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Length-Weight Relation of the Summer Flounder *Paralichthys dentatus* (Linnaeus)

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By

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ABSTRACT

Length-weight equations of the form $W = c\,L^b$ in which W is weight, L is length, and c and b are constants are given for summer flounder for each calendar quarter. Weight for a given length varied seasonally. Males were slightly heavier than females of the same length.

INTRODUCTION

Information on the length-weight relation of fish is needed in studies of condition, growth, and sexual maturity, and in investigations of exploited species to obtain weight yields by size and age groups from length- and age-frequency samples of the catch. The summer flounder, or fluke, is important to otter-trawl fishermen and anglers in New England and Middle Atlantic States (Bigelow and Schroeder, 1953). The only previously published information on its length-weight relation was based on measurements of 118 fish from Chesapeake Bay (Hildebrand and Schroeder, 1928). The present report gives estimated length-weight relations by calendar quarter for fish from catches by New England otter trawlers.

Summer flounder are most abundant in the Middle Atlantic Bight, the area between Cape Cod and Cape Hatteras, and are found close inshore in bays and sounds during late spring to fall and on offshore grounds between the 40- and 85-fm. (fathom) contours in the winter and early spring. Tagging studies have shown that a seasonal inshore-offshore migration occurs and that fish from inshore and offshore grounds are of the same general population (Poole, 1962).

Summer flounder spawn during the fall migration from inshore to offshore grounds. At that time, they are not concentrated and few New England vessels fish for them; as a result no gravid fish were available for inclusion in this study.

The New England catch is from the northern part of the Bight (fig. 1), inshore from Block Island to Nantucket Sound in the summer and offshore from Hudson Canyon to Veatch Canyon in the winter. The fish for this study were caught on these grounds.

METHODS

Length-weight equations were computed from lengths and weights of 2,051 fish caught in 1956-62. Of these, 1,705 were obtained from commercial landings and 346 were from the catch of a research vessel. Most months were represented (table 1).

Table 1.--Number of summer flounder obtained from commercial landings, by month

Month	Number	Month	Number	Month	Number
January..	--	May	138	September	161
February.	262	June	[1] 675	October	46
March....	203	July	--	November	76
April....	188	August	239	December	63

[1] Includes the sample of 346 fish caught by a research vessel.

Commercial landings were sampled at New Bedford, Mass., and Point Judith, R. I. Summer flounder in these ports are sorted into four size categories and packed in boxes of 125 lb. (pounds) upon their removal from the fishing vessels. Boxes of fish were selected arbitrarily, and all fish from a box were measured and weighed so that no selection by size or sex was made within a box. The larger fish were sampled out of proportion to their

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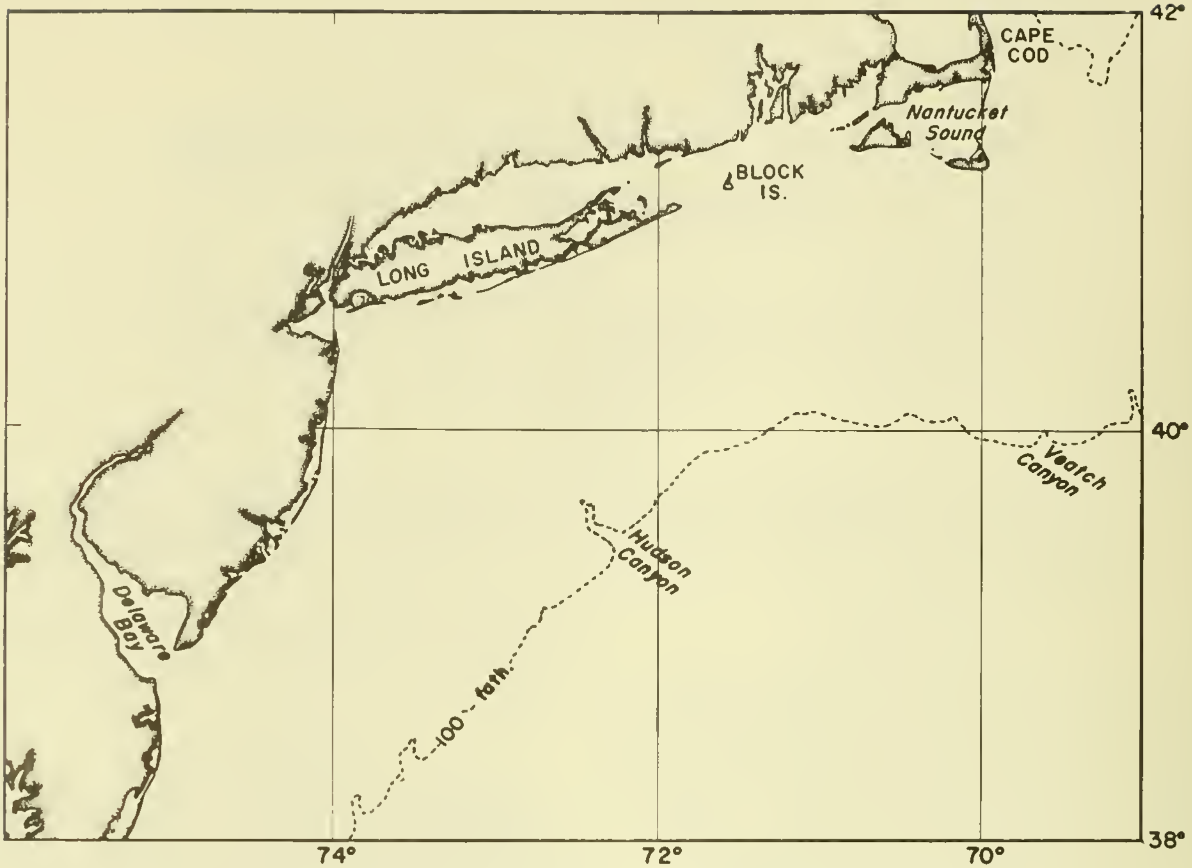

Figure 1.--Chart of the northern part of the Middle Atlantic Bight.

relative frequency in catches to improve their representation in the samples. Examination of the length-weight data by size category indicated that no apparent bias resulted from this selection.

Opportunities for sampling the commercial catch depended on the level of fishing effort for summer flounder and on landings of this species at certain piers in the fishing ports where sampling could be done. Because sampling was about proportional to landings, we believe it fair to assume that the estimated length-weight equations adequately represent the length-weight relation of fish in the New England catch in each season.

Length, weight, and sex were determined for 346 summer flounder in a single catch by a research vessel in June 1961 at Menemsha Bight, Mass. Because the measurements were made in the laboratory, it is likely that they were more accurate than those from commercial samples, which were made under less ideal conditions on the fish-unloading piers.

Total lengths of all fish were measured to the nearest millimeter. Weights in grams were obtained with adjustable spring balances of three capacities in order to read all weights to the nearest unit less than 0.5 percent of the fish weight. We checked the balances occasionally with standard weights and adjusted them as necessary. Their weighing error was about 1 percent.

The equation

$$W = c\ L^{b}$$

in which W = weight, L = length, and c and b are constants was assumed to express the relation of length to weight. The least squares regression of the logarithmic transformation

$$Y = a + bX$$

in which $Y = \log_{10} W$, $a = \log_{10} c$, and $X = \log_{10} L$ was used for estimating values of c and b.

Logarithms of lengths and weights were rounded to 3 decimal places. Each fish was treated as 1 point. Regression statistics for all of the data are given in appendix table 1. Notation for regression analysis follows Snedecor (1956).

SEASONAL VARIATIONS AND SEX DIFFERENCES

The regression equations, based on commercial and research-vessel samples, for estimating log weight ($\hat{Y}$) from log length (X) in each calendar quarter are given in table 2. The regression constants varied slightly from quarter to quarter. The constants for the research vessel and commercial catches in the second quarter also differed.

The standard deviation from regression, $S_{y.x}$, (table 2) was similar in all quarters. The last column of table 2 gives values of S_Y at mean X. S_Y is the standard deviation of $\hat{Y}$ estimated from a single X observation, and it is needed for computing confidence limits for $\hat{Y}$.

Table 3 gives by calendar quarter the calculated weights for each centimeter of length, and the length-frequency distributions of fish used to obtain the regression equations. The equation for the pooled commercial and research-vessel samples was used for the second quarter.

A length-weight table for 118 summer flounder from Chesapeake Bay collected in both summer and winter (Hildebrand and Schroeder, 1928) agreed closely with data of the second and third quarters in the present study (table 3).

We used analysis of covariance to examine possible differences between length-weight relations of males and females for the research-vessel catch of 346 summer flounder. The slopes of the curves were the same ($F = 0.07$), but the elevations (logarithm of adjusted mean weight) differed significantly ($F = 9.39$). We concluded, therefore, that in this sample, which consisted largely of fish less than 45 cm. (centimeters) long, males were slightly heavier for a given length than were females. Further study is needed to establish whether the difference between sexes holds for all sizes and seasons.

Table 2.--Regression equations for estimating log weight ($\hat{Y}$) from log length (X) of summer flounder, values of the constant (c), standard deviations from regression ($S_{y.x}$), and standard deviations at mean X for $\hat{Y}$ estimated from a single X observation (S_Y), by calendar quarter for catches of 1956-62

Months	Sex	Number	Regression equation	c	$S_{y.x}$	S_Y at mean X
			Commercial catch			
January-March....	Both....	465	$\hat{Y} = 3.3525X - 5.9340$	1.0139×10^{-6}	0.03751	0.03755
April-June.......	do......	655	$\hat{Y} = 3.3238X - 5.8579$	1.3872×10^{-6}	.04084	.04087
July-September...	do......	400	$\hat{Y} = 3.3430X - 5.8942$	1.2758×10^{-6}	.04180	.04185
October-December	do......	185	$\hat{Y} = 3.1099X - 5.2741$	5.3220×10^{-6}	.04353	.04365
			Research vessel catch			
June.............	Male....	163	$\hat{Y} = 3.1798X - 5.4802$	3.3102×10^{-6}	.02879	.02887
Do.............	Female..	183	$\hat{Y} = 3.1986X - 5.5391$	2.8902×10^{-6}	.03077	.03086
Do.............	Both....	346	$\hat{Y} = 3.1455X - 5.3977$	4.0016×10^{-6}	.03019	.03023
			Commercial and research vessel catches combined			
April-June.......	do......	1,001	$\hat{Y} = 3.2970X - 5.7872$	1.6324×10^{-6}	.03782	.03784

Table 3.--Length frequencies of summer flounder used in calculating length-weight equations and calculated weights in grams (g.) at each centimeter (cm.) length, by calendar quarter

Length	January-March		April-June		July-September		October-December	
Cm.	No.	G.	No.	G.	No.	G.	No.	G.
27	--	--	1	169	--	--	--	--
28	--	--	4	191	--	--	--	--
29	--	--	8	214	3	218	--	--
30	--	--	21	239	6	244	--	--
31	--	--	28	267	5	272	--	--
32	--	--	44	296	7	302	2	328
33	3	323	73	328	8	335	1	362
34	5	357	75	362	11	370	4	397
35	7	393	80	398	15	408	5	434
36	4	432	74	437	23	448	8	474
37	9	474	80	478	13	491	10	516
38	18	518	86	522	26	537	5	561
39	14	565	66	569	17	586	8	608
40	15	615	47	619	20	638	9	658
41	29	668	33	671	30	692	8	710
42	19	724	38	726	25	750	3	765
43	27	784	21	785	30	812	8	824
44	16	842	16	847	21	877	4	885
45	19	913	17	912	16	945	4	949
46	17	984	15	981	15	1,018	7	1,016
47	14	1,058	12	1,053	8	1,093	19	1,086
48	4	1,135	9	1,129	13	1,172	12	1,159
49	9	1,216	12	1,209	6	1,256	11	1,236
50	12	1,301	13	1,292	2	1,345	11	1,317
51	17	1,391	13	1,380	5	1,436	12	1,401
52	21	1,484	12	1,471	1	1,532	12	1,487
53	15	1,582	8	1,566	2	1,634	--	1,578
54	17	1,684	4	1,665	1	1,739	2	1,673
55	15	1,791	7	1,770	5	1,849	2	1,771
56	13	1,903	5	1,877	5	1,964	1	1,873
57	8	2,019	4	1,990	4	2,084	2	1,979
58	17	2,139	6	2,107	12	2,207	1	2,089
59	5	2,267	6	2,231	2	2,339	1	2,204
60	3	2,400	10	2,356	4	2,474	--	2,322
61	5	2,534	3	2,488	5	2,612	5	2,443
62	9	2,676	6	2,626	1	2,759	3	2,570
63	8	2,822	4	2,768	2	2,909	--	2,700
64	3	2,977	11	2,916	3	3,068	--	2,837
65	5	3,135	2	3,068	4	3,231	--	2,976
66	2	3,299	4	3,226	2	3,400	--	3,121
67	5	3,471	6	3,392	5	3,576	1	3,272
68	5	3,647	3	3,561	--	3,757	--	3,425
69	6	3,828	3	3,738	5	3,944	1	3,584
70	5	4,019	2	3,918	3	4,140	--	3,749
71	12	4,216	--	4,107	1	4,342	--	3,919
72	7	4,416	2	4,298	--	4,548	2	4,091
73	2	4,625	2	4,499	1	4,762	--	--
74	2	4,841	1	4,705	1	4,983	--	--
75	2	5,066	--	4,921	--	5,214	--	--
76	1	5,294	--	5,138	--	5,449	--	--
77	5	5,532	1	5,365	2	5,694	1	--
78	1	5,777	2	5,599	2	5,944	--	--
79	2	6,027	--	5,837	2	6,202	--	--
80	--	6,290	1	6,087	--	--	--	--
81	1	6,557	--	--	--	--	--	--
82	2	6,830	--	--	--	--	--	--
83	2	7,116	--	--	--	--	--	--
84	1	7,406	--	--	--	--	--	--
Total	465	--	1,001	--	400	--	185	--

Appendix table 1.--Data required for calculation of the length-weight regressions for summer flounder, by calendar quarter

Months	Sex	n	ΣX	ΣX^2	ΣY	ΣY^2	ΣXY
			Commercial catch				
January-March........	Both	465	1254.871	3390.422	1447.615	4551.888	3919.904
April-June...........	Both	655	1710.342	4471.998	1847.928	5280.176	4845.061
July-September.......	Both	400	1055.234	2787.137	1170.015	3460.361	3097.765
October-December.....	Both	185	491.758	1308.159	553.638	1666.777	1474.738
			Research vessel catch				
June.................	Male	163	414.028	1051.900	423.262	1101.730	1075.896
June.................	Female	183	473.338	1224.815	500.349	1373.362	1295.790

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