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A method to estimate potential 2-SW salmon harvest in Fishery Statistical Districts 1, 2, 3, and 7 of Cape Breton Island, Nova Scotia

by

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Abstract

In the absence of predictive models for returns of Atlantic salmon stocks to Cape Breton Island, correlation analyses were conducted on the estimated numbers of 2-SW fish in 12 fisheries of Cape Breton and Northumberland Strait, Nova Scotia and on the number of 2-SW fish monitored at the Millbank trapping facility, Miramichi River, New Brunswick. Six significant correlations led to the derivation of predictive equations for 2-SW fish in four Fishery Statistical Districts of Cape Breton, in year n+1, given the number of 1-SW fish counted at Millbank in year n.

Résumé

En l'absence de modèles prévisionnels des retours de saumons atlantiques au Cap-Breton, nous avons fondé notre analyse sur les nombres estimés de poissons de 2 hivres en mer dans 12 pêches du Cap-Breton et du détroit de Northumberland (Nouvelle-Ecosse) et sur le nombre de poissons de 2 hivers en mer dénombrés à la trappe de Millbank, sur la rivière Miramichi (Nouveau-Brunswick). Six corrélations significatives permettent de construire des équations prévisionnelles pour le saumon de 2 hivers en mer dans quatre districts statistiques du Cap-Breton, en l'année n+1, connaissant le nombre de poissons de 1 hiver en mer dénombrés à Millbank en l'année n.

Introduction

Stock-recruitment relationships have not yet been demonstrated for Atlantic salmon from Nova Scotia rivers of the Gulf of St. Lawrence and Cape Breton. Measures of abundance of adult salmon in these waters are limited to sport and commercial catch statistics. Fry and parr data have yet to be shown useful in estimating future adult returns to fisheries. No 1-SW stocks of Cape Breton rivers indirectly measurable in either the sport or commercial fisheries are useful in estimating 2-SW returns to those fisheries in the next year. This paper extends a previously demonstrated correlation between the numbers of 2-SW fish at Millbank on the Miramichi River, New Brunswick, and catch/effort for commercial fisheries of Inverness County, Cape Breton (Marshall,1982). The purpose is to indicate the potential utility of 1-SW counts at Millbank in estimating commercial harvests of 2-SW fish in specific Fishery Statistical Districts of Gulf of St. Lawrence and Cape Breton, Nova Scotia, (Fig. 1) in the following year.

Methods

Analysis was restricted to the data for years 1971-81 for which correlations have been established between 1-SW fish in year n and 2-SW fish in year n+1 at Millbank.

Selection of an appropriate index of stock abundance in the Nova Scotia commercial fisheries was determined from four sequential preliminary correlation analyses of (1) catch/effort (kg/unit-day), (2) total weight, (3) total numbers, and (4) estimated numbers of 2-SW fish harvested from each of Districts 1-9 and 12-13 in year n+1 on the number of 1-SW fish captured at Millbank in year n, 1971-81. There is no fishery for salmon on the Northumberland Strait of Nova Scotia to the west of District 12 (Fig. 1). In all cases, values of the correlation coefficient progressively increased with each trial. Thus, only estimates of 2-SW fish were used in subsequent analysis.

Numbers of 2-SW fish taken in each gear-type in each Fishery District were estimated by assuming average weights of 1.8, 4.5 and 8.2 kg for 1-SW, 2-SW and 3-SW salmon, respectively, and solving two equations for two unknowns so as to exclude both 1-SW fish (mean weight of District landings < 4.5 kg) and 3-SW fish (> 4.5 kg). Decisions on use of data from different gear types (salmon trap and salmon gillnets) singly or combined and inclusion/exclusion of by-catch within a District were also assessed by correlation analysis of landings in proximate Districts.

Predictive equations were derived assuming a multiplicative log-normal distribution of random noise, i.e., higher absolute variation in total adult returns as abundance of seaward migrants increases (Peterman 1981).

Results

Estimates of the numbers of 2-SW fish landed each year in Fishery Districts 1-9 and 12 and 13 appear in Table 1. At 4.5 kg/fish, the 2-SW fish account for 57% (District 9) to 94% (District 4) of the total landings by weight (Table 1).

Correlation analysis of data in Table 1 indicates significant correlations (Table 2) between 2-SW landings of:

District	with	District(s)
12		13
3		2,1,6,7
2		3,1,7
1		3,2,4,6,7
4		1,9
6		3,1,7
7		3,2,1,6
9		4

As well, landings of 2-SW fish at Millbank were significantly correlated with those of Districts 12, 3, 2, 1 and 7. Combined sport landings of 2-SW fish from North, Baddeck, and Middle rivers (District 4) were also correlated with Districts 12, 13, 3, 9 and Millbank. Two-sea-winter fish from the Margaree were correlated with those of Districts 12 and 13 and North-Baddeck-Middle.

Of Districts 12, 3, 2, 1, 7 and North-Baddeck-Middle which were significantly correlated with 2-SW fish at Millbank, only Districts 3, 2, 1 and 7, either separately or combined, were correlated ($p<.05$) with 1-SW fish at Millbank in the previous year (Table 3).

Discussion

Analysis leading to the selection of numbers of 2-SW fish as an index of abundance suggested that incorporation of effort data for a complete fishing season did not contribute to a better index of stock strength. This result may be because fixed-gear salmon fishermen are attuned to their own indexes of stock abundance and can easily shift fishing effort from salmon during times of low abundance to other concurrent inshore fisheries (principally lobsters and cod) by tying up or removing their salmon gear.

The inclusion of 1981 data for which the effective commercial season was 15-20 days less than in previous years was done only after correlation coefficients for the years 1972-80 had been found to be insignificantly higher. Experience with another Gulf stock (Miramichi) in 1981 had already indicated lower than predicted 2-SW returns which could have accounted for a slight decline in r values in the current analysis. Inclusion of 1981 data gave validity to forecasting 1982 estimates for either a regular or similarly abbreviated salmon season.

If the count of 1-SW fish at Millbank, 1981, was unaffected by estuarial dredging activities, estimates of 2-SW harvests in Districts 1, 2, 3 and 7, singly or combined, in 1982 point to an increase over 1981. Total landings would be down 20%, while landings in Districts 1 and 2 would be about 15%, and those of Districts 3 and 7 would be about 35%-45%, below the 10-year means.

If, however, dredging did affect the capture of 1-SW fish at the Millbank trap, as might be suggested by the high 1-SW landings in the 1981 sport fishery (Province of N.B. estimate) relative to the low numbers recorded at Millbank, it is possible that the 2,228 1-SW fish count is an underestimate of the count if there had been no dredging. In fact, the 1981 Miramichi assessment had assumed before provincial angling data were available that the catch efficiency of Millbank, 1981, of 2-SW salmon was only about 50% of that of other years. Hence, a correction for Millbank based on the correlation of 1-SW fish at Millbank and in the provincial sport fisheries statistics, 1971-80 ($r=0.87$) suggested a potential for 4,543 1-SW fish at Millbank in 1981. Corrected for the 1981 commercial fishery the value may have been 4,606 (Table 3). This value would predict 7,190 2-SW fish for the total of Districts 3, 2, 1 and 7 in 1982 (Table 3) which would be 62% above the 10-year mean ($\bar{X}=4,430$; $SE=650$) and would have been surpassed only by the total of 7,947 in 1974. Landings in Districts 3, 2, 1 and 7 would be 95, 55, 52 and 67% above their respective 10-year means.

On the basis of poor 2-SW salmon returns in 1981, 3-SW fish will likely contribute little to the average 8-19% weight (Table 1) normally contributed by 3- and 1-SW fish to landings of those Districts. One-sea-winter fish make virtually no contribution to Districts 2, 3 and 7 and only a minor contribution to District 1.

Bibliography

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Table 1. Estimated numbers of 2-SW salmon landed in commercial fisheries of Fishery Statistical Districts 12, 13, 1-9, Nova Scotia, the Millbank trap on the Miramichi River, New Brunswick, the combined sport landings of the North, Baddeck and Middle rivers and sport catch of the Margaree river of Cape Breton, 1972-81. Ten-year means and the mean annual percentages contributed by 2-SW fish to the total weight of salmon landed in each District are shown.

	Fishery Statistical Districts												
Years	12[1]	13[2]	3[1]	2[1]	1[3]	4[1]	6[1]	7[1]	8[4]	9[4]	Mlbnk	No, Bd, Mid	Marg
1972	994	3,568	170	1,374	1,816	214	41	539	25	53	1,151	271	112
73	545	2,674	199	1,381	1,433	356	36	420	18	25	1,132	195	117
74	754	3,114	571	2,144	2,245	673	124	2,987	23	155	1,791	316	102
75	299	1,756	252	2,006	2,162	790	87	1,471	28	39	1,208	125	60
76	296	1,102	202	1,812	2,034	894	21	434	29	113	943	197	67
77	841	1,771	360	2,540	1,903	559	41	1,993	33	112	1,934	325	132
78	389	2,764	122	1,327	1,557	840	38	462	12	157	693	273	129
79	23	548	18	597	390	210	12	136	14	40	318	136	58
80	423	2,130	379	1,764	2,014	821	75	820	45	99	1,093	238	117
81	281	1,480	107	857	1,101	280	34	201	25	59	752[5]	125	71
$\bar{X}_{10_y}$	484	2,091	238	1,580	1,666	563	50	946	25	85	1,094	220	96
SE	94	298	51	187	180	87	10	293	3	15	149	24	9
$\bar{X}$ % 2-SW	.75	.78	.82	.81	.85	.94	.93	.92	.58	.57			
SE	.04	.03	.03	.03	.03	.02	.01	.03	.07	.06			

[1]based on Redbook total landings (principally salmon gear).
[2]based on Redbook salmon trap net landings (landings by "other" gear are insignificant, but lack estimated mean weights).
[3]based on estimated % 2-SW fish in salmon trap nets and commercial trap nets applied to Redbook total numbers landed (1-SW component is erratic).
[4]based on Redbook salmon gear only (by-catch is very erratic).
[5]estimated count in absence of commercial fishery, including adjustment for dredging effect.

Table 2. Correlation coefficients among estimated numbers of 2-SW salmon landed in commercial fisheries of Fishery Statistical Districts 12, 13, 1-9, Nova Scotia, the Millbank trap on the Miramichi River, New Brunswick, and the sport catch of the North, Baddeck, Middle and Margaree rivers of the Cape Breton, 1972-81.

Fishery District	Fishery District											
	13	3	2	1	4	6	7	8	9	Mlbnk	No, Bd, Mid	Marg
12	.78	.54	.55	.54	-.12	.33	.51	.22	.23	.77	.79	.69
13		.41	.25	.48	-.01	.47	.33	-.06	.25	.43	.63	.68
3			.81	.76	.45	.84	.89	.52	.52	.84	.63	.37
2				.86	.60	.57	.79	.55	.46	.90	.60	.38
1					.68	.67	.64	.56	.45	.74	.52	.31
4						.40	.33	.36	.64	.23	.23	.11
6							.82	.32	.35	.59	.33	.13
7								.25	.49	.84	.58	.24
8									.07	.46	.16	.12
9										.33	.70	.43
Mlbnk											.68	.49
No, Bd, Mid												.82

$P._{05}$ = .632

$P._{01}$ = .765

Table 3. Numbers of 1-SW salmon captured at Millbank on the Miramichi River, New Brunswick, 1971-81, regression equations and statistics for estimating the numbers of 2-SW fish to commercial fisheries of Districts 1, 2, 3 and 7 Cape Breton Island, Nova Scotia, 1982.

Year	Millbank 1-SW	Regression Equations	r	$\hat{Y}$ 1982	95% CI
1971	1962	$\log Y_{D_{2,3,7,1}} = 0.2625 + 0.9811 \log X_{Mlbnk}$	0.73*	3526 (7190)	2,588-4,803 (4,156-12,439)
72	2543				
73	2450				
74	4038	$\log Y_{D_3} = -3.0103 + 1.5496 \log X_{Mlbnk}$	0.69*	151 (464)	87- 263 (173-1,243)
1975	3548				
76	4939	$\log Y_{D_2} = 0.3327 + 0.8344 \log X_{Mlbnk}$	0.81**	1338 (2452)	1,086-1,648 (1,694-3,549)
77	1505				
78	1268	$\log Y_{D_1} = 0.3835 + 0.8244 \log X_{Mlbnk}$	0.67*	1391 (2532)	1,016-1,904 (1,451-4,416)
79	2500				
1980	2139	$\log Y_{D_7} = -2.3155 + 1.5055 \log X_{Mlbnk}$	0.65*	531 (1583)	293- 960 (553-4,535)
81[1]	2228 (4606)				

[1]estimated in the absence of a commercial fishery and, in brackets, without commercial fishery or dredging activities.
** $p < .01$
* $p < .05$

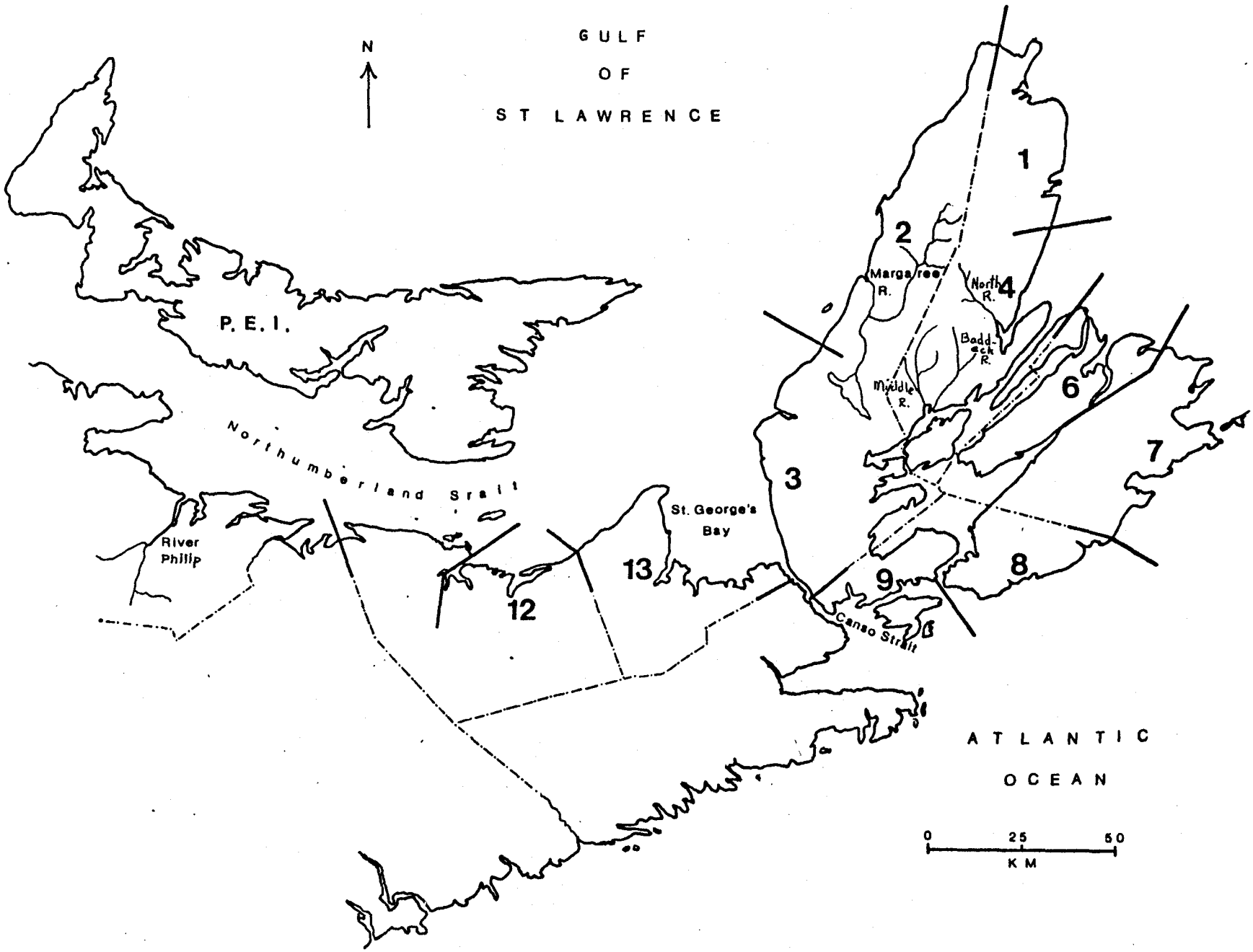

Figure 1. Fishery Statistical Districts 12, 13, 1-9, of Nova Scotia.