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The Length-weight Relationship and Factors for Conversions between Standard and Total Lengths for Seven Michigan Fishes

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Abstract

The factors for conversions between standard and total lengths are presented for the following Michigan fishes: bluegill (Lepomis m. macrochirus), yellow perch (Perca flavescens), pumpkinseed (Lepomis gibbosus), smallmouth black bass (Micropterus d. dolomieu), largemouth black bass (Huro salmoides), rock bass (Ambloplites r. rupestris), and the northern pike (Esox lucius). The ratio of standard to total length was found to increase progressively in all species (that is, the relative length of the tail decreases) as the length of the fish increases. The values of n in the length-weight equation, $W = aL^n$, which was derived for each of the species listed above, ranged from 2.969 for the rock bass to 3.199 for the pumpkinseed. When the numbers of fish were large the actual weights agreed well with those computed from the equation.

The methods followed in the compilation and analysis of the data are described in order that workers may know exactly the procedure employed and thus be able to compare these data with their own.

Introduction

The Michigan Institute for Fisheries Research has been collecting

information on the game fishes of Michigan since 1931. These data include the large numbers of weights and measurements of the State's most important warm-water sport fishes, that serve as the basis of the present report. Comprehensive data on conversion factors and the length-weight relationship are not plentiful in the literature and yet this information has numerous practical applications in fishery work. With the general trend toward the English system in weights and measurements, and toward the measurement of total rather than standard lengths, the table of conversion factors should prove useful in the interpretation of past data where standard length in millimeters and weight in grams were chiefly used. Length-weight data are useful in attempts to evaluate the condition of fish in particular waters.

In the presentation of the data, the methods used in deriving the formulae and in computing the factors will be presented in order that other workers in the field may know the exact procedure by which each set of data was derived, and thus more accurately and easily compare the information with their own figures.

The specimens were collected for the most part by lake-inventory parties of the Institute. Various types of gear were used: experimental gill nets, 5 by 125 feet, with five sections of different sized mesh (ranging from 1 1/2 to 4 inches, stretched measure, as manufactured); gill nets of single mesh size, 5 by 125 feet (meshes from 1 1/2 to 4 inches, stretched measure); fyke and trap nets of various dimensions and mesh sizes; bag seines, 30 to 125 feet long; straight and "common-sense" seines, 6 to 50 feet long; and rod and line. Some samples were taken from sportsmen's catches by creel-census clerks. The specimens employed in this study came from over 500 lakes located in all parts of the State of Michigan.

Conversion factors for changing standard to total length, etc.

In the original compilation of the data on standard and total lengths, each millimeter of total length was made a column heading (on special column paper) and each standard length was recorded in the appropriate column. Average standard lengths and total lengths were computed for 5-millimeter intervals of total length (except for the northern pike where centimeter intervals were used). The ratio, standard to total length, was determined for each of these intervals by dividing the average standard length by the average total length. For example, in the bluegill, 209 fish in the 120- to 124-millimeter group of total length, averaged 122 millimeters in total length and 96 millimeters in standard length. The value 96/122 = 0.786 is the ratio for that group.

Study of the behavior of the ratio with increase in length formed the basis for further combination into two or three larger intervals. The conversion factors recorded in Table 1 are the weighted means of the factors for the 5-millimeter intervals over the indicated range.

The examination of the factors will show that as the fish increased in length the tail became relatively shorter. This change has been observed frequently by others for a variety of species (see Carlander and Smith, 1945), and is probably a characteristic of most or all species.

For the convenience of those who may have use for these conversion data, factors were determined to make possible ready conversions between standard and total lengths, with and without changes in units of measurement.

Length-weight relationship

The arrangement in the original compilation was similar to that followed in the tabulation of data on the standard and total length; that is, the total lengths headed the columns and each weight was recorded under the

proper length of fish. The average weight was then determined by 5-millimeter groups (except for the northern pike where again centimeter intervals were used). The standard length corresponding to the average total length for each 5-millimeter group was computed by use of the appropriate conversion factor, and the length-weight equation was fitted to the means of standard length (millimeters) and weight (grams) for intervals represented by 10 or more fish.

The equation used throughout was that of the general parabola, $W = cL^n$, where W = weight in grams, L = standard length in millimeters, and c and n are constants. According to Hile (1936) this general equation ordinarily gives a better result in the expression of the length-weight relationship than does the cubic parabola, $W = CL^3$, where W = weight in grams, L = standard length in millimeters, and C is a constant.

The equation, $W = cL^n$, expressed in logarithmic form becomes a straight line: $\log W = \log c + n \log L$.

The values of $\log c$ and n are easily determined by fitting a line to the logarithms of L and W. The values of $\log c$ and n are computed from the following formulas which are simply solutions of normal equations:

$$\log c = \frac{\Sigma \log W \cdot \Sigma(\log L)^2 - \Sigma \log L \cdot \Sigma[\log L \cdot \log W]}{N \cdot \Sigma(\log L)^2 - (\Sigma \log L)^2}$$

and

$$n = \frac{\log W - N \cdot \log c}{\log L}.$$

As an illustration of the method that was found most convenient in compiling the length-weight data Table 2 is presented. This table is an excerpt from the original tabulation for the bluegill.

The values for log c and n for the species studied in this work are recorded in Table 3. By substituting these values in the logarithmic form of the equation $W = cL^n$, the calculated weights are derived.

Tables 4 to 10 contain the length-weight data as determined for the seven species. In compiling these tables total length in inches, standard length in millimeters, calculated weight in grams, pounds, and ounces, and empirical weight in ounces are given as a convenience to the worker in comparing these data with other information. This information also has been put in graphical form (Figures 1-7). In general, the curves fit the data very well. The discrepancies that do occur can be attributed to the small numbers of fish at some intervals, to the fact that fish from many localities were combined, and to the circumstance that no separation was made of the data according to maturity, sex, or season or year of capture.

Literature Cited

Carlander, Kenneth D., and Lloyd L. Smith, Jr.

1945. Some factors to consider in the choice between standard, fork, and total lengths in fishery investigations. Copeia, 1945, No. 1. pp. 7-12.

Hile, Ralph.

1936. Age and growth of the cisco, Leucichthys artedi (Le Sueur), in the lakes of the northeastern highlands, Wisconsin. Bull. U. S. Bur. Fish., Vol. 48, pp. 211-317.

Table 1. - Factors for conversions between standard length (S.L.) and total length (T.L.), with and without changes in units, for seven Michigan fishes.

Species	Interval of total length (inches)	Number of fish	Conversion factors: T.L. to S.L. (no change in units)	S.L. to T.L. (no change in units)	S.L. (millimeters) to T.L. (inches)	T.L. (inches) to S.L. (millimeters)
Bluegill	under 5.1	2,335	0.782	1.278	0.0503	19.38
	5.1 - 8.1	3,712	0.793	1.261	0.0497	20.14
	over 8.1	1,253	0.803	1.246	0.0491	20.39
Yellow perch	under 4.0	422	0.833	1.200	0.0472	21.16
	4.0 - 7.8	3,610	0.847	1.181	0.0465	21.51
	over 7.8	1,569	0.852	1.174	0.0462	21.64
Pumpkinseed	under 4.7	843	0.794	1.259	0.0496	20.17
	over 4.7	1,460	0.807	1.239	0.0488	20.50
Smallmouth black bass	under 2.5	8	0.800	1.250	0.0492	20.32
	2.5 -12.6	678	0.826	1.211	0.0477	20.98
	over 12.6	135	0.820	1.220	0.0480	20.83
Largemouth black bass	under 8.3	527	0.820	1.220	0.0480	20.83
	8.3 -15.0	843	0.825	1.212	0.0477	20.96
	over 15.0	86	0.834	1.199	0.0472	21.18
Rock bass	under 5.8	1,066	0.789	1.268	0.0499	20.04
	over 5.8	925	0.802	1.247	0.0491	20.37
Northern pike	under 20.0	1,034	0.860	1.162	0.0458	21.84
	20.0- 31.0	457	0.867	1.153	0.0454	22.02
	over 31.0	22	0.877	1.140	0.0449	22.28

Table 2.--Excerpt from data on the bluegill to illustrate the method employed for the compilation of information on the length-weight relationship. The total and standard lengths are the averages for 5-millimeter intervals of the former measurement.

Total length	Standard length	Number of fish	Average weight (grams)	log L	log W	log L x log W	$(\log L)^2$	Calculated log W	Calculated weight
127	99	135	35	1.9956	1.5441	3.0814	3.9824	1.5550	36
132	105	174	39	2.0212	1.5911	3.2159	4.0852	1.6346	43

Table 3

Values of log *c* and *n* in the length-weight equations for the several species of Michigan game fishes

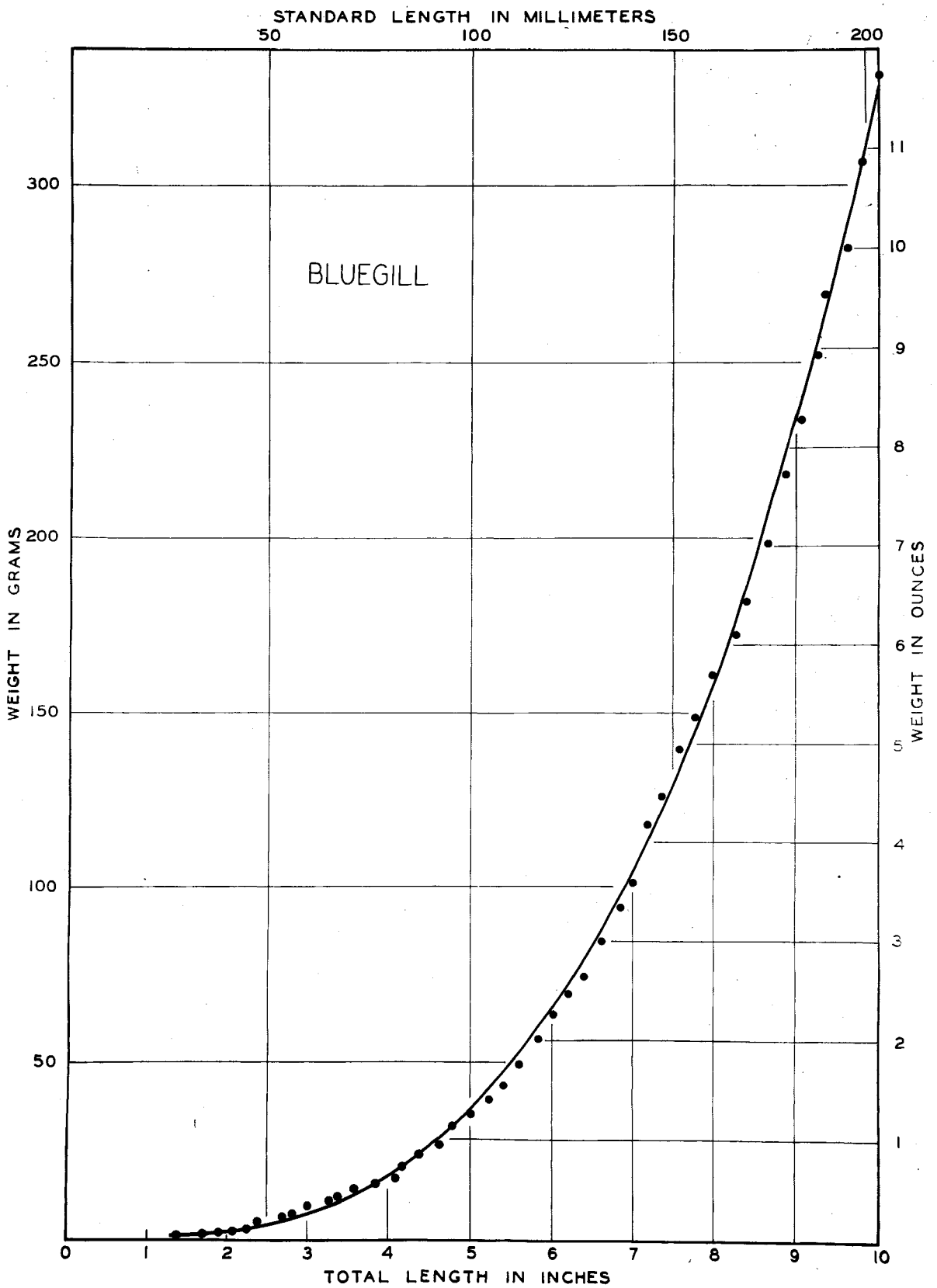
Species	log *c*	*n*
Bluegill	-4.651316	3.11037
Yellow perch	-4.854310	3.054445
Pumpkinseed	-4.789026	3.19857
Smallmouth black bass	-4.725066	3.05150
Largemouth black bass	-4.625223	2.99278
Rock bass	-4.319450	2.96914
Northern pike	-5.223632	3.06647

Table 4

Relationship between the length and weight of the Bluegill in Michigan. See Table 3 for values of the constant in the length-weight equation and Figure 1 for a graphical representation of the length-weight relationship.

Number of fish	Total length (inches)	Standard length (millimeters)	Weight			
			Calculated (grams)	Calculated (pounds)	Calculated (ounces)	Empirical (ounces)
24	1.4	29	1	0.002	0.04	0.04
45	1.7	33	1	0.002	0.04	0.04
56	1.9	37	2	0.004	0.07	0.07
42	2.1	41	2	0.004	0.07	0.07
37	2.3	45	3	0.007	0.11	0.11
41	2.4	48	4	0.009	0.14	0.18
42	2.7	52	5	0.011	0.18	0.21
25	2.8	56	6	0.013	0.21	0.25
26	3.0	60	8	0.015	0.28	0.35
30	3.3	64	9	0.018	0.32	0.35
39	3.4	68	11	0.024	0.39	0.42
61	3.6	72	13	0.029	0.46	0.49
59	3.8	76	16	0.035	0.56	0.56
122	4.1	80	18	0.039	0.63	0.63
109	4.2	84	21	0.046	0.74	0.74
87	4.4	88	25	0.055	0.88	0.85
100	4.6	92	29	0.064	1.02	0.95
137	4.8	95	32	0.070	1.13	1.13
135	5.0	99	36	0.079	1.27	1.23
155	5.2	105	43	0.094	1.52	1.38
174	5.4	109	48	0.106	1.69	1.55
215	5.6	113	54	0.119	1.90	1.76
189	5.8	117	60	0.132	2.12	2.01
221	6.0	121	67	0.147	2.36	2.26
217	6.2	125	74	0.163	2.61	2.50
182	6.4	128	80	0.176	2.82	2.68
183	6.6	132	88	0.194	3.10	3.00
168	6.8	136	96	0.211	3.39	3.35
162	7.0	140	105	0.231	3.70	3.63
176	7.2	144	115	0.253	4.06	4.20
172	7.4	148	125	0.275	4.41	4.48
214	7.6	152	136	0.299	4.80	4.97
191	7.8	156	148	0.326	5.22	5.26
182	8.0	160	160	0.352	5.64	5.71
163	8.2	166	179	0.394	6.31	6.14
197	8.3	170	193	0.425	6.81	6.52
142	8.6	174	207	0.455	7.30	7.05
103	8.8	178	223	0.490	7.87	7.79
88	9.0	182	238	0.524	8.39	8.29
91	9.2	186	255	0.561	8.99	8.96
82	9.3	191	277	0.609	9.77	9.59
47	9.5	194	291	0.640	10.26	10.05
27	9.7	198	310	0.682	10.93	10.90
11	10.0	202	330	0.726	11.64	11.78

Figure 1.--Length-weight relationship of the bluegill. The curve is the graph of the length-weight equation, and the dots represent the empirical data.


STANDARD LENGTH IN MILLIMETERS
50
100
150
200
BLUEGILL
WEIGHT IN GRAMS
300
250
200
150
100
50
WEIGHT IN OUNCES
11
10
9
8
7
6
5
4
3
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1
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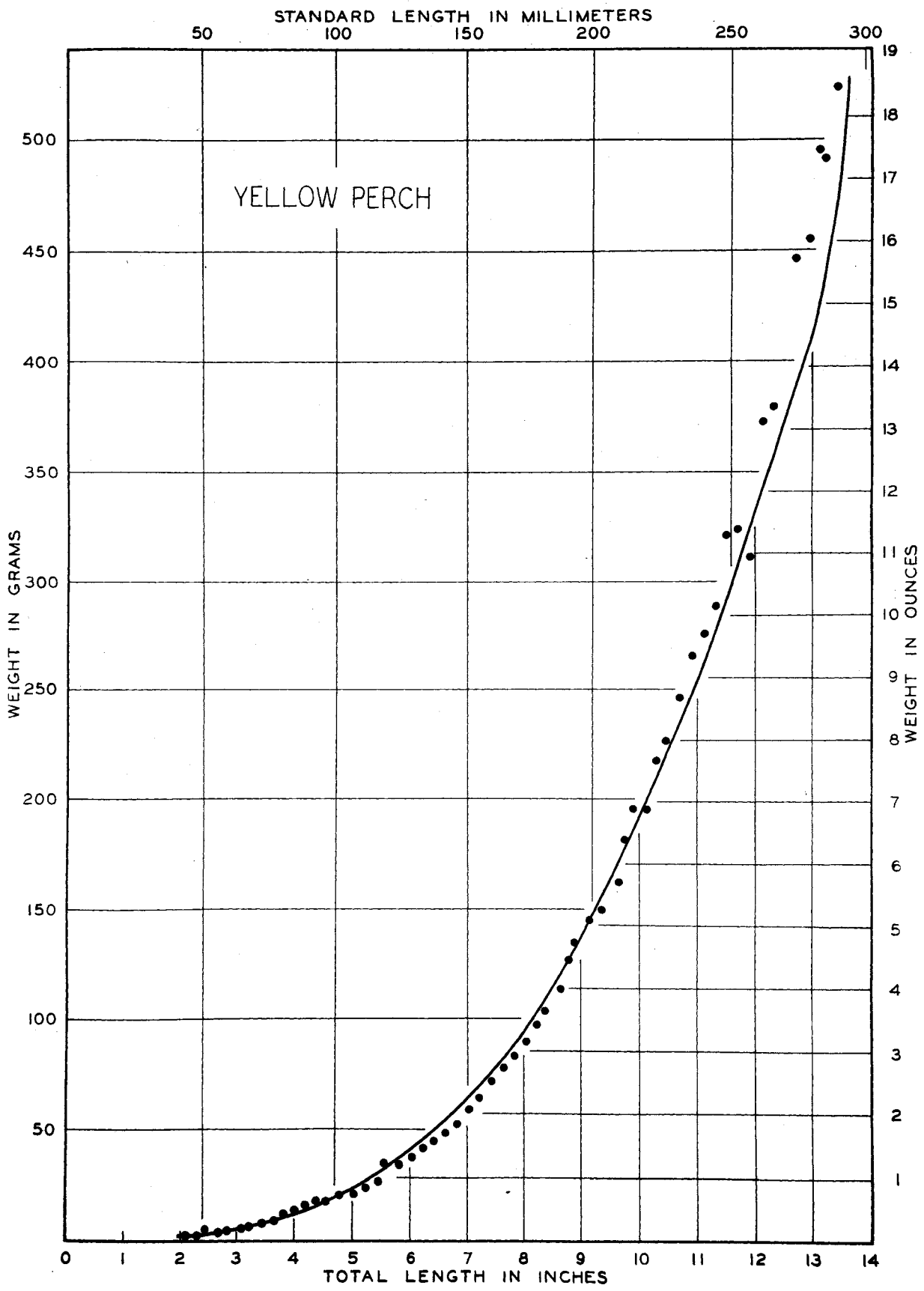
10
TOTAL LENGTH IN INCHES

Table 5

Relationship between the length and weight of the Yellow Perch in Michigan. See Table 3 for values of the constant in the length-weight equation and Figure 2 for a graphical representation of the length-weight relationship.

Number of fish	Total length (inches)	Standard length (millimeters)	Weight			
			Calculated (grams)	Calculated (pounds)	Calculated (ounces)	Empirical (ounces)
7	2.1	43	1	0.002	0.04	0.07
12	2.3	47	2	0.004	0.07	0.07
17	2.4	52	3	0.007	0.11	0.11
29	2.7	56	3	0.007	0.11	0.11
61	2.8	60	4	0.009	0.14	0.14
68	3.1	64	5	0.011	0.18	0.18
58	3.2	68	6	0.013	0.21	0.21
46	3.4	72	7	0.015	0.25	0.25
46	3.6	77	8	0.018	0.28	0.28
31	3.8	81	9	0.020	0.32	0.35
49	4.0	86	11	0.024	0.39	0.42
45	4.2	91	13	0.029	0.46	0.49
46	4.4	95	15	0.033	0.53	0.56
41	4.6	99	17	0.037	0.60	0.60
72	4.8	103	20	0.044	0.71	0.71
77	5.0	108	23	0.051	0.81	0.74
106	5.2	112	25	0.055	0.88	0.85
111	5.4	116	28	0.062	0.99	0.95
141	5.6	120	31	0.068	1.09	1.13
214	5.8	125	35	0.077	1.23	1.20
272	6.0	129	39	0.086	1.38	1.30
242	6.2	133	43	0.095	1.52	1.45
236	6.4	137	47	0.103	1.66	1.52
170	6.6	141	51	0.112	1.80	1.69
135	6.8	146	57	0.125	2.01	1.83
143	7.0	150	62	0.136	2.19	2.05
97	7.2	154	67	0.147	2.36	2.22
81	7.4	158	73	0.161	2.57	2.54
78	7.6	163	80	0.176	2.82	2.75
126	7.8	167	86	0.189	3.03	2.89
123	8.0	172	94	0.207	3.32	3.14
116	8.2	176	101	0.222	3.56	3.35
101	8.3	181	110	0.242	3.88	3.63
92	8.6	185	117	0.257	4.13	3.99
66	8.8	189	125	0.275	4.41	4.41
63	8.9	193	134	0.294	4.73	4.69
61	9.2	198	145	0.319	5.11	5.11
56	9.3	202	154	0.339	5.43	5.26
42	9.6	206	163	0.359	5.75	5.68
47	9.8	210	173	0.381	6.10	6.31
73	9.9	215	186	0.409	6.56	6.84
57	10.1	219	197	0.433	6.95	6.91
60	10.3	223	208	0.458	7.34	7.62
49	10.5	227	220	0.484	7.76	7.94
62	10.7	231	233	0.513	8.22	8.68
53	10.9	236	247	0.543	8.71	9.31
45	11.1	240	261	0.574	9.21	9.70
34	11.3	245	278	0.612	9.81	10.16
20	11.5	249	292	0.642	10.30	11.29
31	11.7	253	306	0.673	10.79	11.39
30	11.9	257	322	0.708	11.36	10.97
35	12.1	261	337	0.741	11.89	13.12
25	12.3	266	357	0.785	12.59	13.37
14	12.5	270	374	0.823	13.19	13.40
16	12.7	274	391	0.860	13.79	15.73
13	12.9	278	408	0.898	14.39	16.01
9	13.1	282	426	0.937	15.03	17.46
12	13.2	287	450	0.990	15.87	17.32
12	13.4	291	470	1.034	16.58	18.52

Figure 2.--Length-weight relationship of the yellow perch. The curve is the graph of the length-weight equation, and the dots represent the empirical data.


STANDARD LENGTH IN MILLIMETERS
50
100
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YELLOW PERCH
WEIGHT IN GRAMS
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WEIGHT IN OUNCES
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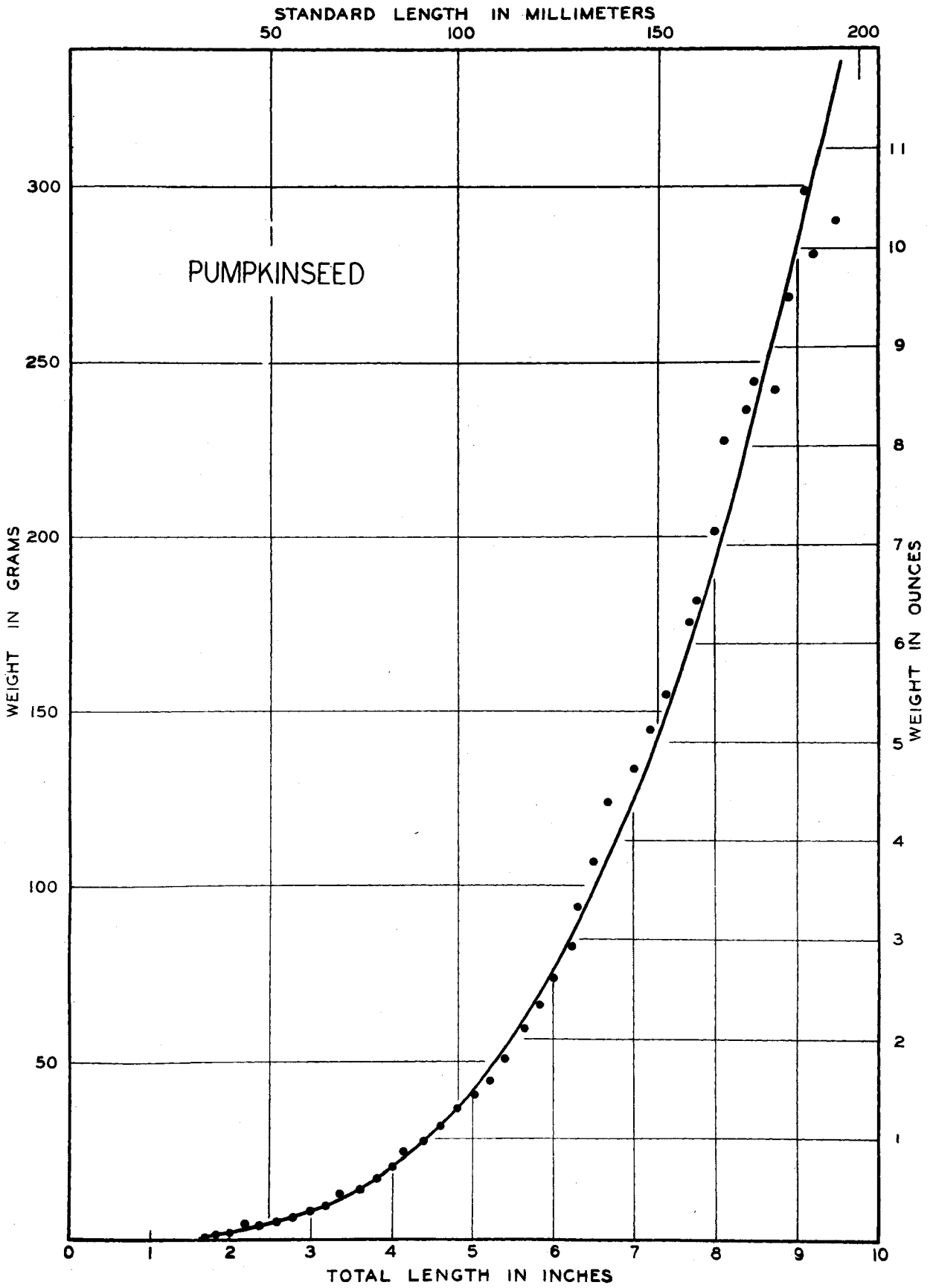
TOTAL LENGTH IN INCHES

Table 6

Relationship between the length and weight of the Pumpkinseed in Michigan. See Table 3 for values of the constant in the length-weight equation and Figure 3 for a graphical representation of the length-weight relationship.

Number of fish	Total length (inches)	Standard length (millimeters)	Weight			
			Calculated (grams)	Calculated (pounds)	Calculated (ounces)	Empirical (ounces)
4	1.7	34	1	0.002	0.04	0.04
5	1.8	37	2	0.004	0.07	0.07
3	2.0	41	2	0.004	0.07	0.07
21	2.2	45	3	0.007	0.11	0.14
59	2.4	49	4	0.009	0.14	0.14
68	2.6	53	5	0.011	0.18	0.18
51	2.8	57	6	0.013	0.21	0.21
38	3.0	61	8	0.018	0.28	0.28
41	3.2	65	10	0.022	0.35	0.35
50	3.4	69	12	0.026	0.42	0.46
71	3.6	73	15	0.033	0.53	0.53
80	3.8	77	18	0.040	0.63	0.63
70	4.0	81	21	0.046	0.74	0.74
57	4.2	85	24	0.053	0.85	0.88
57	4.4	89	28	0.062	0.99	0.99
58	4.6	93	32	0.070	1.13	1.13
82	4.8	98	38	0.084	1.34	1.30
68	5.0	102	43	0.095	1.52	1.48
72	5.2	106	49	0.108	1.73	1.62
76	5.4	110	55	0.121	1.94	1.87
76	5.6	114	62	0.136	2.19	2.12
69	5.8	118	69	0.152	2.43	2.36
73	6.0	122	77	0.169	2.72	2.68
77	6.2	126	85	0.187	3.00	2.96
99	6.3	130	94	0.207	3.32	3.35
84	6.5	134	103	0.227	3.63	3.84
112	6.7	139	116	0.255	4.09	4.41
86	7.0	143	127	0.279	4.48	4.76
64	7.2	147	139	0.306	4.90	5.11
54	7.4	152	154	0.339	5.43	5.50
50	7.6	155	165	0.363	5.82	6.21
27	7.8	159	179	0.394	6.31	6.45
36	8.0	163	194	0.427	6.84	7.30
44	8.1	167	209	0.460	7.37	8.08
28	8.4	172	230	0.506	8.11	8.39
27	8.5	175	243	0.535	8.57	8.68
11	8.7	179	261	0.574	9.21	8.61
8	8.9	183	280	0.616	9.88	9.59
7	9.1	187	300	0.660	10.58	10.69
6	9.2	188	306	0.673	10.79	9.95
3	9.5	194	337	0.741	11.89	10.30

Figure 3.--Length-weight relationship of the pumpkinseed. The curve is the graph of the length-weight equation, and the dots represent the empirical data.


STANDARD LENGTH IN MILLIMETERS
50
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PUMPKINSEED
WEIGHT IN GRAMS
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WEIGHT IN OUNCES
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TOTAL LENGTH IN INCHES

Table 7

Relationship between the length and weight of the Smallmouth Black Bass in Michigan. See Table 3 for values of the constant in the length-weight equation and Figure 4 for a graphical representation of the length-weight relationship.

Number of fish	Total length (inches)	Standard length (millimeters)	Weight			
			Calculated (grams)	Calculated (pounds)	Calculated (ounces)	Empirical (ounces)
1	2.0	41	2	0.004	0.07	0.07
2	2.2	46	2	0.004	0.07	0.07
1	2.6	54	4	0.009	0.14	0.11
1	2.7	55	4	0.009	0.14	0.14
1	2.9	62	6	0.013	0.21	0.17
1	3.0	63	6	0.013	0.21	0.21
2	3.2	68	7	0.015	0.25	0.25
4	3.4	73	9	0.020	0.32	0.35
1	3.7	79	11	0.024	0.39	0.39
1	3.8	81	13	0.026	0.46	0.46
3	4.1	85	15	0.033	0.53	0.53
5	4.3	91	18	0.040	0.63	0.78
5	4.4	93	19	0.042	0.67	0.74
4	4.7	98	23	0.051	0.81	0.85
2	4.9	103	26	0.055	0.92	0.81
4	5.1	106	29	0.064	1.02	1.09
1	5.3	111	33	0.073	1.16	1.09
6	5.4	112	34	0.075	1.20	1.27
4	5.6	117	39	0.086	1.38	1.30
3	5.8	122	44	0.097	1.55	1.52
1	6.0	126	49	0.108	1.73	1.59
2	6.2	127	50	0.110	1.76	1.83
2	6.4	134	58	0.128	2.05	1.90
4	6.6	137	63	0.139	2.22	2.15
5	6.8	141	68	0.150	2.40	2.47
5	7.0	146	76	0.167	2.68	2.68
4	7.2	151	84	0.185	2.96	2.54
4	7.3	154	89	0.196	3.14	3.14
1	7.6	159	99	0.218	3.49	3.63
6	7.7	162	105	0.231	3.70	3.74
5	8.0	167	114	0.251	4.02	3.88
6	8.2	171	124	0.273	4.37	4.44
4	8.3	174	130	0.286	4.59	4.73
4	8.6	175	132	0.290	4.66	4.59
14	8.8	181	146	0.321	5.15	5.43
11	8.9	187	162	0.356	5.71	5.47
16	9.2	190	169	0.372	5.96	5.61
12	9.3	196	187	0.411	6.60	6.49
27	9.6	198	193	0.425	6.81	6.77
49	9.8	203	208	0.458	7.34	7.51
50	9.9	208	223	0.491	7.87	7.76
44	10.1	211	234	0.515	8.25	8.36
46	10.3	216	251	0.552	8.85	8.82
39	10.5	220	265	0.583	9.35	9.31
34	10.7	224	280	0.616	9.88	9.66
40	10.9	228	296	0.651	10.44	9.88
27	11.1	231	308	0.678	10.86	10.90
25	11.3	236	329	0.724	11.60	11.67
12	11.5	240	346	0.761	12.20	11.57
11	11.7	244	364	0.801	12.84	13.01
20	11.9	248	384	0.845	13.54	13.26
13	12.1	253	407	0.896	14.35	13.83
13	12.3	256	421	0.926	14.85	14.85
9	12.6	263	458	1.008	16.15	15.17
6	12.7	265	468	1.030	16.51	17.56
3	12.9	266	474	1.043	16.72	16.96
8	13.1	272	507	1.115	17.88	17.32
8	13.3	278	542	1.192	19.12	17.46
9	13.5	283	572	1.258	20.17	20.07
6	13.7	283	572	1.258	20.17	19.89
6	13.9	288	604	1.329	21.30	20.49
12	14.1	293	636	1.399	22.43	22.15
7	14.3	296	657	1.445	23.17	21.73
9	14.4	299	677	1.489	23.88	23.88
5	14.7	305	720	1.584	25.39	24.27
5	14.8	307	734	1.615	25.89	24.65
9	15.1	314	786	1.729	27.72	30.51
5	15.2	316	802	1.764	28.29	27.55
11	15.4	320	833	1.833	29.38	30.23
1	15.7	330	915	2.013	32.27	30.97
6	15.8	331	923	2.031	32.55	32.70
6	16.1	346	1,058	2.328	37.32	35.62
8	16.3	339	994	2.187	35.06	37.53
7	16.5	340	1,003	2.207	35.38	36.41
1	16.6	342	1,020	2.244	35.98	40.49
3	16.8	354	1,134	2.495	40.00	42.82
10	17.1	355	1,143	2.515	40.31	40.95
3	17.3	358	1,173	2.581	41.37	43.24
2	17.4	361	1,203	2.647	42.43	40.03
3	17.6	363	1,224	2.693	43.17	42.71
4	18.0	373	1,330	2.926	46.91	48.50
2	18.2	370	1,298	2.856	45.78	45.00
1	18.4	374	1,341	2.950	47.30	53.96
2	18.6	403	1,684	3.705	59.39	56.01
2	19.0	401	1,658	3.648	58.48	60.24

Figure 4.--Length-weight relationship of the smallmouth black bass. The curve is the graph of the length-weight equation, and the dots represent the empirical data.

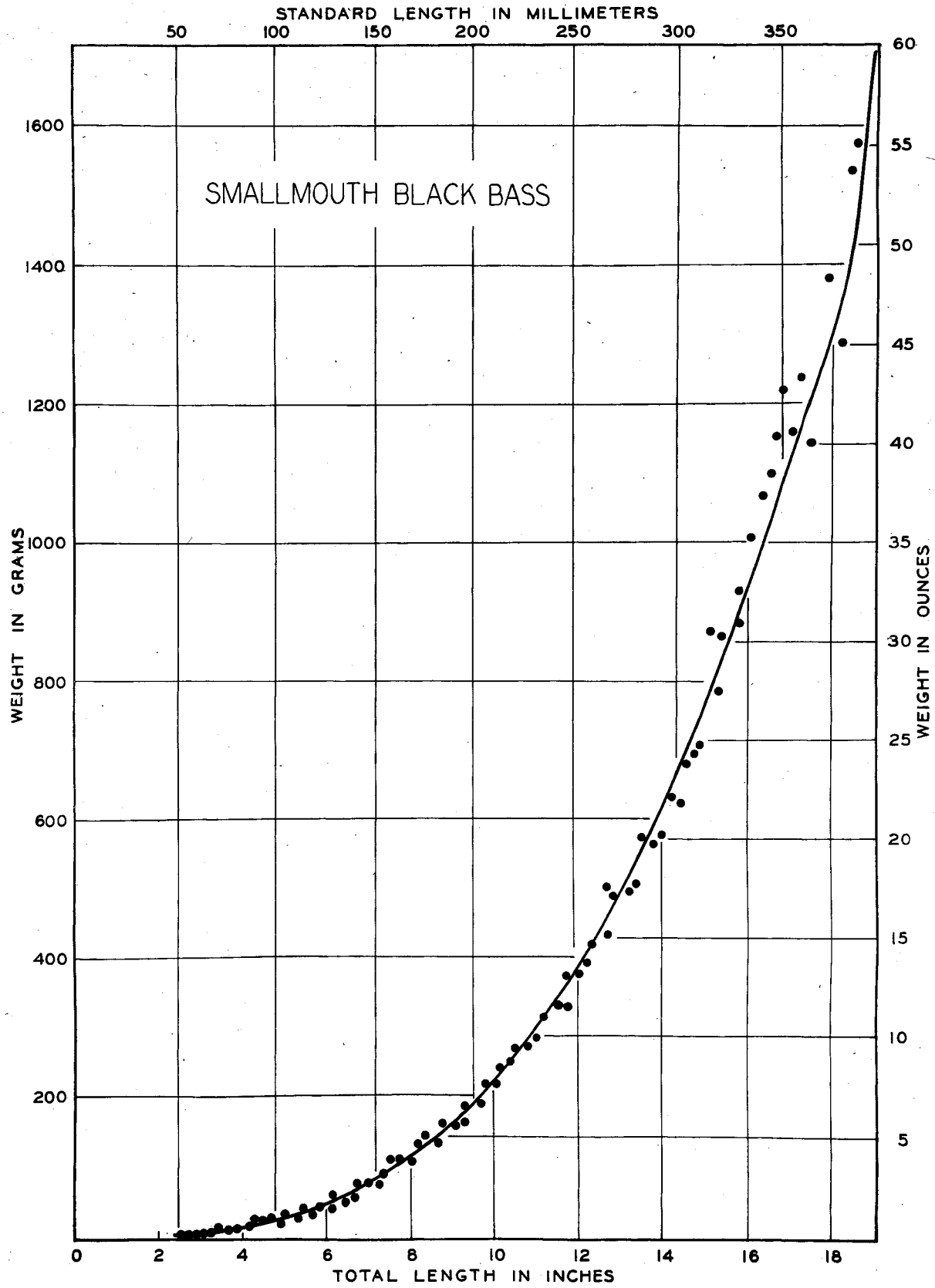

STANDARD LENGTH IN MILLIMETERS
50
100
150
200
250
300
350
SMALLMOUTH BLACK BASS
WEIGHT IN GRAMS
1600
1400
1200
1000
800
600
400
200
WEIGHT IN OUNCES
60
55
50
45
40
35
30
25
20
15
10
5
0
2
4
6
8
10
12
14
16
18
TOTAL LENGTH IN INCHES

Table 8

Relationship between the length and weight of the Largemouth Black Bass in Michigan. See Table 3 for values of the constant in the length-weight equation and Figure 5 for a graphical representation of the length-weight relationship.

Number of fish	Total length (inches)	Standard length (millimeters)	Weight			
			Calculated (grams)	Calculated (pounds)	Calculated (ounces)	Empirical (ounces)
7	2.1	44	2	0.004	0.07	0.07
11	2.2	48	3	0.007	0.11	0.11
12	2.4	51	3	0.007	0.11	0.14
7	2.6	56	4	0.009	0.14	0.14
8	2.8	59	5	0.011	0.18	0.18
11	3.1	63	6	0.013	0.21	0.21
10	3.2	69	7	0.015	0.25	0.25
17	3.4	72	9	0.020	0.32	0.28
19	3.6	76	10	0.022	0.35	0.35
9	3.8	82	13	0.029	0.46	0.42
7	4.0	86	15	0.033	0.53	0.49
10	4.2	89	16	0.035	0.56	0.56
8	4.4	93	18	0.040	0.63	0.63
8	4.6	96	20	0.044	0.71	0.71
15	4.8	102	24	0.053	0.85	0.81
10	5.0	106	27	0.059	0.95	0.95
13	5.2	109	30	0.066	1.06	0.92
11	5.4	112	32	0.070	1.13	1.06
12	5.6	117	37	0.081	1.30	1.16
12	5.8	120	40	0.088	1.41	1.38
7	6.0	125	45	0.099	1.59	1.48
10	6.2	129	49	0.108	1.73	1.76
6	6.4	132	53	0.117	1.87	1.80
8	6.6	139	61	0.134	2.15	1.94
9	6.8	142	65	0.143	2.29	2.19
10	7.0	146	71	0.156	2.50	2.54
11	7.2	150	77	0.169	2.72	2.79
19	7.4	154	83	0.183	2.93	3.07
21	7.6	158	90	0.198	3.17	3.17
13	7.8	164	101	0.222	3.56	3.39
13	8.0	167	106	0.233	3.74	3.77
22	8.2	170	113	0.249	3.99	3.95
19	8.4	174	121	0.266	4.27	4.48
14	8.6	180	133	0.293	4.69	4.62
20	8.8	185	145	0.319	5.11	4.97
18	8.9	188	152	0.334	5.36	5.50
18	9.2	192	161	0.354	5.68	5.82
21	9.4	196	172	0.378	6.07	6.17
22	9.6	199	180	0.396	6.35	6.21
14	9.7	205	197	0.433	6.95	6.56
24	9.9	210	211	0.464	7.44	7.41
16	10.1	213	221	0.486	7.79	7.79
24	10.3	216	230	0.506	8.11	8.04
23	10.6	221	246	0.541	8.68	8.43
21	10.7	225	260	0.572	9.17	9.10
35	10.9	230	278	0.612	9.81	9.35
26	11.1	236	300	0.660	10.58	10.37
43	11.3	238	308	0.678	10.86	10.93
33	11.5	242	323	0.711	11.39	11.92
49	11.7	245	336	0.739	11.85	12.17
34	11.9	251	362	0.796	12.77	12.84
33	12.1	253	369	0.812	13.01	14.00
21	12.3	259	396	0.871	13.97	13.83
23	12.5	262	410	0.902	14.46	14.78
11	12.7	268	438	0.964	15.45	16.15
19	12.8	270	449	0.988	15.84	16.33
17	13.1	277	485	1.067	17.11	16.33
5	13.3	280	500	1.100	17.64	16.26
11	13.5	281	505	1.111	17.81	18.83
12	13.7	287	539	1.186	19.01	20.46
9	13.8	292	567	1.247	20.00	20.03
8	14.1	297	597	1.313	21.06	19.79
9	14.3	300	615	1.353	21.69	23.14
9	14.5	308	666	1.465	23.49	22.89
3	14.7	309	672	1.478	23.70	24.65
8	14.8	313	698	1.536	24.62	27.51
8	15.1	314	705	1.551	24.87	26.49
3	15.3	321	753	1.656	26.56	29.73
6	15.4	327	795	1.749	28.04	30.61
6	15.7	329	811	1.784	28.60	35.45
1	15.8	337	871	1.916	30.72	31.99
5	16.1	348	959	2.110	33.82	35.98
3	16.2	345	934	2.055	32.94	37.67
4	16.4	351	984	2.165	34.71	37.28
4	16.6	350	976	2.147	34.42	36.22
1	16.8	366	1,112	2.446	39.22	42.01
4	17.0	362	1,108	2.438	39.08	41.83
2	17.2	363	1,109	2.440	39.11	48.71
5	17.4	373	1,118	2.460	39.43	48.81
1	17.6	360	1,106	2.433	39.01	29.49
1	17.8	383	1,277	2.809	45.04	43.98
5	18.0	390	1,348	2.966	47.54	47.61
2	18.2	392	1,369	3.012	48.28	64.05
1	18.4	392	1,369	3.012	48.28	54.74

Figure 5.--Length-weight relationship of the largemouth black bass. The curve is the graph of the length-weight equation, and the dots represent the empirical data.

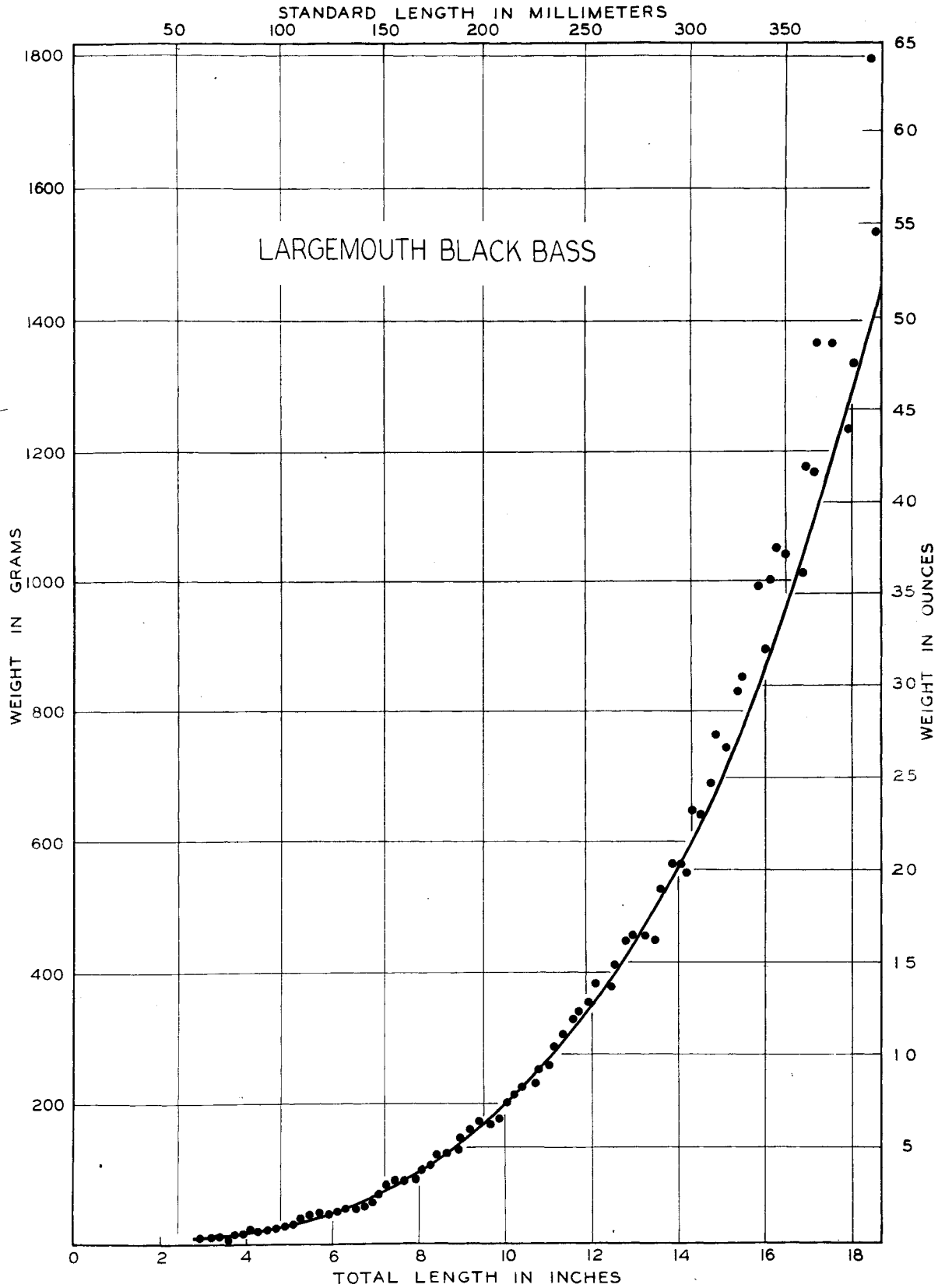

STANDARD LENGTH IN MILLIMETERS
50
100
150
200
250
300
350
LARGEMOUTH BLACK BASS
WEIGHT IN GRAMS
1800
1600
1400
1200
1000
800
600
400
200
WEIGHT IN OUNCES
65
60
55
50
45
40
35
30
25
20
15
10
5
0
2
4
6
8
10
12
14
16
18
TOTAL LENGTH IN INCHES

Table 9

Relationship between the length and weight of the Rock Bass in Michigan. See Table 3 for values of the constant in the length-weight equation and Figure 6 for a graphical representation of the length-weight relationship.

Number of fish	Total length (inches)	Standard length (millimeters)	Weight			
			Calculated (grams)	Calculated (pounds)	Calculated (ounces)	Empirical (ounces)
5	1.5	30	1	0.002	0.04	0.04
2	1.7	33	2	0.004	0.07	0.04
1	1.8	36	2	0.004	0.07	0.11
2	2.0	42	3	0.007	0.11	0.14
3	2.3	46	4	0.009	0.14	0.14
2	2.4	48	5	0.011	0.18	0.14
3	2.7	54	7	0.015	0.25	0.21
4	2.8	57	8	0.018	0.28	0.32
5	3.1	61	10	0.022	0.35	0.35
9	3.2	65	12	0.026	0.42	0.42
9	3.4	69	14	0.031	0.49	0.49
24	3.6	73	16	0.035	0.56	0.60
49	3.8	77	19	0.042	0.67	0.63
79	4.1	80	21	0.046	0.74	0.74
71	4.2	84	25	0.055	0.88	0.88
56	4.4	88	28	0.062	0.99	0.95
57	4.6	92	32	0.070	1.13	1.13
50	4.8	96	37	0.081	1.30	1.30
47	5.0	100	41	0.090	1.45	1.45
68	5.2	104	47	0.103	1.66	1.69
97	5.4	108	52	0.114	1.83	1.83
54	5.6	112	58	0.128	2.05	2.12
53	5.8	116	65	0.143	2.29	2.36
46	6.0	122	75	0.165	2.65	2.54
70	6.2	126	83	0.183	2.93	2.89
66	6.4	130	91	0.200	3.21	3.10
72	6.6	134	99	0.218	3.49	3.39
62	6.8	138	108	0.238	3.81	3.63
53	7.0	142	118	0.260	4.16	4.02
34	7.2	146	128	0.282	4.51	4.41
35	7.4	150	139	0.306	4.90	4.73
35	7.6	154	150	0.330	5.29	5.22
36	7.8	158	162	0.356	5.71	5.47
45	8.0	162	174	0.383	6.14	5.85
27	8.2	166	187	0.411	6.60	6.52
24	8.3	170	201	0.442	7.09	7.27
18	8.6	174	215	0.473	7.58	7.87
13	8.8	178	230	0.506	8.11	7.87
13	8.9	182	246	0.541	8.68	8.50
10	9.2	186	262	0.576	9.24	9.77
14	9.3	190	280	0.616	9.88	9.52
15	9.5	194	297	0.653	10.48	11.18
23	9.7	198	312	0.686	11.00	11.67
18	9.9	202	335	0.737	11.82	12.03
13	10.1	205	350	0.770	12.34	12.77
14	10.3	210	376	0.827	13.26	13.09
17	10.5	213	392	0.862	13.83	15.06
5	10.7	217	414	0.911	14.60	14.07
5	10.9	221	437	0.961	15.41	16.82
5	11.1	226	467	1.027	16.47	15.84
2	11.3	231	500	1.100	17.64	18.48

Figure 6.--Length-weight relationship of the rock bass. The curve is the graph of the length-weight equation, and the dots represent the empirical data.

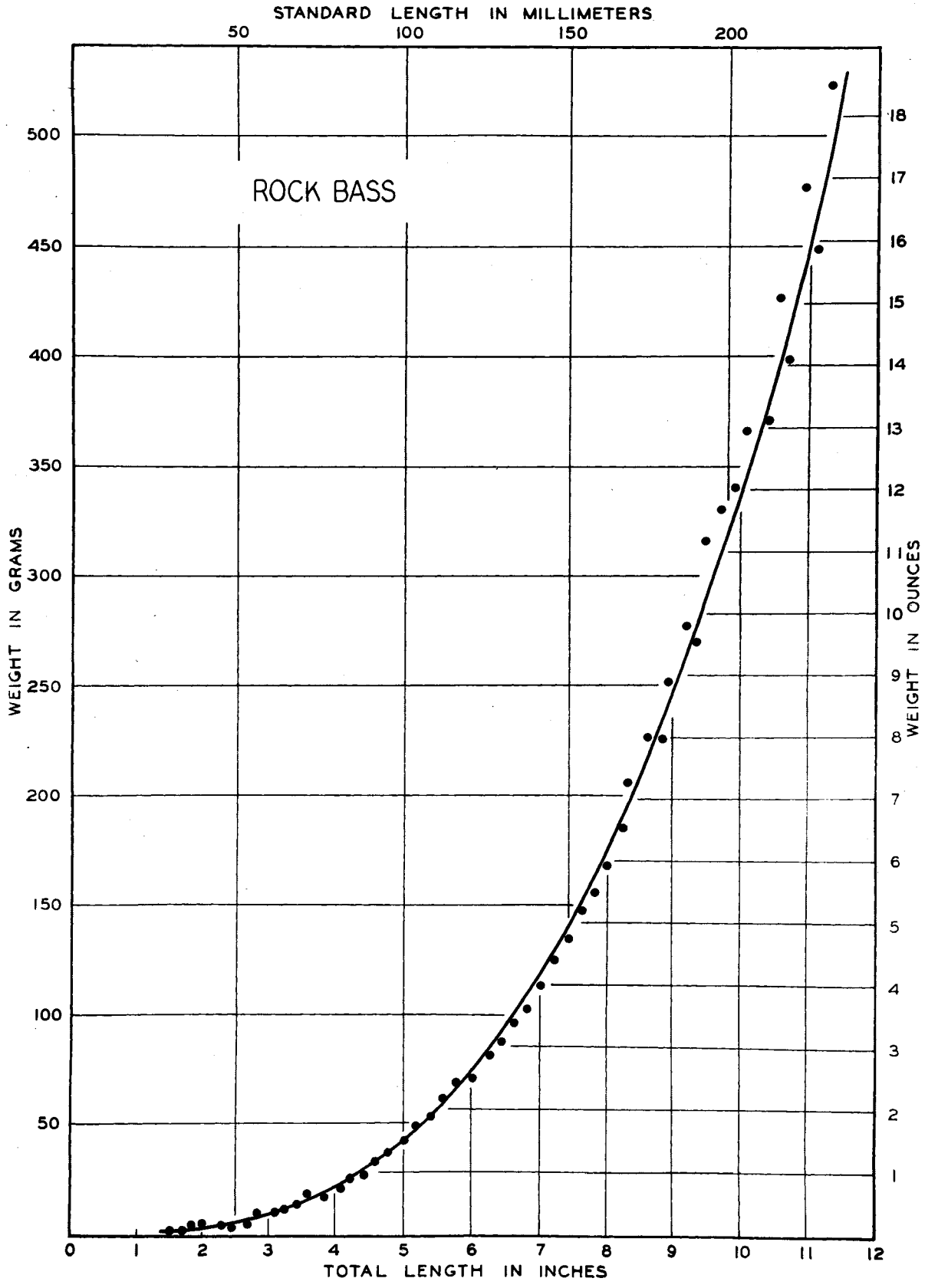
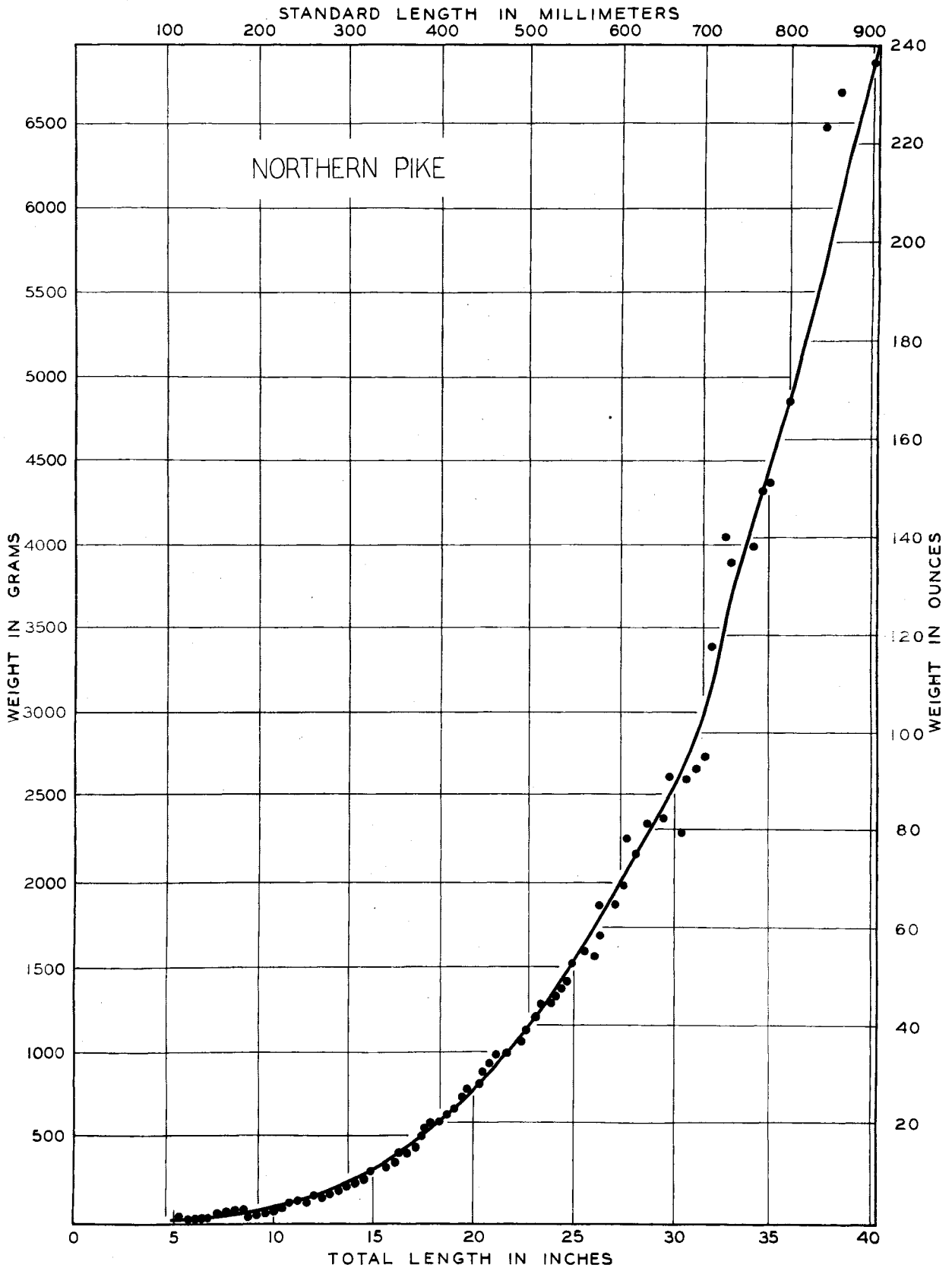

STANDARD LENGTH IN MILLIMETERS
50
100
150
200
ROCK BASS
WEIGHT IN GRAMS
500
450
400
350
300
250
200
150
100
50
WEIGHT IN OUNCES
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
1
2
3
4
5
6
7
8
9
10
11
12
TOTAL LENGTH IN INCHES

Table 10

Relationship between the length and weight of the northern pike in Michigan. See Table 3 for values of the constant in the length-weight equation and Figure 7 for a graphical representation of the length-weight relationship.

Number of fish	Total length (inches)	Standard length (millimeters)	Weight			
			Calculated (grams)	Calculated (pounds)	Calculated (ounces)	Empirical (ounces)
10	2.6	56	1	0.002	0.04	0.04
6	2.9	64	2	0.004	0.07	0.04
8	3.4	74	3	0.007	0.11	0.07
1	3.8	82	4	0.009	0.14	0.28
2	4.2	90	6	0.013	0.21	0.32
3	4.6	100	8	0.018	0.28	0.32
2	4.8	106	10	0.022	0.35	0.42
3	5.3	115	13	0.029	0.46	0.56
1	5.8	126	17	0.037	0.60	0.67
1	6.1	132	20	0.044	0.71	0.71
2	6.3	138	22	0.048	0.78	0.99
2	6.8	148	27	0.059	0.95	1.16
8	7.3	159	34	0.075	1.20	1.23
7	7.6	167	39	0.086	1.38	1.52
8	8.0	175	45	0.099	1.59	1.69
8	8.4	183	52	0.114	1.83	1.98
13	8.8	192	60	0.132	2.12	2.01
19	9.2	200	68	0.150	2.40	2.12
13	9.6	210	79	0.174	2.79	2.36
24	9.9	217	87	0.191	3.07	2.79
9	10.3	225	98	0.216	3.45	3.10
7	10.8	237	114	0.251	4.02	3.99
5	11.2	245	126	0.277	4.44	4.41
8	11.7	256	145	0.319	5.11	4.94
13	12.0	262	156	0.343	5.50	5.50
10	12.5	273	177	0.389	6.24	5.85
26	12.8	279	189	0.416	6.67	6.45
16	13.2	289	210	0.462	7.41	6.98
31	13.6	297	228	0.502	8.04	7.79
32	14.0	306	250	0.550	8.82	8.43
41	14.4	314	271	0.596	9.56	9.45
42	14.7	322	293	0.645	10.33	10.09
30	15.2	331	319	0.702	11.25	10.76
43	15.6	339	343	0.755	12.10	11.36
39	16.0	349	375	0.825	13.23	12.38
40	16.3	355	395	0.869	13.93	13.68
21	16.5	361	416	0.915	14.67	15.45
23	17.0	372	455	1.001	16.05	16.26
23	17.6	383	498	1.096	17.56	18.45
23	17.8	388	518	1.140	18.27	19.19
34	18.2	398	561	1.234	19.79	20.00
29	18.6	407	601	1.322	21.20	21.27
30	19.1	416	642	1.412	22.64	22.57
27	19.5	425	686	1.509	24.20	25.29
27	19.8	434	732	1.610	25.82	26.38
30	20.2	445	790	1.738	27.86	27.40
41	20.5	452	828	1.822	29.20	30.23
29	21.0	462	886	1.949	31.25	31.92
25	21.2	467	916	2.015	32.31	33.93
24	21.7	477	977	2.149	34.46	34.46
24	22.2	490	1,061	2.334	37.42	37.00
23	22.6	496	1,102	2.424	38.87	38.62
16	23.1	507	1,178	2.592	41.53	41.30
15	23.4	516	1,243	2.735	43.84	44.44
17	23.7	523	1,296	2.851	45.71	44.69
14	24.1	532	1,365	3.003	48.14	47.47
12	24.4	539	1,422	3.128	50.15	49.06
13	24.9	548	1,496	3.291	52.76	53.12
12	25.4	560	1,598	3.516	56.36	55.51
7	25.9	572	1,705	3.751	60.14	53.72
8	26.1	576	1,742	3.832	61.44	58.37
6	26.3	579	1,770	3.894	62.43	64.09
5	26.9	591	1,886	4.149	66.52	64.86
7	27.3	601	1,985	4.367	70.01	69.24
5	27.6	614	2,120	4.664	74.77	78.30
4	28.0	616	2,141	4.710	75.51	75.16
5	28.7	633	2,327	5.119	82.07	81.30
3	29.3	637	2,372	5.218	83.66	82.32
3	29.8	648	2,502	5.504	88.25	90.82
3	30.3	658	2,620	5.764	92.41	78.83
4	30.6	666	2,720	5.984	95.93	90.26
3	31.2	679	2,886	6.349	101.79	92.20
5	31.5	684	2,952	6.494	104.12	94.56
5	31.9	710	3,310	7.282	116.74	117.70
1	32.6	726	3,542	7.792	124.93	139.99
2	32.7	728	3,572	7.858	125.98	134.98
3	34.0	760	4,076	8.967	143.76	137.66
1	34.6	770	4,244	9.337	149.69	150.00
3	34.8	775	4,329	9.524	152.68	151.03
1	36.2	807	4,902	10.784	178.89	167.99
1	37.6	838	5,500	12.100	193.99	222.98
1	38.3	851	5,765	12.683	203.33	230.10
2	40.3	897	6,777	14.909	239.02	237.93

Figure 7.--Length-weight relationship of the northern pike. The curve is the graph of the length-weight equation, and the dots represent the empirical data.


STANDARD LENGTH IN MILLIMETERS
100
200
300
400
500
600
700
800
900
NORTHERN PIKE
WEIGHT IN GRAMS
6500
6000
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
WEIGHT IN OUNCES
240
220
200
180
160
140
120
100
80
60
40
20
0
5
10
15
20
25
30
35
40
TOTAL LENGTH IN INCHES

Original: American Fisheries Society
cc: Fish Division
Education-Game
Institute for Fisheries Research
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Supplement to Report Number 1065 on the Length-weight Relationship and Factors for the Conversions between Standard and Total Lengths for Seven Michigan Game Fishes

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Coefficients of Condition

Since Report number 1065 was submitted it was decided to incorperate the data on coefficients of condition. This supplement will also be included in the published paper.

The coefficient of condition, K, has been determined for the seven species. In the determination of the coefficients the following formula was used:

$$K = \frac{100{,}000\ W}{L^3},$$

where W = weight in grams

and L = standard length in millimeters.

The coefficient of condition determined for a species from actual average weights and lengths is subject to fluctuation particularly at lengths represented by small numbers of specimens. In order to smooth out these fluctuations the coefficients of condition, as presented in this paper, were calculated from the length-weight data. The equation used was:

$$\log K = a + m \cdot \log L,$$

where $a = \log c + 5$,

and $m = n - 3$.

Log s and N were obtained from the previous calculations of the length-weight relationship.

Because of the trend toward the use of the English system of weights and measures, the metric coefficient of condition has been converted into an English coefficient, C, (based on total length in inches and weight in pounds), by use of the following equation:[1]

$$C = 36.1\ r^3\ K_m\ ,$$

where r = ratio of standard to total length

and K_m = coefficient of condition in metric system.

Tables 11- 17 contain the data on the coefficients of condition.

[1] This equation was presented by Dr. Ralph Hile at the Tri-State Fisheries Conference, held at Higgins Lake, Michigan, on Feb. 14-15, 1946. It was published in the mimeographed minutes of the meeting which were distributed only to those present at the conference. The author extends his appreciation to Dr. Hile for permission to use his data, and for the many suggestions offered in the presentation of this paper.

Table 11

Coefficient of Condition for the Bluegill in Michigan

Standard length (millimeters)	K (metric)	C (English)
29	3.83	56
33	3.88	57
37	3.93	57
41	3.98	58
45	3.42	58
48	3.45	59
52	3.46	60
56	3.50	60
60	3.53	61
64	3.55	61
68	3.57	62
72	3.59	62
76	3.61	62
80	3.64	62
84	3.65	63
88	3.67	63
92	3.68	64
95	3.70	64
99	3.72	64
103	3.74	67
109	3.74	67
113	3.75	68
117	3.77	68
121	3.78	68
125	3.80	68
128	3.81	69
132	3.82	69
136	3.83	69
140	3.84	69
144	3.86	69
148	3.87	70
152	3.88	70
156	3.89	70
160	3.90	70
166	3.92	71
170	3.93	72
174	3.94	72
178	3.95	72
182	3.96	72
186	3.97	72
191	3.98	72
194	3.99	72
198	3.99	72
202	4.00	73

Table 12

Coefficient of Condition for the Yellow Perch in Michigan

Standard length (millimeters)	K (metric)	C (English)
43	1.69	35
47	1.70	35
52	1.70	35
56	1.71	35
60	1.72	36
64	1.72	36
68	1.73	36
72	1.73	36
77	1.74	36
81	1.74	36
86	1.75	38
91	1.75	38
95	1.76	39
99	1.76	39
103	1.76	39
108	1.77	39
112	1.77	39
116	1.77	39
120	1.78	39
125	1.78	39
129	1.78	39
133	1.79	39
137	1.79	39
141	1.79	39
146	1.79	39
150	1.80	39
154	1.80	39
158	1.80	39
163	1.80	39
167	1.81	40
172	1.81	40
176	1.81	40
181	1.81	40
185	1.82	41
189	1.82	41
193	1.82	41
198	1.82	41
202	1.82	41
206	1.83	41
210	1.83	41
215	1.83	41
219	1.83	41
223	1.83	41
227	1.83	41
231	1.84	41
236	1.84	41
240	1.84	41
245	1.84	41
249	1.84	41
253	1.84	41
257	1.85	41
261	1.85	41
266	1.85	41
270	1.85	41
274	1.85	41
278	1.85	41
282	1.85	41
287	1.86	42
291	1.86	42

Table 13

Coefficient of Condition for the Smallmouth Black Bass in Michigan

Standard length (millimeters)	K (metric)	C (English)	Standard length (millimeters)	K (metric)	C (English)
41	2.27	42	244	2.48	50
46	2.28	42	248	2.48	50
54	2.30	47	253	2.48	50
55	2.30	47	256	2.49	51
62	2.31	47	263	2.49	51
63	2.31	47	265	2.49	50
68	2.32	47	266	2.49	50
73	2.33	47	272	2.49	50
79	2.34	48	278	2.50	50
81	2.35	48	283	2.50	50
85	2.35	48	283	2.50	50
91	2.36	48	288	2.50	50
93	2.36	48	293	2.50	50
98	2.37	48	296	2.50	50
103	2.37	48	299	2.50	50
106	2.38	48	305	2.50	50
111	2.38	48	307	2.51	50
112	2.38	48	314	2.51	50
117	2.39	49	316	2.51	50
122	2.39	49	320	2.51	50
126	2.40	49	330	2.52	50
127	2.40	49	331	2.52	50
134	2.41	49	336	2.52	50
137	2.41	49	339	2.52	50
141	2.41	49	340	2.52	50
146	2.42	49	342	2.52	50
151	2.42	49	354	2.52	50
154	2.42	49	355	2.53	50
159	2.43	49	358	2.53	50
162	2.43	49	361	2.53	50
167	2.43	49	363	2.53	50
171	2.44	50	373	2.53	50
174	2.44	50	370	2.53	50
175	2.44	50	374	2.53	50
181	2.44	50	403	2.54	51
187	2.45	50	401	2.54	51
190	2.45	50			
196	2.45	50			
198	2.45	50			
203	2.46	50			
208	2.46	50			
211	2.46	50			
216	2.46	50			
220	2.47	50			
224	2.47	50			
228	2.47	50			
231	2.47	50			
236	2.48	50			
240	2.48	50			

Table 14

Coefficient of Condition for the Largemouth Black Bass in Michigan

Standard length (millimeters)	K (metric)	C (English)	Standard length (millimeters)	K (metric)	C (English)
44	2.28	45	251	2.24	45
48	2.28	45	253	2/24	45
51	2.28	45	259	2.24	45
56	2.28	45	262	2.24	45
59	2.28	45	268	2.24	45
63	2.27	45	270	2.24	45
69	2.27	45	277	2.24	45
72	2.27	45	280	2.24	45
76	2.27	45	281	2.24	45
82	2.27	45	287	2.24	45
86	2.27	45	292	2.24	45
89	2.27	45	297	2.24	45
93	2.27	45	300	2.24	45
96	2.26	45	308	2.24	45
102	2.26	45	309	2.24	45
106	2.26	45	313	2.24	45
109	2/26	45	314	2.24	47
112	2.26	45	321	2.24	47
117	2.26	45	327	2.24	47
120	2.26	45	329	2.24	47
125	2.26	45	337	2.24	47
129	2.26	45	348	2.24	47
132	2.26	45	345	2.24	47
139	2.26	45	351	2.24	47
142	2.26	45	350	2/24	47
146	2.26	45	366	2.24	47
150	2.26	45	362	2.24	47
154	2.25	45	363	2.24	47
158	2.25	45	373	2.23	47
164	2.25	45	360	2.23	47
167	2.25	45	383	2.23	47
170	2.25	45	390	2.23	47
174	2/25	46	392	2.23	47
180	2.25	46	392	2.23	47
185	2.25	46			
188	2.25	46			
192	2.25	46			
196	2.25	46			
199	2.25	46			
205	2.25	46			
210	2.25	46			
213	2.25	46			
216	2.25	46			
221	2.25	46			
225	2.25	46			
230	2.25	46			
236	2.24	45			
238	2.24	45			
242	2/24	45			
245	2.24	45			

Table 15
Coefficient of Condition for the Rock Bass in Michigan

Standard length (millimeters)	K (metric)	C (English)
30	4.32	77
33	4.32	77
36	4.30	76
42	4.28	76
46	4.27	76
48	4.26	76
54	4.25	75
57	4.24	75
61	4.23	75
65	4.23	75
69	4.22	75
73	4.21	75
77	4.21	75
80	4.20	74
84	4.19	74
88	4.19	74
92	4.18	74
96	4.18	74
100	4.17	74
104	4.17	74
108	4.16	74
112	4.16	74
116	4.16	74
122	4.15	77
126	4.14	77
130	4.14	77
134	4.14	77
138	4.13	77
142	4.13	77
146	4.13	77
150	4.12	77
154	4.12	77
158	4.12	77
162	4.12	77
166	4.11	77
170	4.11	77
174	4.10	76
178	4.10	76
182	4.10	76
186	4.10	76
190	4.09	76
194	4.09	76
198	4.09	76
202	4.09	76
205	4.08	76
210	4.08	76
213	4.08	76
217	4.08	76
221	4.07	76
226	4.07	76
231	4.07	76

Table 16

Coefficient of Condition for the Northern Pike in Michigan

Standard length (millimeters)	K (metric)	C (English)	Standard length (millimeters)	K (metric)	C (English)
56	0.53	12	490	0.50	12
64	0.53	12	496	0.50	12
74	0.53	12	507	0.50	12
82	0.52	12	516	0.50	12
90	0.52	12	523	0.50	12
100	0.52	12	532	0.49	12
106	0.52	12	539	0.49	12
115	0.52	12	548	0.49	12
126	0.52	12	560	0.49	12
132	0.52	12	572	0.49	12
138	0.52	12	576	0.49	12
148	0.51	12	579	0.49	12
159	0.51	12	591	0.49	12
167	0.51	12	601	0.49	12
175	0.51	12	614	0.49	12
183	0.51	12	616	0.49	12
192	0.51	12	633	0.49	12
200	0.51	12	637	0.49	12
210	0.51	12	648	0.49	12
217	0.51	12	658	0.49	12
225	0.51	12	666	0.49	12
237	0.51	12	679	0.49	12
245	0.51	12	684	0.49	12
256	0.51	12	710	0.49	12
262	0.51	12	726	0.49	12
273	0.50	11	728	0.49	12
279	0.50	11	760	0.49	12
289	0.50	11	770	0.49	12
297	0.50	11	775	0.49	12
306	0.50	11	807	0.49	12
314	0.50	11	838	0.49	12
322	0.50	11	851	0.49	12
331	0.50	11	897	0.49	12
339	0.50	11			
349	0.50	11			
355	0.50	11			
361	0.50	11			
372	0.50	11			
383	0.50	11			
388	0.50	11			
398	0.50	11			
407	0.50	11			
416	0.50	11			
425	0.50	11			
434	0.50	11			
445	0.50	12			
452	0.50	12			
462	0.50	12			
467	0.50	12			
477	0.50	12			

Table 17

Coefficient of Condition for the Pumpkinseed in Michigan

Standard length (millimeters	K (metric)	C (English)
34	3.29	59
37	3.35	61
41	3.42	62
45	3.48	63
49	3.54	64
53	3.60	65
57	3.65	66
61	3.70	67
65	3.75	68
69	3.79	68
73	3.83	69
77	3.88	70
81	3.91	71
85	3.95	71
89	3.99	72
93	4.02	73
98	4.07	77
102	4.10	78
106	4.13	78
110	4.16	79
114	4.19	80
118	4.22	80
122	4.25	80
126	4.28	81
130	4.30	82
134	4.33	82
139	4.36	83
143	4.39	83
147	4.41	84
152	4.44	84
155	4.46	85
159	4.48	85
163	4.50	85
167	4.52	86
172	4.55	86
175	4.57	87
179	4.59	87
183	4.61	87
187	4.62	88
188	4.63	88
194	4.66	88