49	2.5-2.99	3-3.49	3.5-5.0	Above	Totals	% Total Area
00-09.999	3,473	263	209	13	13	0	0	0	0	0	0	3,969	14.9
10-19.999	2,907	481	119	81	9	1	0	0	0	0	0	3,599	13.5
20-29.999	3,058	103	281	382	20	11	0	0	0	0	0	3,856	14.5
30-39.999	2,497	5	190	702	173	13	0	0	2	0	22	3,605	13.6
40-49.999	1,343	1,608	381	97	54	29	1	15	8	36	0	3,571	13.4
50-59.999	9	1,167	1,273	914	220	138	53	6	22	10	101	3,913	14.7
60-69.999	0	0	749	1,012	418	217	82	36	0	2	313	2,829	10.6
70-79.999	0	0	142	511	318	99	12	0	0	0	170	1,252	4.7
Grand total area	13,287	3,627	3,344	3,711	1,224	508	149	57	33	48	606	26,594	100.0
Percent total area	50.0	13.6	12.6	14.0	4.6	1.9	0.6	0.2	0.1	0.2	2.3		

TABLE 2. Recreational catch of Atlantic salmon for the Stewiacke River as recorded by DFO by size-class (grilse < 2.3 kg and large salmon ≥ 2.3 kg) with effort in rod days and catch·rod-day^{-1}, 1970 to 1985.

Year	Grilse No.	Grilse Wt.	Large salmon No.	Large salmon Wt.	Total No.	Total Wt.	Effort (rod-days)	Catch·effort^{-1}
1970	355	529	163	733	518	1,263	2,160	0.240
71	337	493	46	184	383	676	1,357	0.282
72	343	601	265	956	608	1,557	2,347	0.259
73	520	943	224	752	744	1,695	2,954	0.252
74	1,087	1,972	355	1,242	1,442	3,215	2,310	0.624
75	442	802	180	653	622	1,455	1,150	0.541
76	940	1,731	198	711	1,138	2,442	2,070	0.550
77	104	182	370	1,399	474	1,581	4,240	0.112
78	545	989	75	363	620	1,352	2,300	0.270
79	681	1,236	239	867	920	2,103	7,200	0.128
80	41	74	203	921	244	995	3,520	0.069
81	531	963	89	363	620	1,327	2,852	0.217
82	307	524	97	352	404	876	4,655	0.087
83	1,033	1,874	111	401	1,144[4]	2,275	9,480	0.121
84[1]	200[2]						4,813	0.109
85[1]	491[3]	UK					UK	

1 Fish greater than 63 cm released.

2 Stub returns indicate 395 grilse and 130 salmon (O'Neil et al. 1985)

3 Preliminary estimate from stub returns (S.F. O'Neil, pers. comm.).

4 Stub returns indicate 1,300 grilse and 223 salmon retained and 361 grilse and 75 salmon reported released (S.F. O'Neil, pers. comm.).

TABLE 3. Number and percentage of grilse (< 2.3 kg) and salmon (2.3 kg or over) recorded caught in the Stewiacke River sport fishery by month for the period 1970 to 1983.

	Grilse		Salmon		Total	
	No.	%	No.	%	No.	%
July	22	0.3	13	0.5	35	0.4
August	647	8.9	166	6.3	813	8.2
September	2,265	31.2	675	25.8	2,940	29.8
October	4,332	59.6	1,761	67.3	6,093	61.7
Total	7,266		2,615		9,881	

TABLE 4. Age distribution, percent females, mean fork length of females, fecundity and contribution to potential egg deposition by one sea-winter (1SW) and two sea-winter (2SW) Atlantic salmon at first maturity as determined from 98 fish sampled in the sport fishery, Stewiacke river, 1968.

Total age after smolt	Spawning history	Freshwater age	No. @ age	% Female @ age	Length @ age	± SD	Fecundity @ age	% @ age	Contribution: Egg· $fish^{-1}$	Contribution: %	Contribution: % by total age
1SW											
1	0	2	44	62	53.1	2.7	3,043	45	849	26	28
	0	3	4	50	53.4	0.0	3,078	4	62	2	
2	1	2	17	65	62.8	4.0	4,350	17	481	15	22
	1	3	7	71	61.8	2.2	4,193	8	238	7	
3	1,2	2	6	100	71.5	3.8	5,991	6	359	11	
	1,2	3	1	100	71.1	---	5,904	1	59	2	24
	1	2	5	100	77.2	2.9	7,389	5	369	11	
5	1,2,3,4	2	1	100	96.3	---	14,922[1]	1	149	5	5
										79	
2SW											
2	0	2	6	100	72.7	3.7	6,262	6	376	11	15
	0	3	2	100	75.0	1.8	6,815	2	136	4	
3	2	2	2	50	78.7	---	7,009	2	70	2	2
	2	3	1	0	---	---	----	1	---		
4	2,3	2	2	100	76.2	3.5	7,122	2	142	4	4
										21	
			===					===	=====		
Totals			98					100	3,290		

[1] Beyond range of length-fecundity relationship.

TABLE 5. Age distribution, percent females, mean fork length, fecundity and contribution to potential egg deposition by one sea-winter (1SW) and two sea-winter fish at first maturity as determined from 172 fish sampled in the sport fishery on the Stewiacke River, 1983.

Total age after smolt	Spawning history	Freshwater age	No. @ age	% Female @ age	Length @ age	Fecundity @ age	% @ age	Contribution Egg·fish^{-1}	Contribution %
1SW									
1	0	2	147	75	52.4	2,967	85	1,891	83
		3	8	50	55.7	3,350	5	84	4
2	1	2	15	60	64.4	4,614	9	249	11
		3	1	0	61.9	0	0.5	0	0
Total			171						98
2SW									
4	2,3	2	1	100	90.6	12,099	0.5	60	2
			1						2
Totals			172					2,284	100

Age data provided by S.F. O'Neil

TABLE 6. Age distribution, mean length and percent females of Atlantic salmon sampled from the sport fishery (restricted to fish <63 cm) on the Stewiacke River, 1984

Total age after smolt	Spawn history	Freshwater age	Number @ age	Length @ age	± SD	% female
1SW						
1	0	2	31	54.6	2.4	67.9
	0	3	15	55.9	2.9	66.7
2	1	2	19	60.2	1.7	66.7
	1	3	1	62.3	---	----
Total			66			

TABLE 7. Numbers of grilse (< 2.3 kg) and salmon (> 2.3 kg) reported landed, number of licenses and seasons for the District 42 commercial drift net fishery, 1970 to 1984. (Cutting 1984)

Year	Grilse	Salmon	Licenses	Season
1970	236	105	26	May 1 - Aug 15
71	128	45	26	"
72	28	133	19	"
73	28	12	17	"
74	85	88	17	"
75	1	14	16	"
76	119	231	14	"
77	7	35	14	"
78	564	0	14	"
79	237	139	14	"
80	3	292	13	"
81	263	418	13	Jun 1 - Aug 10
82	169	157	12	"
83	457	148	12	"
84	122	117	12	Jul 28 - Aug 10

TABLE 8. Age distribution, mean length and percent at age of Atlantic salmon sampled in the commercial fishery of FSD 42, July 23 to August 10, 1984.

Total age after smolt	Spawning history	Freshwater age	Number @ age	Length @ age	Length SD	% at age
1SW						
1	0	2	18	54.6	2.2	20.9
		3	11	54.4	2.6	12.7
2	1	2	12	62.1	3.1	13.9
	1	3	2	59.0	2.3	
3	1	2	5	76.2	4.4	5.8
	1,2	2	8	71.3	5.6	8.1
	1	3	1	81.0	---	1.2
4	1,2,3	2	11	74.8	2.2	12.7
	1,2,3	3	4	77.5	5.7	4.6
2SW						
2	0	2	2	70.0	---	2.3
	0	3	1	68.5	---	1.1
3	2	2	1	66.0	---	1.6
	2	3	1	85.0	---	1.6
Total			77			

TABLE 9. Age distribution, percent female, mean fork length of females, fecundity and contribution to potential egg deposition by one sea-winter (1SW) and two sea-winter (2SW) Atlantic salmon at first maturity as determined from 28 fish collected by boat mounted electrofishing in the Stewiacke River, October 1983.

Total age after smolt	Spawning history	Freshwater age	No. @ age	% Female @ age	Length @ age	± SD	Fecundity @ age	% @ age	Contribution: Egg·fish^{-1}	Contribution: %	Contribution: % by total age
1SW											
1	0	2	13	92	54.9	2.8	3,252	46	1,376	30	30
2	1	2	6	83	68.8	2.7	5,424	21	945	21	21
3	1,2	2	3	66	76.0	9.9	7,070	11	513	11	
	1,2	3	1	100	72.0	---	6,102	4	244	5	29
	1	2	2	100	79.5	0.7	8,042	7	563	13	
			25						3,641	81	
2SW											
2	0	2	1	100	68.8	2.7	5,424	4	216	5	5
3	2	2	1	100	80.8	---	8,191	4	328	7	7
4	2,3	2	1	100	80.0	---	8,191	4	328	7	7
Totals			3						872	18	
Grand total			28						4,513		

TABLE 10. Age distribution, percent female, mean fork length of females, fecundity and contribution to potential egg deposition by one sea-winter (1SW) and two sea-winter (2SW) Atlantic salmon at first maturity as determined by combining 298 fish sampled in the sport fishery and electrofishing operation on the Stewiacke River, 1983.

Total age after smolt	Spawning history	Freshwater age	No. @ age	% Female @ age	Length[1] @ age (cm)	Fecundity @ age	% @ age	Contribution to Potential Escapement: Egg·fish^{-1}	Contribution to Potential Escapement: %	Contribution to Potential Escapement: % by total age
1SW										
1	0	2	204	73	52.7	2,999	68.5	148	10	14
		3	12	50	54.9	3,252	4.0	65	4	
2	1	2	38	66	64.4	4,614	12.9	396	28	33
		3	8	62	61.8	4,193	2.7	78	5	
3	1,2	2	9	89	73.0	6,331	3.0	169	12	
	1,2	3	2	100	71.6	6,013	0.7	60	4	26
	1	2	7	100	78.0	7,610	2.3	152	10	
5	1,2,3,3	2	1	100	96.3	14,922[2]	0.3	45	3	3
Totals			281				94.4	1,113		76
2SW										
2	0	2	7	100	72.1	6,125	2.3	123	8	13
	0	3	2	100	75.0	6,815	0.7	68	5	
3	2	2	3	66	79.4	8,012	1.0	74	5	5
	2	3	1	0	----		0.3	--	-	
4	2,3	2	4	100	80.8	8,436	1.3	84	6	6
Totals			17				5.6	349		24
Grand total			298				100	1,462		100

[1] Weighted (sample size) average of means.
[2] Beyond range of length fecundity relationship.

TABLE 11. Age, length, number of eggs and egg diameters for 12 Stewiacke River salmon collected and stripped in 1983[1]

Years FW	Years SW	Spawning history	Length (cm)	Number of eggs	Egg diameter (mm)
2	3	2	82.0	6,896	6.21
2	3	1 2	84.0	10,583	6.68
2	3	1	78.0	6,780	6.82
UK			81.3	8,651	6.57
2	3	1 2	74.5	7,220	6.21
3	3	1 2	71.0	8,072	5.65
2	2	1	65.8	4,863	5.80
?	2	1	63.0	3,960	6.13
2	1		59.5	3,696	5.77
2	1		52.5	3,025	5.24
UK			54.2	3,085	5.92
2	2	1	64.5	4,524	5.80

$Y = 431.3e^{(0.0368X)}$

$r^2 = 0.90$

[1] Eggs estimated by water displacement

TABLE 12. Physical characteristics of the Stewiacke River sampling sites, 1984.

Site name	Site code	Distance from 10m contour(km)	Length (m)	Area m^2	Assigned % orthograde	% Surface gradient	Area-weighted % surface gradient	Area-weighted average depth (cm)
Stewiacke R.	S8427	14.387	750	19,990	0.02	0.00	0.00	---
Stewiacke R.	S8426	17.299	260	6,874	0.02	0.00	0.00	---
Rutherford Bk.								
Sect. 2	S8422.2	27.925	115	1,583	0.42	0.15	0.21	12.2
Sect. 6	S8422.6	28.400	105	1,167	0.42	0.00	0.16	14.0
Sect. 9	S8422.9	28.751	109	1,160	0.42	0.61	0.63	10.7
Overall 2,6,9	S8422.269	27.925	329	3,910	0.42	0.20	0.32	12.3
Little R.								
Sect. 1	S8420.1	28.635	97	380	2.67	0.62	0.70	11.5
Sect. 2	S8420.2	28.738	90	368	2.67	0.98	1.08	11.4
Overall 1,2	S8420	28.635	187	748	2.67	0.79	0.89	11.5
Little R.								
Sect. 1	S8414.1	30.130	92	336	5.26	1.47	1.47	17.2
Sect. 2	S8414.2	30.223	103	407	2.76	1.13	1.14	15.7
Sect. 3	S8414.3	30.312	89	327	2.76	1.64	1.60	19.7
Overall 2,3	S8414.23	30.223	192	734	2.76	1.36	1.34	17.5
Chapman Bk.								
Sect. 1	S8421.1	37.188	89	273	5.51	3.85	1.25	15.7
Sect. 2	S8421.2	37.278	58	210	3.05	2.71	2.59	10.7
Overall 1,2	S8421	37.188	147	483	3.94	3.40	1.83	13.7
Goshen Bk.	S8418	46.048	161	505	3.16	1.53	0.57	10.8
Newton Bk.								
Sect. 1	S8416.1	50.591	141	981	1.15	0.81	0.80	16.6
Sect. 2	S8416.2	50.732	139	918	1.15	0.71	0.72	18.6
Sect. 3	S8416.3	50.871	160	965	1.15	0.90	1.03	27.5
Overall 1,2,3	S8416	50.591	440	2,864	1.15	0.81	0.85	20.9
Pembrooke R.								
Sect. 8	S846.8	52.800	98	1,260	0.41	0.30	0.32	35.6
Sect. 4	S846.4	53.215	102	1,130	0.41	0.41	0.50	23.7

TABLE 12. (continued)

Site name	Site code	Distance from 10m contour(km)	Length (m)	Area m^2	Assigned % orthograde	% Surface gradient	Area-weighted % surface gradient	Area-weighted average depth (cm)
Sect. 2	S846.2	53.397	95	1,027	0.41	0.60	0.59	30.8
Overall 2,4,8	S846.	52.800	295	3,417	0.41	0.19	0.46	30.2
Newton Bk.								
Sect. 1	S848.1	55.200	187	984	3.27	2.10	1.74	15.1
Sect. 2	S848.2	55.386	170	761	2.90	3.31	1.57	18.0
Overall 1,2	S848	55.200	357	1,745	3.07	2.68	1.67	16.5
Fulton Bk.								
Sect. 1	S8419.1	56.011	61	283	7.85	1.51	1.53	21.6
Sect. 2	S8419.2	56.080	33	192	14.40	0.94	0.81	14.8
Sect. 3	S8419.3	56.115	71	457	7.17	1.29	1.28	16.2
Overall 1,2,3	S8419	56.011	165	932	8.93	0.56	1.26	17.5
Newton Bk.								
Sect. 1	S8417.1	56.603	123	567	1.38	2.23	2.08	11.4
Sect. 2	S8417.2	56.726	122	388	1.38	2.79	0.85	14.4
Sect. 3	S8417.3	56.848	119	379	1.38	1.48	1.00	14.4
Overall 1,2,3	S8417	56.003	364	1,334	1.38	2.17	1.42	13.2
Cox Bk.								
Sect. 5	S844.5	58.410	107	633	0.52	1.08	1.03	31.4
Sect. 6	S844.6	58.517	111	878	0.52	0.26	0.27	51.8
Sect. 7	S844.7	58.628	105	878	0.52	0.63	0.62	30.7
Overall 5,6,7	S844.	58.40	323	2,389	0.52	0.65	0.60	38.7
Scrubgrass Bk.								
Sect. 1	S8424.1	59.624	120	439	2.16	1.07	0.84	9.2
Sect. 2	S8424.2	59.744	120	370	2.16	1.66	1.20	9.5
Overall 1,2	S8424	59.624	240	809	2.16	1.36	1.01	9.3
Sucker Bk.								
Sect. 1	S8428.1	60.982	81	181	6.19	3.08	1.65	14.3
Sect. 2	S8428.2	61.063	126	334	3.90	3.09	2.05	13.6
Overall 1,2	S8428	60.982	207	515	4.78	3.09	3.18	13.9

TABLE 12. (continued)

Site name	Site code	Distance from 10m contour(km)	Length (m)	Area m^2	Assigned % orthograde	% Surface gradient	Area-weighted % surface gradient	Area-weighted average depth (cm)
Stewiacke R.								
Sect. 1	S842.1	62.238	103	2,404	0.41	0.86	0.88	13.2
Sect. 2	S842.2	62.341	97	2,833	0.41	0.33	0.34	12.4
Overall 1,2	S842	62.238	200	5,237	0.41	0.61	0.59	12.8
Little Br. Cox Bk.								
Sect. 1	S8411.1	65.266	121	485	4.04	3.31	2.39	27.4
Sect. 2	S8411.2	65.389	100	452	4.86	3.17	2.56	25.0
Sect. 3	S8411.3	65.492	100	395	5.05	2.50	2.52	25.4
Overall 1,2,3	S8411	65.266	321	1,332	4.62	3.01	2.49	26.1
Stewiacke R.								
	S8425	69.306	128	1,799	0.82	0.30	0.26	35.5
Stewiacke R.								
Sect. 1	S841.1	71.258	107	304	0.62	1.02	0.94	11.7
Sect. 2	S841.2	71.365	104	234	0.62	1.10	1.43	11.7
Overall 1,2	S841	71.258	211	538	0.62	1.06	1.15	11.7
Fall Bk.								
Sect. 1a	S8423.11	71.925	128	398	1.62	1.46	1.31	11.1
Sect. 1b	S8423.12	72.053	90	260	1.62	1.43	1.09	11.3
Sect. 1c	S8423.13	72.143	91	209	1.62	1.56	1.42	9.1
Overall 1a,b,c	S8423.1	71.925	309	867	1.62	1.48	1.27	10.7
Sect 2	S8423.2	72.234	168	716	3.02	1.63	1.41	13.8

TABLE 13. Densities ($m^{-2} \cdot 10^2$) of Atlantic salmon fry (age 0+) and parr (age 1+ and 2+) estimated by mark-recapture technique[a] from 46 electrofishing sites in the Stewiacke River during July and August of 1984.

Site name	Site code	Fry	Parr densities by year class 1+	2+	Total parr
Stewiacke R.					
	8427.0	0.0	0.0	0.0	0.0
Stewiack R.					
	8426.0	0.0	0.0	0.0	0.0
Rutherford Bk.					
Sect. 2	8422.2	21.2	10.7	0.0	10.7
Sect. 6	8422.6	32.0	22.5	0.0	22.5
Sect. 9	8422.9	24.6	16.5	1.3	17.8
Overall 2,6,9	8422.3	17.2	15.4	0.4	15.8
Little R.					
Sect. 1	8420.1	113.4	52.3	34.5	86.8
Sect. 2	8420.2	197.2	67.0	28.5	95.5
Overall 1,2	8420.0	145.8	57.0	30.7	87.7
Little R.					
Sect. 1	8414.1	93.8	13.5	17.6	31.1
Sect. 2	8414.2	69.6	17.8	25.8	43.6
Sect. 3	8414.3	21.3	9.0	15.3	24.3
Overall 1,2,3	8414.0	41.6	12.7	19.4	32.1
Chapman Bk.					
Sect. 1	8421.1	100.0	15.4	7.7	23.1
Sect. 2	8421.2	67.0	37.5	8.7	46.2
Overall 1,2	8421.0	80.7	26.1	7.8	33.9
Goshen Bk.					
	8418.0	52.7	21.6	0.0	21.6
Newton Bk.					
Sect. 1	8416.1	108.6	15.1	1.8	16.9
Sect. 2	8416.2	161.8	30.7	6.4	37.1
Sect. 3	8416.3	109.7	18.0	6.0	24.0
Overall 1,2,3	8416.0	121.5	20.3	5.0	25.3
Pembroke R.					
Sect. 8	846.8	40.3	21.4	2.1	23.5
Sect. 4	846.4	27.3	19.6	1.2	20.8
Sect. 2	846.2	42.4	18.9	2.6	21.5
Overall 2,4,8	846.0	36.3	20.6	2.1	22.7
Newton Bk.					
Sect. 1	848.1	15.4	6.8	7.6	14.4
Sect. 2	848.2	40.8	15.0	13.1	28.1
Overall 1,2	848.0	23.8	9.6	9.7	19.3
Fulton Bk.					
Sect. 1	8419.1	15.6	11.5	0.0	11.5
Sect. 2	8419.2	10.2	9.3	0.0	9.3
Sect. 3	8419.3	10.2	13.7	0.0	13.7
Overall 1,2,3	8419.0	10.8	11.5	0.0	11.5
Newton Bk.					
Sect. 1	8417.1	36.0	.7	7.6	8.3
Sect. 2	8417.2	16.2	2.1	18.8	20.9
Sect. 3	8417.3	51.9	3.3	8.4	11.7
Overall 1,2,3	8417.0	48.0	3.4	10.6	14.0
Cox Bk.					
Sect. 5	844.5	74.4	14.4	1.7	16.1

TABLE 13. (continued)

Site name	Site code	Parr densities by year class Fry	1+	2+	Total parr
Sect. 6	844.6	28.7	6.7	0.2	6.9
Sect. 7	844.7	67.4	12.0	0.6	12.6
Overall 5,6,7	844.6	54.2	10.7	0.8	11.5
Scrubgrass Bk.					
Sect. 1	8424.1	175.5	21.9	0.5	22.4
Sect. 2	8424.2	67.1	22.3	0.0	22.3
Overall 1,2	8424.0	116.4	21.6	0.3	21.9
Sucker Bk.					
Sect. 1	8428.1	21.0	21.0	3.3	24.3
Sect. 2	8428.2	9.3	17.2	2.7	19.9
Overall 1,2	8428.0	12.3	18.5	3.0	21.5
Stewiacke R.					
Sect. 1	842.1	14.7	18.7	4.1	22.8
Sect. 2	842.2	43.4	23.5	2.0	25.5
Overall 1,2	842.0	24.3	19.9	3.0	22.9
Little Br. Cox Bk.					
Sect. 1	8411.1	7.9	1.5	2.4	3.9
Sect. 2	8411.2	3.3	.7	4.4	5.1
Sect. 3	8411.3	1.9	1.3	2.0	3.3
Overall 1,2,3	8411.0	2.9	.9	3.3	4.2
Stewiacke R.					
	8425.0	13.0	5.8	0.5	6.3
Stewiacke R.					
Sect. 1	841.1	21.4	25.0	5.2	30.2
Sect. 2	841.2	18.8	22.0	4.1	26.1
Overall 1,2	841.0	20.3	23.7	4.6	28.3
Fall Bk.					
Sect. 1a	8423.1	17.8	14.1	5.0	19.1
Sect. 1b	8423.1	17.9	9.0	9.3	18.3
Sect. 1c	8423.1	9.6	6.7	16.5	23.2
Overall Sect. 1	8423.1	15.5	10.6	8.5	19.1
Sect. 2	8423.2	11.1	1.8	7.0	8.8
All sites; n=46					
Mean		45.7	15.6	6.2	21.8
Standard deviation		47.3	13.0	8.1	18.1
All sites >0.12% orthogradient; n=44					
Mean		47.8	16.3	6.5	22.8
Standard deviation		47.3	12.8	8.1	17.9
Without Little River sites; n= 42					
Mean		42.7	14.2	5.3	19.5
Standard deviation		40.9	8.5	6.1	9.7

[a] Fry estimates derived from age-1+ parr efficiency and numbers of fry counted during the marking run.

TABLE 14. Physical characteristics of the Stewiacke River electrofishing sampling sites added in 1985.

Site name	Site code	Distew (km)	Length (m)	Area m^2	Assigned % orthograde	% Surface gradient	Area-weighted % surface gradient	Area-weighted average depth (cm)
Little R.								
	S851.4	8.312	97	1,251	0.49	0.32	0.43	37.2
East Bk.								
Sect. 1	S853.1	13.440	106	408	0.76	0.56	0.48	19.9
Sect. 3	S853.3	13.656	106	418	0.76	0.77	0.63	28.3
Overall 1,3	S853.0	13.440	212	826	0.76	0.37	0.56	24.1
Putnam Bk.								
Sect. 1	S854.1	23.414	114	450	1.22	1.17	1.25	20.8
Sect. 2	S854.2	23.527	112	447	1.22	1.46	1.46	25.2
Sect. 3	S854.3	23.639	97	398	1.22	1.99	1.99	18.9
Overall 1,2,3	S854.0	23.414	322	1,295	1.22	1.52	1.55	21.7
Rutherford Bk.								
Sect. 1	S855.1	31.317	105	905	1.52	0.71	0.72	41.1
Sect. 2	S855.2	31.422	116	1,009	1.52	0.56	0.50	39.8
Overall 1,2	S855.0	31.317	221	1,913	1.52	0.63	0.61	40.4
South Br. Stewiacke								
Sect. 1	S857.1	51.242	100	985	0.12	0.00	0.05	44.8
Sect. 2	S857.2	51.342	100	858	0.12	0.38	0.39	46.3
Overall 1,2	S857.0	51.242	200	1,843	0.12	0.08	0.21	45.5
Blackie Bk.								
	S858	47.615	131	415	4.29	1.04	0.98	20.6
Big Br. Stewiacke R.								
	S859	67.245	121	791	1.00	0.96	0.69	16.1
Sutherland Bk.								
Sect. 1	S8510.1	69.987	139	716	1.29	1.16	1.08	14.1
Sect. 2	S8510.2	70.126	173	1,089	1.29	1.36	1.36	13.8
Sect. 3	S8510.3	70.299	139	680	1.29	1.09	0.98	15.7
Overall 1,2,3	S8510	69.987	452	2,485	1.29	1.22	1.19	14.3

TABLE 15. Densities ($m^{-2} \cdot 10^2$) of Atlantic salmon fry (age 0+) and parr (age 1+ and 2+) estimated by mark and recapture technique from 29 electrofishing sites in the Stewiacke River during July and August of 1985.

Site name	Site code	Fry	Parr densities by year-class 1+	2+	Total parr
Little R.					
	851.4	15.2	19.9	0.6	20.5
East Bk.					
Sect. 1	853.1	29.6	16.7	8.5	25.2
Sect. 3	853.3	0.0	9.6	10.3	19.9
Overall 1,3	853.0	19.2	12.8	9.0	21.8
Putnam Bk.					
Sect. 1	854.1	13.1	57.9	16.2	74.1
Sect. 2	854.2	13.7	56.2	17.1	73.3
Sect. 3	854.3	12.8	49.3	25.1	74.4
Overall 1,2,3	854.0	8.4	51.5	19.0	70.5
Rutherford Bk.					
Sect. 1	855.1	14.3	18.0	2.5	20.5
Sect. 2	855.2	14.4	15.5	3.4	18.9
Overall 1,2	855.0	14.2	16.5	2.9	19.4
South Br. Stewiacke					
Sect. 1	857.1	0.0	2.5	0.0	2.5
Sect. 2	857.2	0.0	2.5	0.0	2.5
Overall 1,2	857.0	0.0	1.4	0.0	1.4
Blackie Bk.					
	858.0	26.6	15.9	1.0	16.9
Big Br. Stewiacke					
	859.0	57.2	21.2	10.2	31.4
Sutherland Bk.					
Sect. 1	8,510.1	26.1	15.4	5.3	20.7
Sect. 2	8,510.2	21.0	16.8	5.0	21.8
Sect. 3	8,510.3	8.1	18.4	8.4	26.8
Overall 1,2,3	8,510.0	17.8	16.4	5.9	22.3
Stewiacke R.					
Sect. 1	841.1	36.4	21.5	2.4	23.9
Sect. 2	841.2	30.8	14.8	5.0	19.8
Overall 1,2	841.0	32.2	17.5	3.3	20.8
Newton Bk.					
Sect. 1	848.1	1.7	32.8	1.9	34.7
Sect. 2	848.2	0.7	29.8	2.8	32.6
Overall 1,2	848.0	1.2	31.3	2.3	33.6
Little Br. Cox Bk.					
Sect. 1	8,411.1	0.0	17.7	0.8	18.5
Sect. 2	8,411.2	0.0	9.2	1.1	10.3
Sect. 3	8,411.3	0.0	8.5	2.0	10.5
Overall 1,2,3	8,411.0	0.0	12.0	1.1	13.1
Newton Bk.					
Sect. 1	8,417.1	0.0	19.5	0.5	20.0
Sect. 2	8,417.2	0.0	37.3	4.1	41.4
Sect. 3	8,417.3	0.0	30.9	2.6	33.5
Overall 1,2,3	8,417.0	0.0	26.8	1.5	28.3
Little R.					
Sect. 1	8,420.1	0.0	107.0	35.4	142.4
Sect. 2	8,420.2	0.0	105.0	21.4	126.4
Overall 1,2	8,420.0	0.0	100.0	27.2	127.2

TABLE 15. (continued)

Site Name	Site Code	Parr densities by year-class Fry	1+	2+	Total Parr
Stewiacke R.	8,425.0	19.8	9.1	1.1	10.2
Stewiacke R.	8,427.0	0.0	0.3	0.4	0.7
All sites; n=29					
Mean		11.8	26.9	6.7	33.6
Standard deviation		14.5	26.3	8.6	33.9
All sites >0.12% orthogradient; n=26					
Mean		13.1	29.8	7.5	37.3
Standard deviation		14.7	26.2	8.8	34.0
Without Little River and Putnam Brook; n=21					
Mean		14.4	19.0	3.8	22.8
Standard deviation		15.8	7.9	3.1	8.3

TABLE 16. Index number of eggs (x 10^3) deposited in the Stewiacke River and tributaries as indicated by sport catches in year i-4 and i-5 contributing to first recruit eggs (0.76 two-and 0.24 three-year smolts) in year i as indicated by the combined catch in sport and commercial fisheries for fish $<$ 2.3 kg.

	No. of eggs x 10^3	
Year i	Spawners i-4 and i-5	Recruits i
1975	1,104	963
1976	1,693	2,332
1977	2,118	243
1978	3,618	2,555
1979	2,445	2,056
1980	2,811	56
1981	2,245	1,794
1982	1,788	1,078
1983	2,442	3,356
1984	1,577	731
1985	1,575	
1986	1,285	
1987	2,494	

TABLE 17. Age distribution, mean length and contribution to potential egg deposition for Atlantic salmon less than 2.3 kg sampled from the District 42 commercial fishery in 1984.

Total age after smolt	Spawning history	Freshwater age	No.	Mean length	± SD	Egg• female^{-1} @ length	% Female[1]	Egg• fish^{-1}
1	0	2	17	54.4	2.2	3,200	71.7	2,294
	0	3	11	54.3	2.5	3,200	71.7	2,294
2	1	2	2	59.7	----	3,880	65.3	3,716
	1	3	1	56	----	3,387		

[1] Weighted mean percent from 1968 + 1983 sport samples.

TABLE 18. Total precipitation (mm) recorded at Upper Stewiacke for the months July to October, 1970 to 1985. Data from Inland Waters Directorate, Environment Canada.

Year	July	August	September	October	Average monthly
1970	189	155	67	102	137
71	79	327	29	54	145
72	142	76	66	199	95
73	151	110	41	71	101
74	107	55	127	101	96
75	28	15	102	82	48
76	46	51[1]	115	115	71
77	130	83	137	141	117
78	55	29	60	136	48
79	164	178	113	161	152
80	116	45	101	118	87
81	133	67	118	156	106
82	111	100	101	29	104
83	178	193	80	58	150
84	57	160	66	49	94
85	53	130	24	69	69

[1] Based on Musquodoboit discharge 1.1 x July

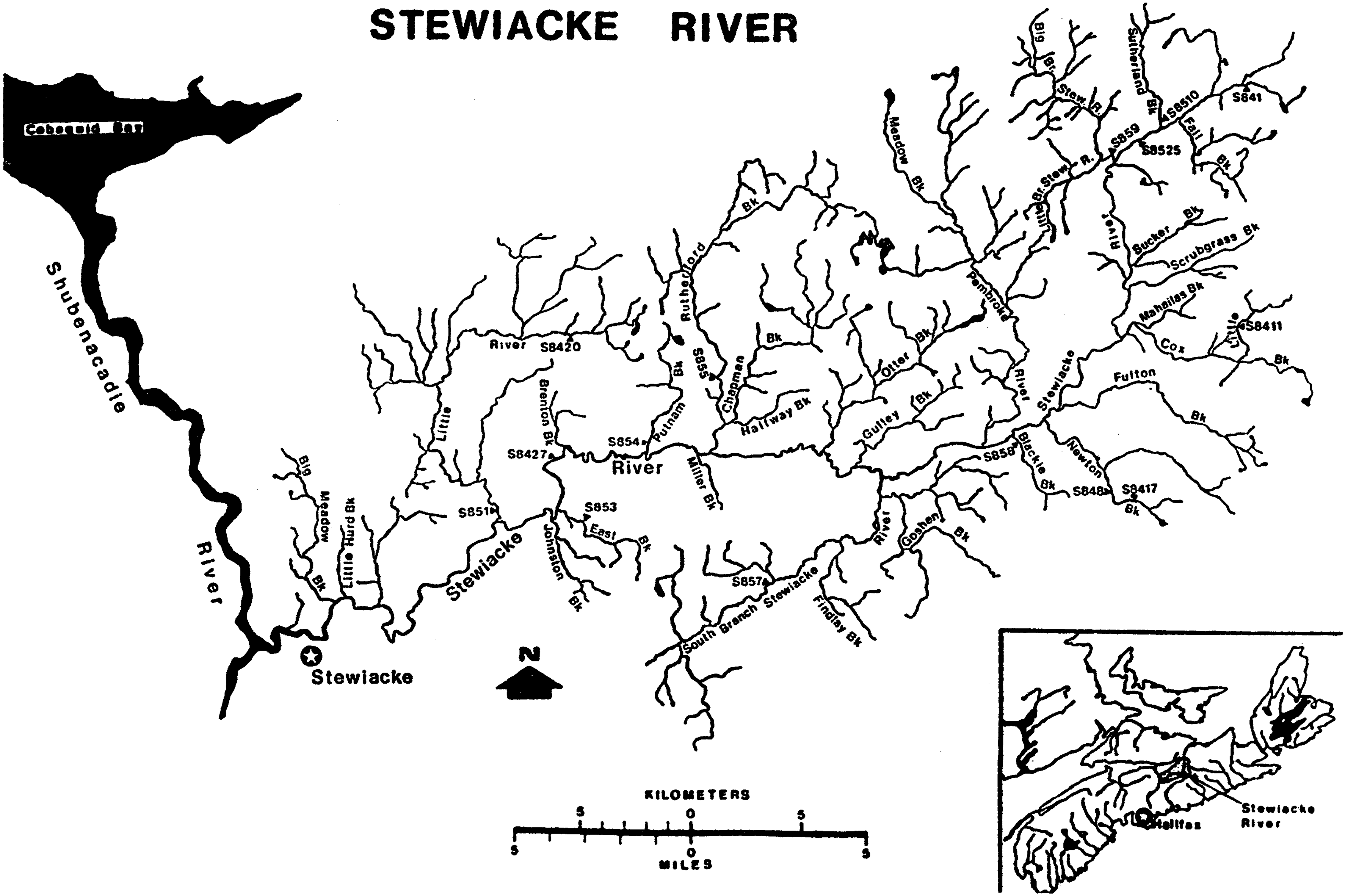

FIG. 1. Map of Stewiacke River and tributaries.

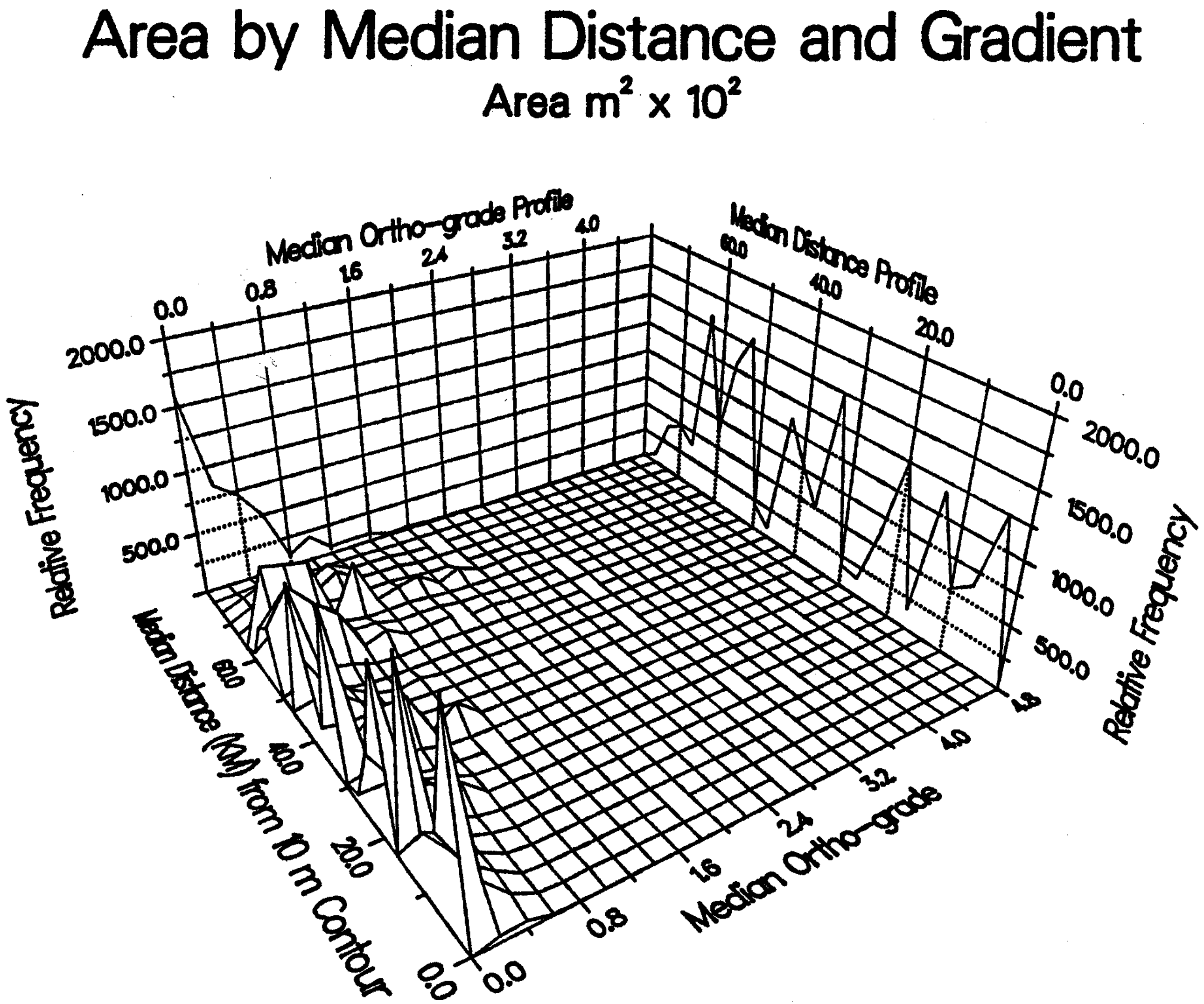

FIG. 2. Distribution of area (m² x 10²) by median value of percent ortho gradient intervals and distance intervals for the Stewiacke River. Profiles are integral values and voids in the surface grid correspond to locations of less than the required area for calculating the smoothed fit.

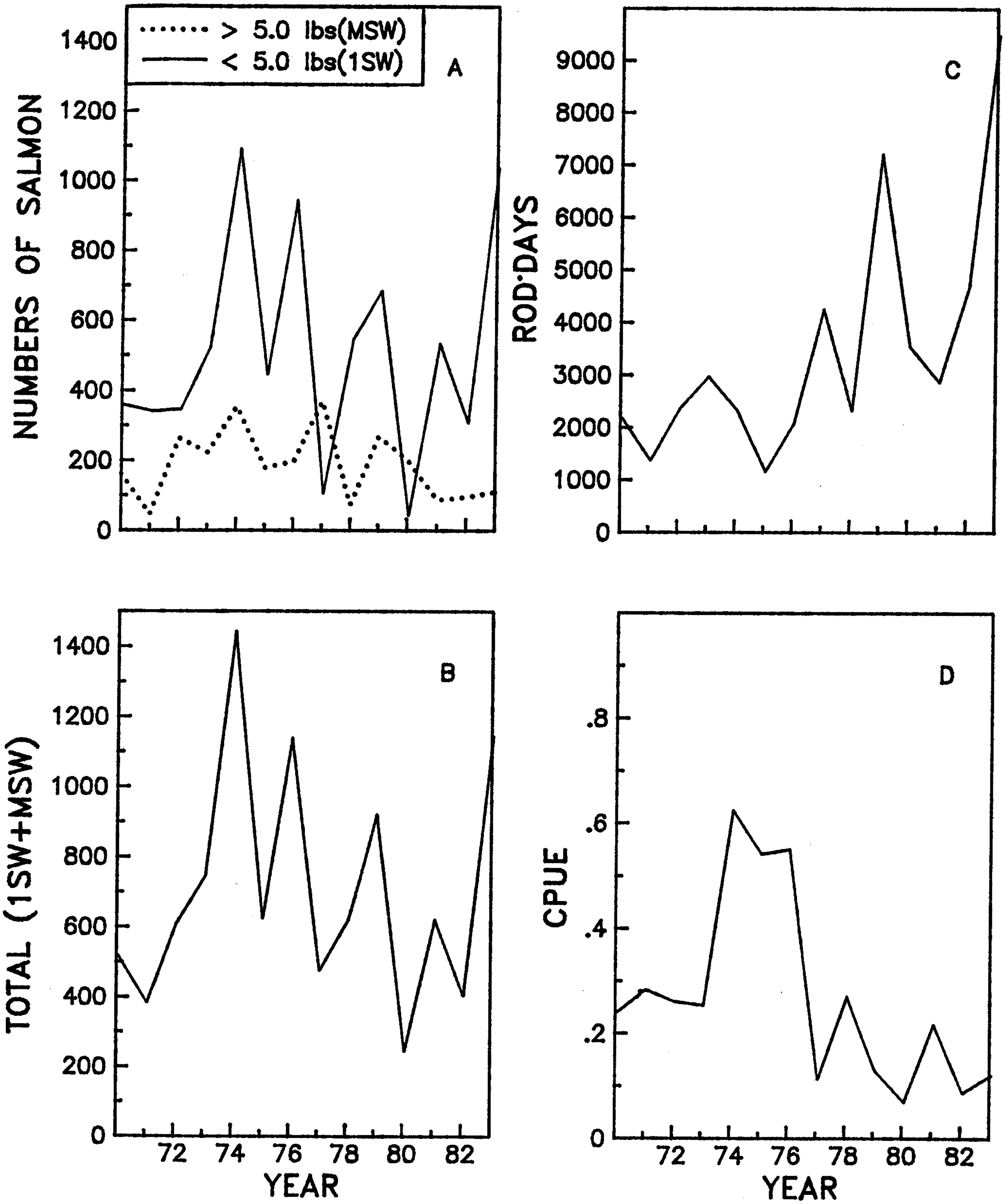

FIG. 3. Number of salmon > 5.0 lbs., < 5.0 lbs., (A); total number of salmon, (B); effort in rod days, (C); and catch per unit effort, (D); reported from the sport fishery in the Stewiacke River during 1970 to 1983.

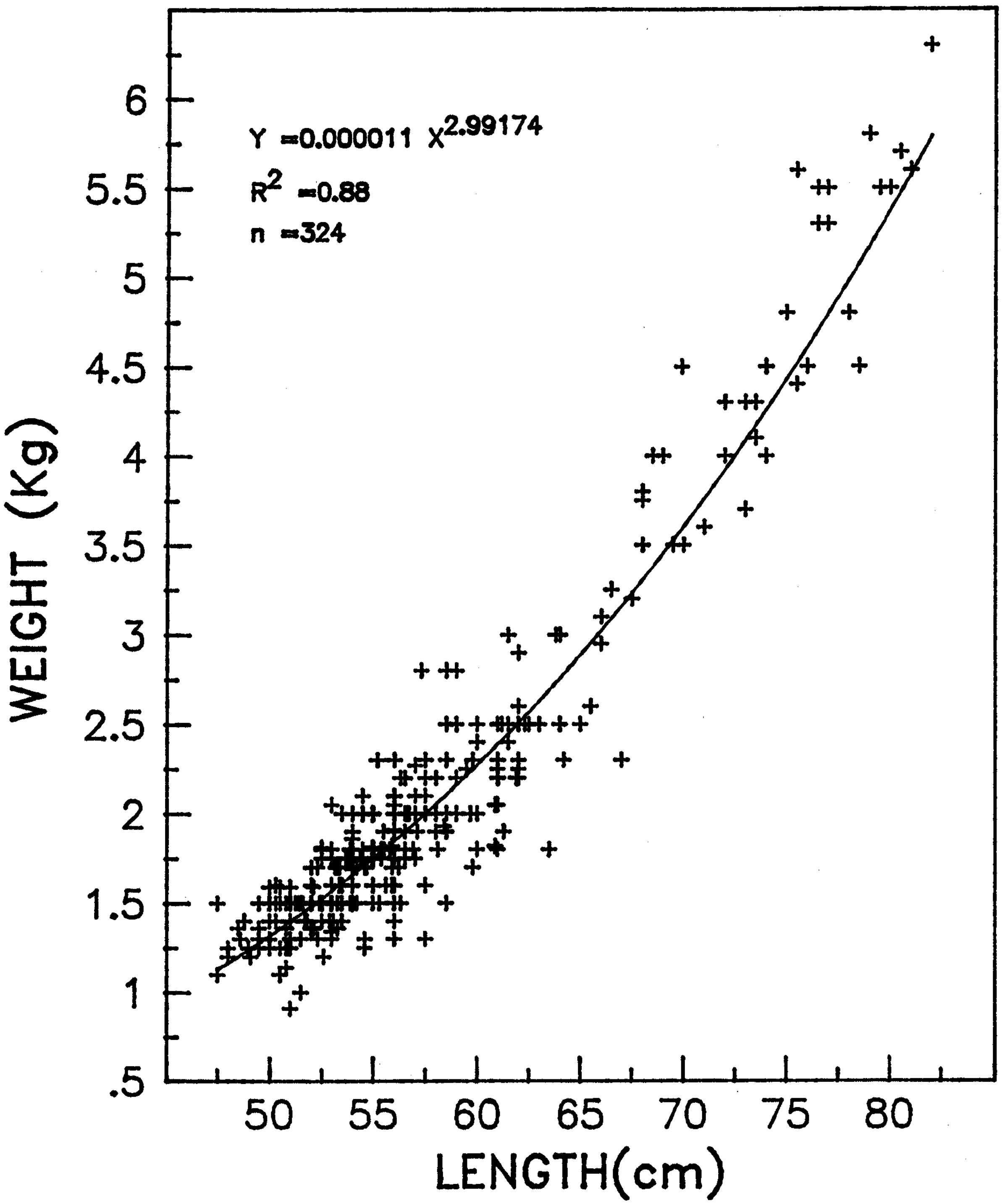

FIG. 4. Weight on length relationship for 324 Atlantic salmon collected from the Stewiacke River sport fishery and the commercial fishery of District 42 during 1984.

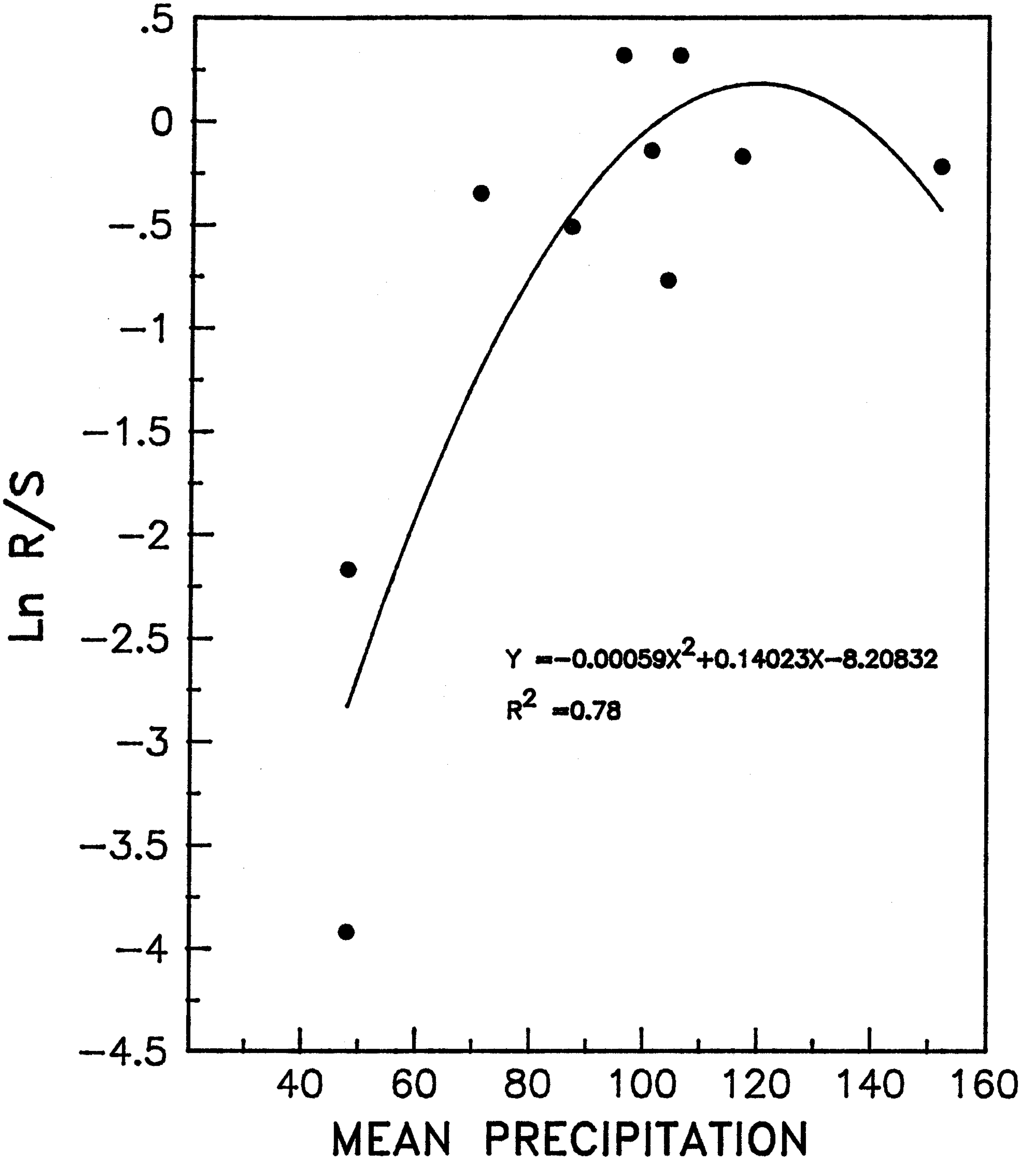

FIG. 5. Plot of Ln ratio of recruit eggs to spawner eggs and mean precipitation at Upper Stewiacke for the months of July to October in the year previous to smoltification of recruits.

APPENDIX 1. Age distribution, percent female, mean fork length, fecundity and contribution to potential egg deposition by one sea-winter and two sea-winter fish at first spawning as determined from all adult Atlantic salmon passing through the Big Salmon River counting fence, 1965 to 1973.

Total age after smolting	Spawning history	No.	% Female @ age	$\bar{x}$ length of females	$\pm$ SD	Fecundity @ age	% @ Age	Eggs·fish^{-1}	%
1SW									
1	0	1,659	66	52.9	3.9	2,503	50.0	825	25.0
2	1	673	67	63.1	4.5	4,169	20.0	558	17.0
3	1 2	483	81	71.9	4.5	6,473	14.0	734	22.0
4	1 2 3	189	92	78.1	4.1	8,826	6.0	487	15.0
5	1 2 3 4	45	100	83.1	4.8	11,333	1.0	113	3.0
6	1 2 3 4 5	7	100	83.5	4.4	11,562	0.2	23	0.7
7	1 2 3 4 5 6	1	100	88.0	---	14,479	0.7	4	0.1
	Totals	3,057					91.2	2,744	82.8
2SW									
2	0	132	89	71.6	5.3	6,377	4.0	227	7.0
3	2	115	86	77.5	5.1	8,565	3.0	221	7.0
4	2 3	25	92	81.6	5.0	10,514	1.0	97	3.0
5	2 3 4	5	80	81.6	7.7	10,514	0.1	1	0.2
	Totals	277					8.1	546	17.2
GRAND TOTALS		3,334					99.3	3,290	100.0

1 Table adapted from B. Jessop (in press)