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Similarities in Annual Recruitment of Atlantic Salmon to Sport Fisheries of Inner Bay of Fundy Rivers and Stock Forecasts for 1987

by

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ABSTRACT

Similarities in stock characteristics and annual recruitment to the Atlantic salmon sport fisheries were explored for six stocks (four random and two selected) of the inner Bay of Fundy. Patterns were similar for most stocks. Sea temperature did not improve the precipitation-modified stock-recruitment index for the Stewiacke River, N.S., but it did improve the sport fishery predictor for the Big Salmon River, N.B. Inter-correlation between the environmental parameters was explored and discussed. Forecast recruits to fisheries of the inner Bay of Fundy for 1987 were low.

RESUME

Les caractéristiques du stock et le recrutement annuel du saumon atlantique destiné à la pêche sportive ont été étudiés pour six stock (quatre choisis au hasard et deux sélectionnées) de la partie intérieure de la baie de Fundy afin d'en évaluer les ressemblances. La structure était la même pour la plupart des stocks. La température de la mer n'a pas réduit l'effet négatif des précipitations sur l'indice de recrutement dans la rivière Stewiacke (N.-E.), mais elle améliore les prévisions de la pêche sportive pour la rivière Big Salmon (N.-B.). Les corrélations entre les paramètres environnementaux ont été étudiées et discutées. Le recrutement prévu pour la pêche dans la partie intérieure de la baie de Fundy en 1987 est faible.

INTRODUCTION

Atlantic salmon stocks of the inner Bay of Fundy, Salmon Fishing Area (SFA) 22 and part of (SFA) 23, (Fig. 1) have been noted for their dissimilarity to salmon stocks of other (SFA's) in Maritime Canada (CAFSAC Adv Doc 83/23) (Anon. 1984). Unlike stocks in nearby SFA's recruits to the Stewiacke River, Nova Scotia and Big Salmon River, New Brunswick, have been shown to mature most always after one sea-winter (1SW; grilse) and can return for up to six consecutive spawnings (Ducharme 1969, Jessop 1986, Amiro and McNeill 1986).

Recruits·spawner^{-1} to the Stewiacke River, have been related to precipitation the summer previous to smoltification (Amiro and McNeill 1986). Water temperature in the Bay of Fundy has also been suggested as influencing the numbers of recruits (Ritter, unpublished thesis[1]). The possibility that one or both of these variables might enable forecasts of recruits to sport fisheries throughout these SFA's warranted further examination.

In light of the need to provide advice to managers for specific SFA's and of the unique nature of stocks in SFA 22 and part of SFA 23, this paper describes similarities between stocks and provides preliminary analysis in the forecasting of recruitment to the sport fisheries for rivers of the inner Bay of Fundy.

BACKGROUND

The inner Bay of Fundy, defined as northeast of a line from Harbourville, N.S., to St. Martins, N.B., (Fig. 2) contains 37 potential Atlantic salmon angling rivers (Table 1; Swetnam and O'Neil (1984), and O'Neil and Swetnam (1984) and O'Neil, et. al. (1986)). Catches of 1SW fish in Salmon Fishing SFA's 22 and 23 were 29% of the Nova Scotia, and 23% of the New Brunswick, 1SW provincial totals during 1983 to 1985 (S.F. O'Neil pers. comm.)[2].

The Stewiacke and Big Salmon rivers were selected for assessment as index stocks because of their stock sizes and availability of data. Stock characteristics documented for both rivers are similar except that the Big Salmon River however maintains an earlier run timing with 30% to 50% (1981-1985) of the sport catch recorded in July. Early entrants to the Stewiacke River are rare and consequently the angling season opens in August. Increased August catches from the Stewiacke, such as in 1983, may be associated with higher than-normal-August water levels.

In order to derive some indication of similiarity of the stocks in the inner Fundy, the recreational catches of salmon of the inner 37 rivers were classified as:
"A type", late-run, i.e., August and later, and/or comprised of grilse and "small"

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salmon (known to be repeat-spawning grilse on the Stewiacke and Big Salmon rivers); "B type", early-run, i.e., June and comprised of a few grilse and two-sea-winter salmon; or "C type", few or no catches recorded. There were 24 "A", 1 "B" and 12 "C" type stocks (Table 1).

In addition to the Stewiacke River and Big Salmon River (BSR) "index" stocks, four randomly selected "A-type" stocks with nearly complete recreational catch records for 1970 to 1985 (Table 2) were examined with correlation analysis using STAT80[1]. Attempts to streamline the grilse forecasting technique for the Stewiacke River (Amiro and McNeill 1986) included analysis of precipitation and discharge data (Table 3) for key month(s) of the pre-smolt stage, removal of the commercial component in the recruits, and elimination of the stock side of the recruitment function.

RESULTS

Sport catches of grilse, 1970 to 1985, of the two selected and four randomly chosen rivers (Table 2) were, when ranked, in phase and generally significantly correlated (Table 3). Correlations were higher for the Stewiacke and somewhat lower for BSR. Catches showed no trend for the years 1970 to 1985.

Stewiacke Recruitment

The sport-catch-based recruitment model for Stewiacke River (Amiro and McNeill 1986) was recalculated using only recruit eggs derived from the numbers of grilse in the angling fishery excluding the grilse harvested in the commercial fishery. Spawner eggs were derived the same as before, i.e., eggs of repeat spawners (salmon) and grilse angled in years proportionate to age at smoltification and contributing to a recruit year (grilse catch). Regression of $\log_e$-transformed recruit eggs$\cdot$spawner^{-1} eggs (Ln Rs/S), 1975 to 1984, (Table 4) with $\log_e$ transformed average July to October precipitation (Table 5) (1973 to 1982) at Upper Stewiacke was significant ($p=0.006$, $r^2=0.625$, Figure 3).

The resulting equation was;

(1) $Y=2.34\ X\ -11.52$

where Y=Ln(Recruit eggs sport grilse/Spawner eggs (yr i)

X=Ln(Average precipitation July to October (yr i-2)

Standard error of the estimate was 0.718.

A simplified approach relating sport-caught grilse (1970 to 1985) to $\log_e$-transformed average July to October monthly precipitation (1968 to 1983) was also significant ($p=0.013$, $r^2=0.369$).

Average July to October precipitation at Upper Stewiacke for the year previous to smoltification (yr i-2 of recruits) and May to July sea surface temperatures at St. Andrews, N.B. (yr i-1 of recruits) (Table 6) regressed upon Ln Rs/S (Table 4) $\log_e$ transformed ratios of recruit eggs$\cdot$spawner^{-1} eggs as well as upon the numbers of grilse in the sport fishery provided similar results.

Transformed precipitation values were significantly positively correlated with Ln Rs/S for the months July and August ($p=0.024$ and $p=0.052$, Table 7). Numbers of angled grilse were correlated only with July precipitation ($p=0.046$).

1 STAT80, Release 2.9k, January 1985, P.O. Box 510881, Salt Lake City, Utah 84151.

Sea surface temperatures (SST) were significantly negatively correlated with Ln Rs/S for the months of May ($p=0.023$) and June ($p=0.012$), but not with July ($p=0.077$). Similar results were found with angled grilse -- June showing the highest correlation ($p=0.005$, Table 7).

Multiple Effects Model (Stewiacke)

Because intercorrelation between the two environmental variables with the highest correlations, Ln July precipitation (yr i-2) and June sea surface temperature (yr i-1) was not significant ($p=0.080$), multiple effects recruitment models were examined using stepwise multiple regression.

Recruits·spawner-1 (Ln Rs/S) analysis proceeded with June temperature ($p=0.012$, $r^2=0.569$) and then with Ln July precipitation ($p=0.044$, $R^2= 0.590$). Partial F-test indicated the addition of the second independent variable was not significant ($p=0.570$).

Recruitment (angled grilse) analysis proceeded with June temperature ($p=0.005$, $r^2=0.443$) and continued with Ln July temperature ($p=0.012$, $R^2=0.493$). Partial F test indicated the addition of the second variable was not significant ($p=0.278$).

Big Salmon River Recruitment

Discharge data from the nearby Point Wolfe River (PW) (Table 5) was used as surrogate for environmental conditions affecting survival of pre-smolts which recruited to BSR sport catch in yr i+2. Sea surface temperatures at St. Andrews N.B., in yr i-1 (the smolt year) were used to index effects of the marine environment.

Correlations between BSR angled grilse (1970 to 1985) and $\log_e$ transformed June to October PW discharges (1968 to 1983) indicated that only the month of September was significantly ($p=0.005$) correlated (Table 8).

Correlations between BSR angled grilse and sea surface temperatures (1969 to 1984) for the months May to July, yr i-1, indicated only the month of July ($p=0.055$) was significantly negatively correlated (Table 8).

Multiple Affects Model (Big Salmon)

Because intercorrelation between the two independent variables, Ln September PW discharges (yr i-2) and July sea temperatures (yr i-1) was not significant ($p=0.495$), stepwise multiple regression was used to develop a sport recruitment model.

The analysis proceeded with Ln September PW discharge ($p=0.005$, $r^2=0.453$) and continued with July temperature ($p=0.003$, $R^2=0.591$). Partial F test indicated the addition of the second variable was marginally significant ($p=0.057$).
The resulting equation was,

(2) $Y=180.0 X_1 - 134.1X_2 + 1905.1$

where Y=Big Salmon River grilse sport catch (yr i-1)
X_1=Ln September Point Wolfe discharge (yr i-2)
X_2=July sea surface temperature (yr i-1)

Standard error of the estimate was 156.6.

FORECASTS

Forecast numbers of grilse to be angled in the Stewiacke sport fishery by equation (1) were 232 in 1986 and 218 in 1987.

Forecast numbers of grilse to be taken in the Big Salmon river sport fishery by equation (2) were 394 in 1986 and 69 in 1987.

DISCUSSION

Atlantic salmon stocks of the inner Bay of Fundy generally consist of late-run grilse and repeat spawners. Annual fluctuation of the sport catches of grilse in the selected sample rivers were, in total well, correlated. However, the Big Salmon river stock was somewhat different in timing of the first entrants.

These similarities and correlations were possibly influenced both positively, i.e., catch reports for most of the rivers were compiled through a central office and could be subject to records or impressions of core rivers, and negatively, i.e., the operation of a fish counting fence at the head of tide on the BSR, 1964 to 1973 influenced the timing of entry of fish as well as the locations of captures.

The Stewiacke recruit$\cdot$spawner^{-1} precipitation model was not significantly affected by exclusion of the commercial grilse catch. While this bodes well for continued use of the model in years without a commercial fishery, other problems aggravate the relationship. Recruits were calculated from observer/reporter estimates of catch, a system replaced in 1984 by license stub-returns which are thought to have increased the Stewiacke estimated catch by 47.5%. Analysis presented here utilized the last of the available observer/reporter estimates.

While the Stewiacke recruit model for sport-caught grilse, dependent on either precipitation or sea temperature, was based on more years and had a higher statistical probability, it did not account for as much of the observed variation as the recruit$\cdot$spawner^{-1} model. Inclusion of two environmental variables, for BSR, approached the significance of the Stewiacke recruit$\cdot$spawner^{-1} egg model. The BSR two parameter model, links for the first time mechanisms within freshwater and marine environments which have major affects on the numbers of grilse caught and assumed available.

Lack of correlation between the residuals of either the Stewiacke recruit$\cdot$spawner^{-1} or sport caught grilse recruit models and June to October discharges for the Musquodoboit River (an adjacent drainage with discharges correlated to precipitation at Upper Stewiacke) in the year of recruitment supports the assumption that catches are indicative of the quantity of grilse available rather than of highly variable exploitation rates possibly dependant on water levels. It seems that the precise timing of entry into a river may be dependant on water levels but the fish eventually enter and a significant proportion are caught. It is possible that most of the catchable portion is removed in a relatively short period.

Recruitment models modified by environmental affects are generally impossible to control experimentally. The possibility of spurious relationships when using multiple independent variables is reason for cautious interpretation. However, the use of both the Stewiacke and BSR models is supported by the sample size (up to 16 years), the uniformity in the direction of effects and the logical plausibility of the mechanisms.

Annual survival rates of parr and marine survival have been suggested as the parameters most affecting yield of Atlantic salmon (Evans and Dempson, 1986). Behaviour of juvenile Atlantic salmon has been observed to be altered by water level and by temperature (Keenleyside and Yamamoto 1962; Saunders & Gee 1964; Gibson 1978). Therefore discharge or precipitation, both of which are functionally related to water level (Dunne & Leopold, 1978), may be indicators of survival potential at sensitive stages which substantially influence recruitment.

Marine survival of Big Salmon river smolts is reported to range from 1.0% to 16.7% (Jessop, 1986). While these values may have been affected by tagging and handling at the counting fence, they may also indicate the impact of the marine environment. Water temperature during the early weeks of marine migration has many possible mechanisms that could affect survival at what is likely the most sensitive time in the marine phase. Temperature may regulate primary production at lower trophic levels indirectly governing food supply and survival of smolts. Temperature could also influence the type, distribution, density, timing or duration of exposure to predators and/or competitors. Factors affecting the survival of salmon during the summer previous to smoltification and early post-smolt stages have the potential to substantially alter the number of recruits. If sea temperature and precipitation were correlated such that survival was not counter-balanced in the relationship then extremes in the numbers of recruits results.

Although intercorrelation between July precipitation in yr i-2 and June sea surface temperature yr i-1 of recruits was not significant, total June to October precipitation lagged one year was negatively correlated with total May to August sea surface temperature. Similarly total Musquodoboit discharge for the months June to October lagged one year was significantly negatively correlated with total May to August sea surface temperature ($r=-0.506$, $p=0.046$). Total discharge for the Point Wolfe River against SST was negative in sign but not quite significant ($r=-0.464$, $p= 0.071$). Total precipitation at Upper Stewiacke was significantly positively correlated with total discharges at Musquodoboit ($r=0.881$, $p=0.000$) and Point Wolfe ($r=0.764$, $p=0.001$). Musquodoboit and Point Wolfe total discharges were also correlated ($r=0.667$, $p=0.005$).

The negative correlation of annual recruitment with sea surface temperatures and positive correlation of annual recruitment with precipitation or discharge and the significant negative relationship between the sea surface temperature and discharge indicate a "boom or bust" scenario. This pattern is exhibited in the grilse angling data for rivers of the inner Bay of Fundy. The only moderating factor is the magnitude of the spawning escapement, i.e., the stock side of the stock recruitment relationship which may offset harsh environmental conditions.

Correlations between environmental factors and recruitment in and about the inner Bay of Fundy indicate a hypothesis that annual weather patterns control a significant portion of the variation in annual recruitment.

The 1987 forecasts for grilse returns to Stewiacke and Big Salmon rivers are lower than average. This pertains on the Stewiacke in spite of a rather high index of spawners contributing to the 1987 recruit year. However, as noted by Amiro and McNeill (1986), low precipitation in 1985 did not occur until September and this may not impact to the degree forecast by the model. Analysis presented here would suggest July and August low precipitation has the greatest negative impact on recruitment to this river.

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TABLE 1. Rivers of "Inner" Bay of Fundy for which some historical Atlantic salmon angling has been reported. Salmon stocks have been classified as: A, late run predominately grilse and repeat spawners; B, early-run, predominately two-sea-winter, few repeat spawners, and; C, unknown, i.e., little or no reported catches.

River	A	B	C
Cornwallis	X		
Gaspereau (Kings Co.)		X	
St. Croix (Hants Co.)	X		
Kennetcook	X		
Shubenacadie	X		
Stewiacke	X		
Salmon (Colchester Co.)	X		
North (Colchester Co.)	X		
Chiganois	X		
Debert	X		
Folly	X		
Great Village	X		
Portapique	X		
Bass (Colchester Co.)	X		
Little Bass	X		
Economy	X		
Harrington	X		
Diligent			X
Apple	X		
River Hebert	X		
Maccan	X		
Napan (Cumberland Co.)			X
Tantramar			X
Demoiselle			X
Crooked Creek			X
Shepody			X
West (Albert Co.)			X
Alma	X		
Point Wolfe	X		
Coverdale			X
Turtle Creek			X
Weldon Creek			X
Pollett	X		
Petitcodiac	X		
Big Salmon[a]	X		
Irish			X
Mosher (Saint John Co.)			X

[a] Early and late run grilse present.

TABLE 2. Sport catch of grilse ($\leq$ 5.0 lb or 2.3 kg) for six rivers of the inner Bay of Fundy, 1970 to 1985.

Year	Debert	Shubenacadie	North (Col.)	Folly	Big salmon	Stewiacke
1970	2	24	4	16	231	355
1971	61	57	24	73	191	337
1972	17	6	5	31	182	343
1973	68	46	3	N.A.	378	520
1974	84	126	51	196	373	1,087
1975	60	50	16	61	187	442
1976	61	235	77	87	664	940
1977	17	7	28	15	200	104
1978	154	23	121	303	360	554
1979	38	60	14	77	932	681
1980	11	6	5	11	5	41
1981	14	176	24	62	645	531
1982	85	45	103	132	456	307
1983[a]	370	175	387	502	304	1,033
1984[a]	42	44	53	47	351	381
1985[a]	61	183	72	65	278	1,000

[a] Based on license stub return data. Previous to 1983 based on DFO, Conservation and Protection Branch data.

TABLE 3. Spearman rank correlation coefficients for sport catches of grilse between six rivers of inner Bay of Fundy for the years 1970 to 1985.

Variable Y Variable X	Corr Coef	Df	P(2-Tail)
Stewiacke			
Year	.275	13	.321
Debert	.508	13	.053
Shubenacadie	.711	13	.003
North (Col.)	.490	13	.064
Folly	.625	13	.013
Big Salmon	.532	13	.041
Big Salmon			
Year	.303	13	.271
Debert	.338	13	.218
Shubenacadie	.613	13	.015
North (Col.)	.461	13	.084
Folly	.621	13	.014

TABLE 4. Stewiacke River stock eggs and recruit eggs to sport and commercial fisheries, recruit eggs to the sport fishery only for recruits less than 2.3 kg, logarithm of recruits • spawner^{-1} eggs and logarithm of average July to October precipitation at Upper Stewiacke.

Rec year	Stock eggs $\cdot 10^3$ (S)	Recruit sport+com $\cdot 10^3$ (Rs+p)	Recruit Sport Eggs $\cdot 10^3$ (Rs)	Ln (Rs/S)	Ln Avg. Precip
75	1,104	963	961	-.1387	4.6151
76	1,693	2,332	2,043	.1879	4.5643
77	2,118	243	226	-2.2377	3.8712
78	3,618	2,555	1,184	-1.1170	4.2627
79	2,445	2,056	1,480	-.5020	4.7622
80	2,811	56	89	-3.4527	3.8712
81	2,245	1,794	1,154	-.6655	5.0239
82	1,788	1,078	667	-.9861	4.4659
83	2,442	3,356	2,254	-.0801	4.6634
84	1,577	731	435	-1.2879	4.6444
85	1,575		691[1]		4.2341
86	1,285		685[1,2]		4.5433
87	2,494				4.2341

1. Not included in regression.
2. Based on stub return data, previous to 1985 based on DFO, Conservation and Protection Branch data.

TABLE 5. Mean monthly precipitation (mm) at Upper Stewiacke for June to October for the years 1968 to 1983 (A); mean monthly discharges (cms) for Musquodoboit River, 1968-1983 (B); and mean monthly discharges (cms) for the Point Wolfe River, 1968-1985 (C).

Year	June	July	August	September	October
			-A-		
68	98.3	18.0	90.7	57.2	72.1
69	36.8	69.6	58.7	80.0	82.0
70	92.7	189.0	154.7	66.5	102.6
71	30.5	79.0	326.6	29.2	54.4
72	112.5	141.7	75.9	65.5	199.4
73	160.5	151.4	110.2	40.9	70.9
74	55.9	106.9	54.6	126.7	101.1
75	25.1	28.4	14.7	101.6	81.8
76	42.2	46.2	51.0	114.6	156.0
77	125.1	129.7	82.5	137.1	140.6
78	95.3	54.7	28.9	60.1	136.0
79	55.1	164.1	177.9	112.7	160.5
80	70.4	116.0	45.4	100.8	118.2
81	119.2	132.8	67.2	118.1	155.8
82	74.0	110.8	100.4	101.2	29.4
83	46.2	177.9	193.4	80.2	57.8
84		57.0			
85		53.0			
			-B-		
68	10.40	4.05	.71	1.26	1.50
69	6.56	1.63	1.60	.58	2.70
70	16.70	12.40	18.20	14.50	15.70
71	9.57	3.95	71.90	10.40	7.26
72	29.20	10.90	15.60	2.82	29.50
73	22.10	14.20	31.60	3.16	1.60
74	16.30	8.71	2.15	8.88	22.00
75	4.66	.60	.26	.46	10.60
76	3.58	3.60	3.84	13.80	26.40
77	22.60	11.30	18.90	12.30	37.30
78	7.43	4.07	.61	.81	12.70
79	21.10	7.28	19.00	6.75	26.90
80	4.28	4.76	1.46	3.55	15.30
81	21.70	12.90	9.27	6.70	20.10
82	4.63	7.64	12.80	10.20	2.96
83	12.60	19.40	29.70	8.63	4.55
			-C-		
68	4.18	1.04	.49	.50	3.39
69	3.27	4.49	2.07	1.84	2.55
70	3.42	4.03	2.47	3.88	6.54
71	2.17	1.51	3.28	1.82	4.59
72	7.04	3.99	2.89	1.83	7.98
73	4.53	8.05	6.80	1.00	.67
74	4.34	3.42	.82	2.69	5.39
75	2.69	1.51	.66	1.77	3.46
76	1.52	6.83	2.98	4.04	8.06
77	10.40	2.34	2.61	5.09	12.30
78	3.60	1.05	.39	.46	3.05
79	3.90	4.77	6.96	7.25	6.33
80	2.11	2.52	1.20	1.77	4.40
81	7.58	2.39	3.03	1.22	19.70
82	2.23	3.50	3.89	3.42	1.19
83	4.43	1.63	4.50	1.49	3.68
84				1.60	
85				0.33	

TABLE 6. Mean monthly water temperature (C°) taken twice daily at St. Andrews, N.B., DFO wharf, 1969 to 1984.

-A-

Year	May temperature	June temperature	July temperature
69	6.8	9.9	12.1
70	8.2	10.1	13.3
71	7.8	10.5	13.4
72	7.1	10.2	12.0
73	6.9	9.1	12.3
74	6.2	9.8	12.3
75	6.3	9.3	11.9
76	8.9	11.8	13.9
77	6.6	10.5	11.9
78	7.5	9.9	12.3
79	7.9	10.8	12.7
80	6.8	9.3	11.5
81	7.3	9.8	12.6
82	7.2	9.6	12.0
83	7.9	11.0	12.0
84	6.7	10.2	12.6
85	-	8.7	11.9
86	-	9.4	12.2

TABLE 7. Pearson correlation coefficients between $\log_e$ transformed ratio of recruit eggs·spawner-1 eggs (Ln Rs/S); numbers of grilse in the Stewiacke sport fishery and $\log_e$ transformed, June to October mean precipitation at Upper Stewiacke (yr i-2); May to July sea surface temperature (yr i-1).

Variable Y (Years) Variable X	Corr	Df	P(2-Tail)
Ln Rs/S (75-84)			
Ln Jun precip.	.307	8	.387
Ln Jul precip.	.700	8	.024
Ln Aug precip.	.627	8	.052
Ln Sep precip.	.285	8	.425
Ln Oct precip.	.050	8	.892
Stewiacke grilse (70-85)			
Ln Jun precip.	.206	14	.444
Ln Jul precip.	.505	14	.046
Ln Aug precip.	.357	14	.175
Ln Sep precip.	.227	14	.398
Ln Oct precip.	.258	14	.335
Ln Rs/S (75-84)			
May temp.	-.705	8	.023
Jun temp.	-.754	8	.012
Jul temp.	-.583	8	.077
Stewiacke grilse (70-85)			
May temp.	-.584	14	.018
Jun temp.	-.666	14	.005
Jul temp.	-.472	14	.065

TABLE 8. Pearson correlation coefficients between grilse caught in the sport fishery in the Big Salmon River, N.B. and monthly river discharge in the nearby Point Wolfe River (yr i-2) and sea temperatures at St. Andrew's (yr i-1).

-A-

Variable Y Variable X	Corr	T	Df	P(2-Tail)
BSR grilse angled				
May Temp	-.297	-1.165	14	.263
Jun Temp	-.196	-0.749	14	.466
Jul Temp	-.488	-2.090	14	.055
Jun PW disch.	.477	2.031	14	.062
Jul PW disch.	.032	0.118	14	.907
Aug PW disch.	.168	0.638	14	.534
Sep PW disch.	.669	3.371	14	.005
Oct PW disch.	.375	1.513	14	.153

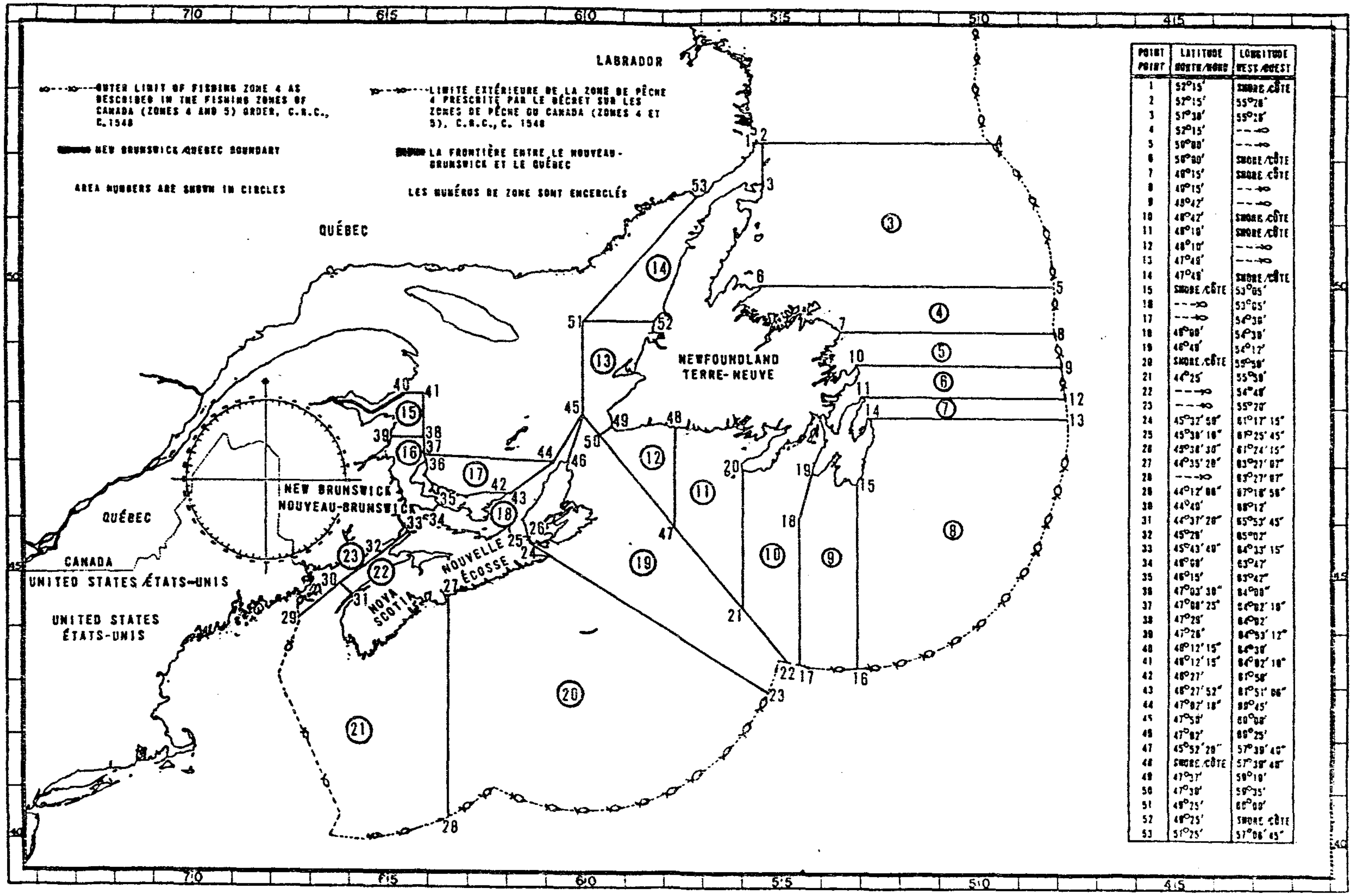

Fig. 1. Atlantic Salmon Fishing Areas.

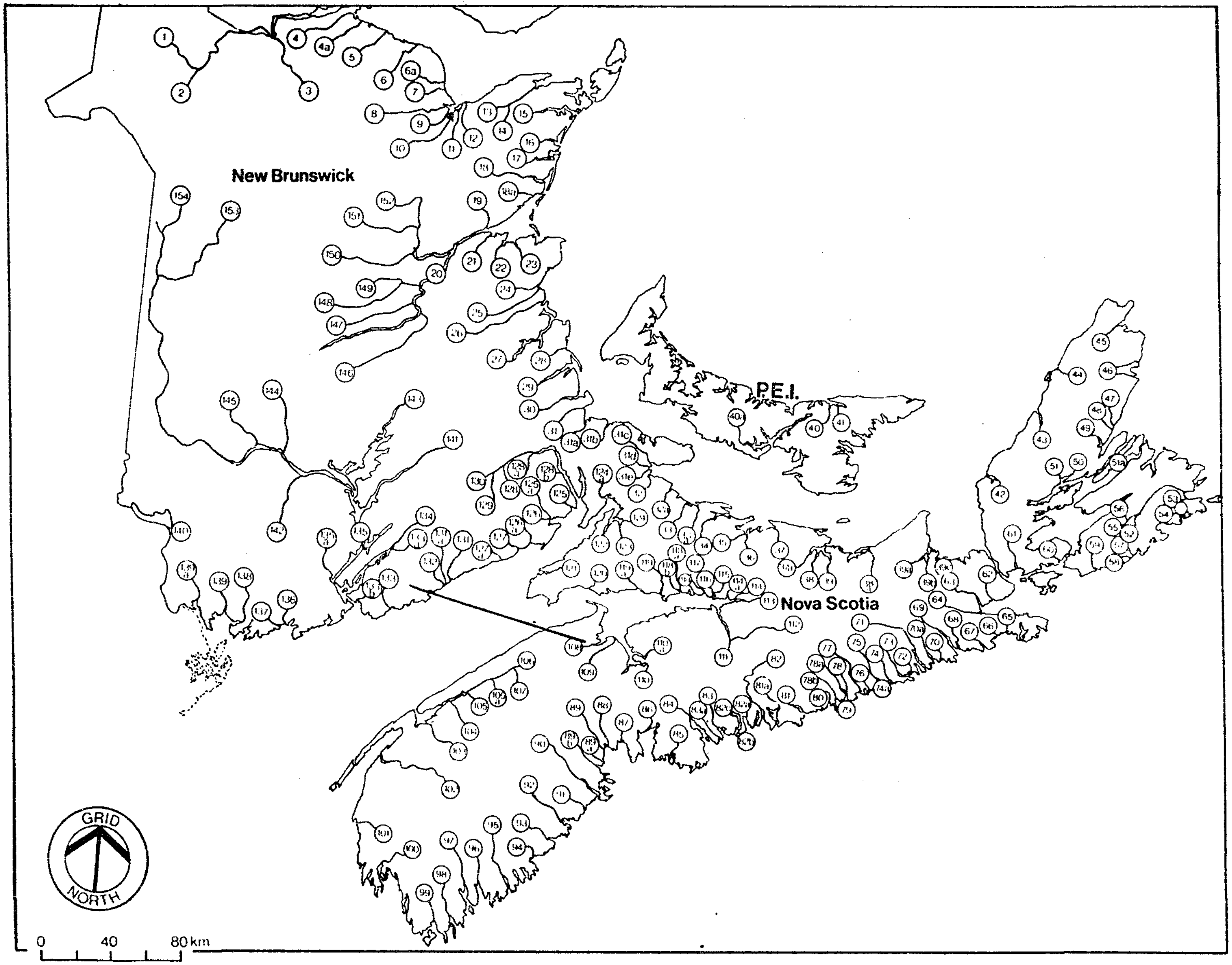

FIG. 2. Atlantic salmon angling rivers, Maritime Provinces.

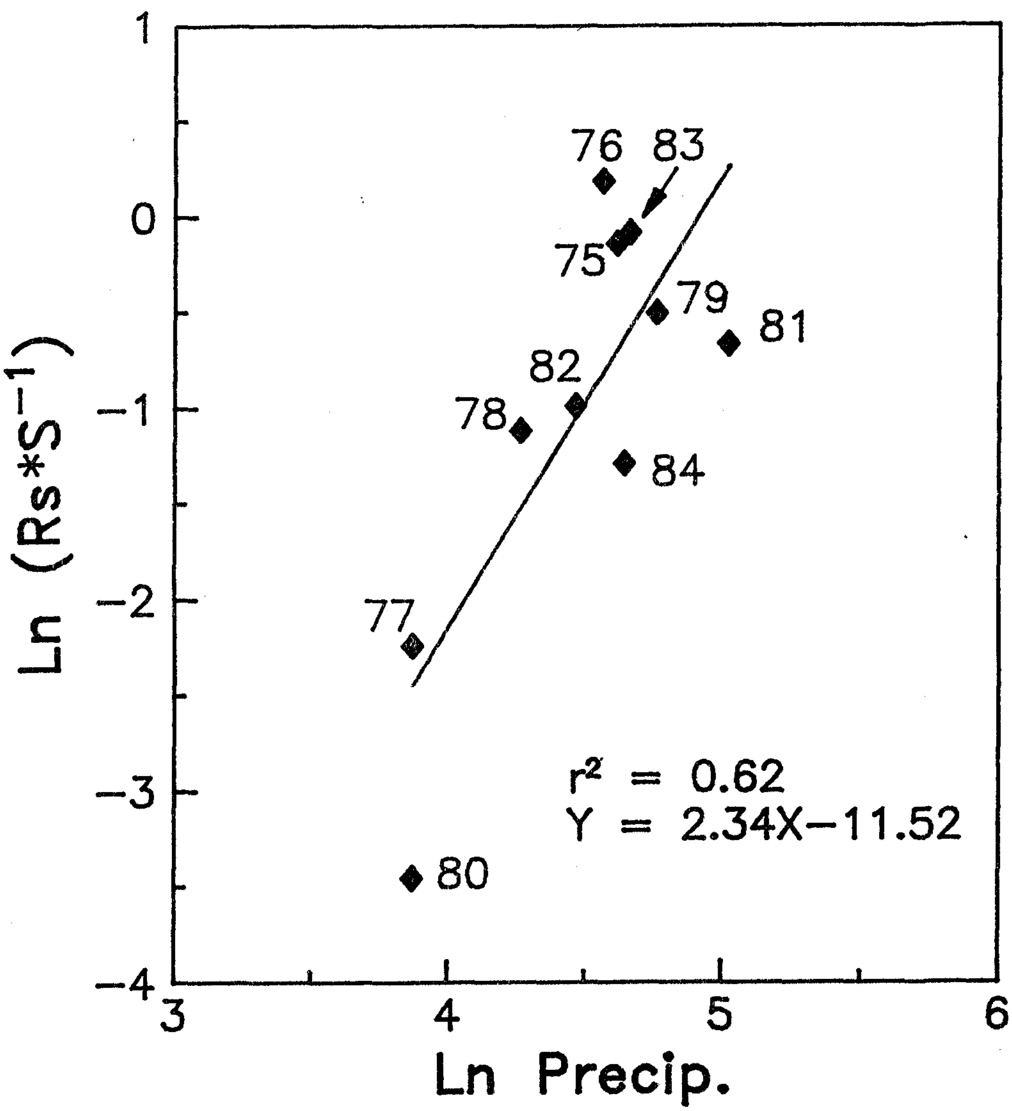

Fig. 3. Stewiacke, recruit–eggs per spawner egg (indexed from sport catch) on July–Oct. average precipitation.