

The rate of growth and sex ratio for seven Michigan fishes

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Abstract

The average size for the various age-groups is presented for seven Michigan fishes: the bluegill (Lepomis m. macrochirus), yellow perch (Perca flavescens), pumpkinseed (Lepomis gibbosus), rock bass (Ambloplites r. rupestris), largemouth black bass (Micropterus salmoides), smallmouth black bass (Micropterus d. dolomieu), and the black crappie (Pomoxis nigre-maculatus). Ages were determined for 25,723 specimens. Only two species showed consistent sex differences in growth rate. The female yellow perch grew more rapidly than did the males, and the male rock bass were consistently larger than the females of corresponding age.

Sex ratio for each of the species also is presented. The percentage of males varied from 39 percent in the yellow perch to 52 percent for the pumpkinseeds and black crappie.

Weights for each of the age-groups were calculated from the length-weight equations.

Introduction

The Michigan Institute for Fisheries Research has been collecting information on the more important game and pan fishes since 1931. Included in the materials were many thousands of scale samples, with records

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of length, weight, and sex for many of the fishes. This paper deals with the age determinations from these samples.

Average size for the various age-groups

Age determinations were made from the scale samples of 25,723 game and pan fishes. The seven species studied were the bluegill, yellow perch, pumpkinseed, rock bass, smallmouth black bass, largemouth black bass, and the black crappie. The samples were taken by the lake inventory parties of the Institute, by means of variety of gear, including gill nets of various mesh sizes, seines, fyke and trap nets, and rod and line. Some samples were taken by creel-census clerks from catches made by fishermen. Lakes from all parts of the State of Michigan were represented in the collections. Most of the samples were collected between May and October, but every month of the year was represented.

The scale sample was removed from the side of the fish, just below the lateral line, directly under the spiny-dorsal fin. The scales were placed in standard scale envelopes of the Institute with the data on length, weight, sex, date of collection recorded on the envelope. In the laboratory the scales were cleaned and mounted on glass slides in a glycerin-gelatin medium. They were examined on a microprojection apparatus, the ages were assessed, and the data recorded on growth-analysis cards for later tabulation. The samples were first sorted by age-group, then by date of collection, sex, and under sex by length. This procedure facilitated further study of the samples. The age of the fish is given as the number of annuli present on the scale. Thus a fish in age-group III would have three annuli present on the scale, plus a varying amount of marginal growth depending upon the time of

year in which it was caught. In order to keep comparisons on a calendar-year basis the author interprets the age of the fishes taken between January 1 and the time of annulus formation in the spring as though the annulus was complete on the scale margin. This virtual annulus is indicated in the age of the fish by an asterisk after the age number signifying that the age given is actually one year greater than the number of visible annuli on the scale would indicate.

No calculations of length were made from scale measurements in this study. The author believes it best not to use calculated lengths until such a time as the body-scale relationship for each of these species can be determined for Michigan waters. Present indications are that few if any of the species here reported have a constant body-scale ratio. A study now in progress will give the necessary information on this relationship. In this paper, therefore, the average size for each age-group is based upon the lengths of the fish at the time of capture. Thus it may be that the lengths as presented are somewhat smaller than the actual length at the completion of the full years growth. This fact may account for some of the difference in growth between Michigan fishes and those reported from other states.

In the preparation of the materials for this study the question arose as to whether different regions of the state might not have a different rate of growth. Beckman (1943) in a study on the time of annulus formation was able to delineate three zones within the State of Michigan in which growth began on different dates. The growth-rate materials were separated on the basis of these three zones and the averages for each zone were obtained. Comparisons showed that no consistent growth differences occurred and therefore all lakes were combined and one average derived for the entire state.

Three groupings were made for the species in each zone--male, female and sex unknown. When more than one collection was available from a lake the average size of each age-group was determined as the weighted average of all collections from each lake. To obtain the average size for each age-group from all lakes the simple average was taken.

Only two species showed a consistent sex difference in rate of growth. The female yellow perch were consistently larger than the males of corresponding age, while the male rock bass were larger than the females. This phenomenon has been observed by other workers for these same species (Eile, 1941; Eddy and Carlander, 1942; Schneberger, 1935; Eile and Jobes, 1942). For a general growth curve, such as those presented in Figures 1-7, the sexes were combined (including fish for which the sex was unknown) to give a single curve. Tables 1-7 present the data for each sex and for the sexes combined. The weights given in Tables 1-7 were calculated from the length-weight equations derived for these species in an earlier study (Beckman, 1948).

Comparisons were made between the growth made in Michigan waters with that made in some of the other states. As pointed out earlier some of the difference in growth may be attributed to the fact that the Michigan average is based upon actual lengths at time of capture and not upon the calculated lengths at the end of the growing season as was the case with many of the averages reported in the literature. The bluegill in Michigan grew at a rate somewhat slower than that reported for other states; for example, bluegills of age-group IV were 6.6 inches in total length whereas they averaged 7.2 inches in Indiana (Ricker, 1942), 6.8 inches in Illinois (Bennett, 1945), and 7.2 inches in Minnesota (Eddy and Carlander, 1942). A similar situation was evidenced by the largemouth black bass; age-group III averaged 10.0 inches in total length in Michigan, 12.7 inches in Minnesota (Eddy and Carlander, 1942), 12.5 inches in Wisconsin (Bennett, 1937), and 10.8 inches in Connecticut (Webster, 1942).

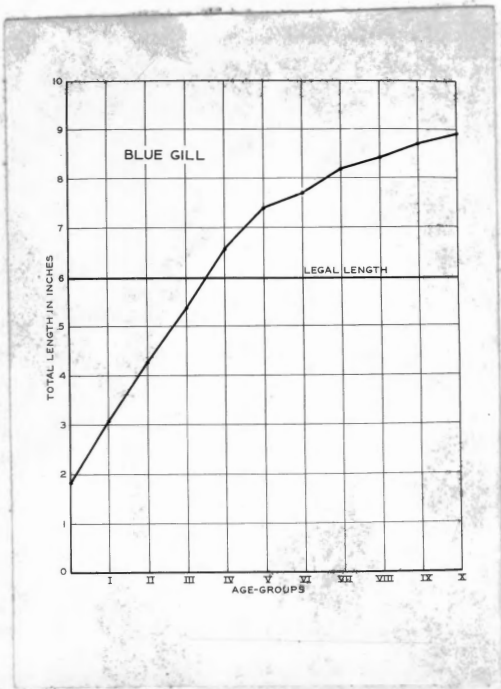


Figure 1.--Average size for the various age-groups of the bluegill

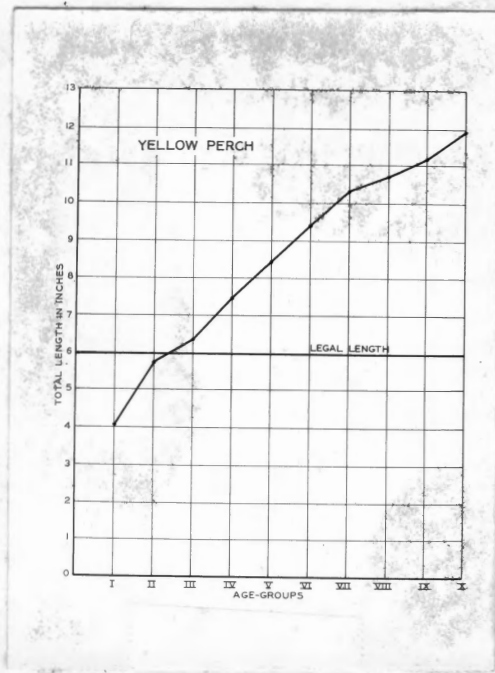


Figure 2.--Average size for the various age-groups of the yellow perch

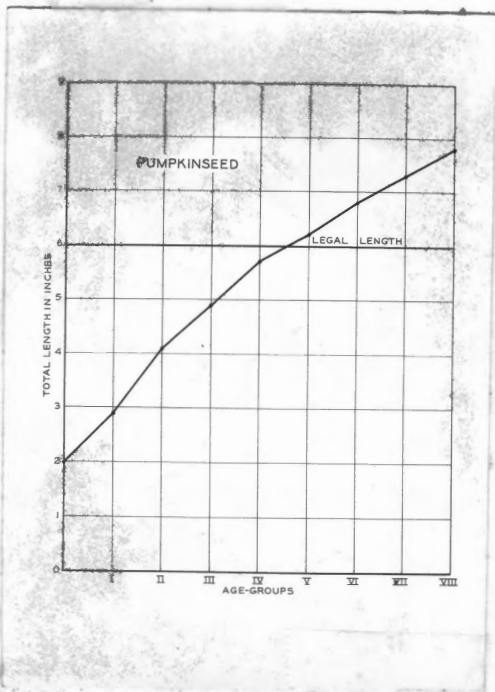


Figure 3.--Average size for the various age-groups of the pumpkinseed

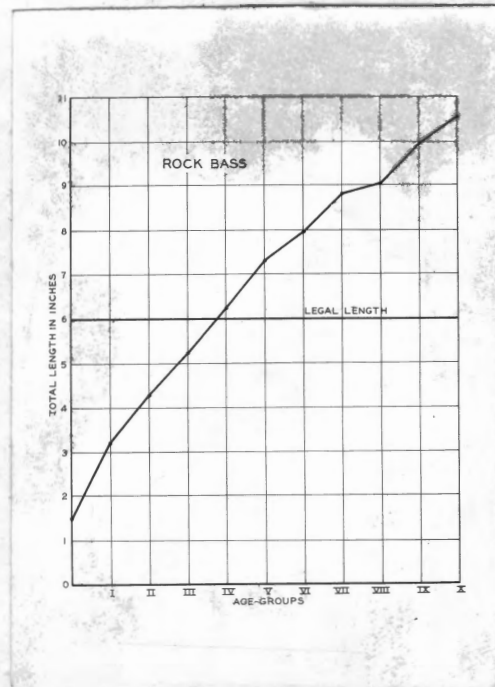


Figure 4.--Average size for the various age-groups of the rock bass

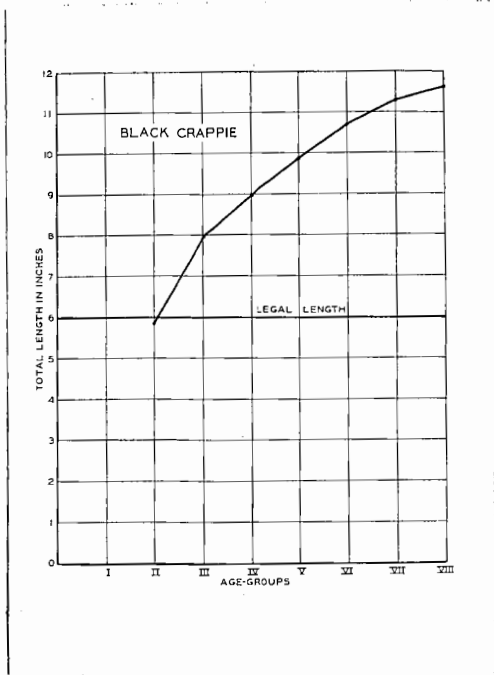


Figure 5.--Average size for the various age-groups of the black crappie

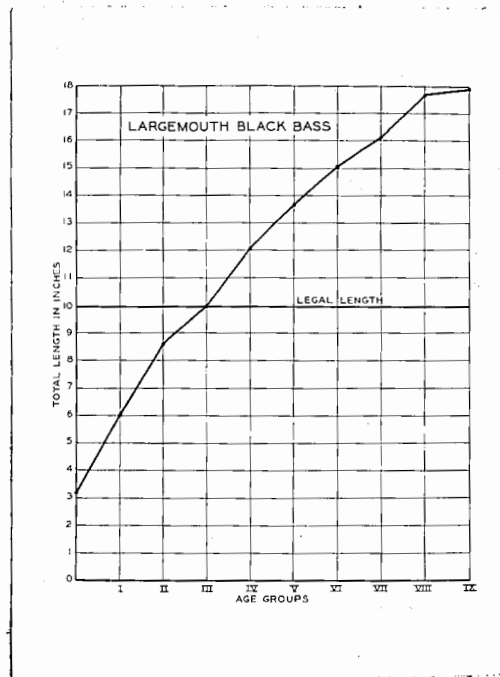


Figure 6.--Average size for the various age-groups of the largemouth black bass

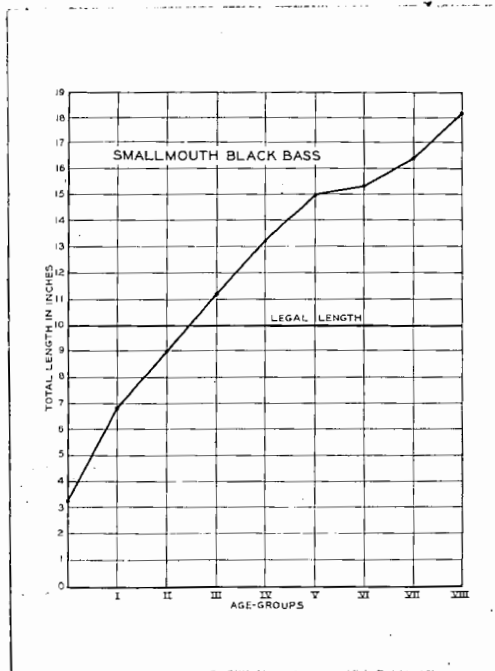


Figure 7.--Average size for the various age-groups of the smallmouth black bass

Table 1.--The average size for the various age-groups, the calculated weight, and the sex ratio for the bluegill in Michigan.
(Based upon 8,159 specimens from 153 lakes).

Age-group	Sex	Number of specimens	Total length (inches)	Standard length (millimeters)	Calculated weight (puncés)	Percentage of males
0	Male
	Female
	Both	13	1.7	33	0.03	...
I	Male	118	3.6	72	0.46	48
	Female	130	3.4	68	0.39	
	Both	470	3.1	61	0.30	
II	Male	213	4.8	95	1.13	46
	Female	253	4.8	95	1.13	
	Both	944	4.3	86	0.81	
III	Male	644	5.6	113	1.90	48
	Female	698	5.7	115	2.01	
	Both	1,933	5.4	109	1.69	
IV	Male	615	6.7	134	3.25	48
	Female	671	6.6	132	3.10	
	Both	1,774	6.6	132	3.10	
V	Male	433	7.4	148	4.41	47
	Female	487	7.3	146	4.21	
	Both	1,308	7.3	146	4.21	
VI	Male	305	7.9	158	5.41	42
	Female	409	7.7	154	5.01	
	Both	934	7.7	154	5.01	
VII	Male	123	7.9	158	5.41	36
	Female	222	8.3	170	6.81	
	Both	425	8.2	166	6.31	
VIII	Male	53	8.3	170	6.81	31
	Female	116	8.4	171	7.00	
	Both	260	8.4	171	7.00	
IX	Male	12	8.3	170	6.81	23
	Female	40	8.8	178	7.87	
	Both	79	8.7	176	7.55	
X	Male	4	8.6	174	7.30	27
	Female	11	9.1	184	8.69	
	Both	19	8.9	180	7.92	
Total	Male	2,520	45
	Female	3,037	...	...	...
	Both	8,159	...	...	...

Table 2.--The average size for the various age-groups, the calculated weight, and the sex ratio for the yellow perch in Michigan. (Based upon 7,314 specimens from 198 lakes).

Age-group	Sex	Number of specimens	Total length (inches)	Standard length (millimeters)	Calculated weight (pounds)	Percentage of males
0	Male
	Female
	Both
I	Male	189	4.5	97	0.56	48
	Female	208	4.6	99	0.60	
	Both	596	4.1	88	0.42	
II	Male	535	5.6	120	1.09	40
	Female	813	6.1	131	1.45	
	Both	1,576	5.8	125	1.23	
III	Male	701	6.0	129	1.38	41
	Female	1,008	6.7	143	1.90	
	Both	1,969	6.4	137	1.66	
IV	Male	456	7.1	152	2.27	38
	Female	742	7.6	163	2.82	
	Both	1,390	7.5	160	2.70	
V	Male	292	8.2	176	3.56	37
	Female	496	8.7	187	4.27	
	Both	856	8.5	184	4.02	
VI	Male	140	9.2	198	5.11	34
	Female	266	9.6	206	5.75	
	Both	453	9.5	205	5.64	
VII	Male	76	9.5	205	5.64	34
	Female	146	10.7	231	8.22	
	Both	246	10.4	225	7.55	
VIII	Male	41	10.1	219	6.95	27
	Female	109	10.9	236	8.71	
	Both	155	10.8	233	8.47	
IX	Male	11	10.9	236	8.71	19
	Female	47	11.4	247	10.06	
	Both	59	11.3	245	9.81	
X	Male	3	12.0	259	11.62	23
	Female	10	12.0	259	11.62	
	Both	14	12.0	259	11.62	
Total	Male	2,444	39
	Female	3,853	...	...	...
	Both	7,314	...	...	...

Table 3.--The average size for the various age-groups, the calculated weight, and the sex ratio for the pumpkinseed in Michigan. (Based upon 3,534 specimens from 182 lakes).

Age-group	Sex	Number of specimens	Total length (inches)	Standard length (millimeters)	Calculated weight (ounces)	Percentage of males
0	Male	10	2.1	43	0.09	83
	Female	2	2.2	45	0.11	
	Both	20	2.0	41	0.07	
I	Male	83	2.8	57	0.21	46
	Female	96	3.2	65	0.35	
	Both	326	2.9	59	0.25	
II	Male	180	4.3	87	0.92	58
	Female	133	4.2	85	0.85	
	Both	494	4.1	82	0.79	
III	Male	481	5.2	106	1.73	53
	Female	435	5.0	102	1.52	
	Both	1,224	4.9	100	1.43	
IV	Male	269	5.9	120	2.58	50
	Female	265	5.9	120	2.58	
	Both	681	5.7	116	2.31	
V	Male	180	6.5	134	3.63	54
	Female	154	6.5	134	3.63	
	Both	455	6.2	126	3.00	
VI	Male	105	6.8	139	4.21	54
	Female	89	6.9	141	4.33	
	Both	231	6.8	139	4.21	
VII	Male	38	7.2	147	4.90	50
	Female	37	7.3	149	5.17	
	Both	77	7.3	149	5.17	
VIII	Male	7	7.4	152	5.43	33
	Female	14	8.4	172	8.11=	
	Both	26	7.8	159	6.31	
Total	Male	1,354	52
	Female	1,229	...	...	...
	Both	3,534	...	...	...

Table 4.--The average size for the various age-groups, the calculated weight, and the sex ratio for the rock bass in Michigan.
(Based upon 2,466 specimens from 126 lakes).

Age-group	Sex	Number of specimens	Total length (inches)	Standard length (millimeters)	Calculated weight (ounces)	Percentage of males
0	Male
	Female
	Both	17	1.5	30	0.04	...
I	Male	39	3.5	71	0.52	42
	Female	53	2.6	50	0.20	
	Both	176	3.2	65	0.42	
II	Male	107	4.3	86	0.93	61
	Female	69	4.5	90	1.06	
	Both	348	4.3	86	0.93	
III	Male	186	5.4	108	1.83	48
	Female	204	5.2	104	1.66	
	Both	498	5.2	104	1.66	
IV	Male	234	6.6	134	3.21	44
	Female	292	6.2	126	2.93	
	Both	630	6.2	126	2.93	
V	Male	125	7.5	152	5.10	44
	Female	162	7.1	144	4.33	
	Both	338	7.3	148	4.71	
VI	Male	76	8.2	166	6.60	48
	Female	82	8.0	162	6.14	
	Both	183	7.9	160	5.92	
VII	Male	56	8.9	182	8.68	47
	Female	63	8.6	174	7.58	
	Both	129	8.8	178	8.11	
VIII	Male	38	9.5	194	10.48	43
	Female	50	8.5	173	7.27	
	Both	92	9.0	183	8.86	
IX	Male	16	9.3	190	9.88	40
	Female	24	8.6	174	7.58	
	Both	42	9.9	202	11.82	
X	Male	6	10.4	211	13.58	55
	Female	5	10.1	205	12.34	
	Both	13	10.5	213	13.83	
Total	Male	883	47
	Female	1,004	...	...	...
	Both	2,466	...	...	...

Table 5.--The average size for the various age-groups, the calculated weight, and the sex ratio for the black crappie in Michigan. (Based on 1,323 specimens from Old lakes).

Age-group	Sex	Number of specimens	Total length (inches)	Standard length (millimeters)	Calculated weight (ounces)	Percentage of males
0	Male
	Female
	Both
I	Male
	Female
	Both
II	Male	205	6.5	131		56
	Female	161	6.3	127		
	Both	430	5.9	118	...	
III	Male	122	7.8	157		50
	Female	124	8.0	161		
	Both	336	8.0	161	...	
IV	Male	102	8.9	179		61
	Female	66	9.0	181		
	Both	253	9.0	181	...	
V	Male	44	10.0	201		42
	Female	61	9.8	197		
	Both	143	9.9	199	...	
VI	Male	31	10.0	201		41
	Female	45	10.9	219		
	Both	113	10.7	215	...	
VII	Male	10	11.1	223		32
	Female	21	11.0	221		
	Both	40	11.3	227	...	
VIII	Male	0		0
	Female	4	10.6	213		
	Both	8	11.6	233	...	
Total	Male	515	52
	Female	484	...	...	...
	Both	1,323	...	...	...

Table 6.--The average size for the various age-groups, the calculated weight, and the sex ratio for the largemouth black bass in Michigan. (Based on 2,307 specimens from 175 lakes).

Age-group	Sex	Number of specimens	Total length (inches)	Standard length (millimeters)	Calculated weight (ounces)	Percentage of males
0	Male	4	3.6	76	0.35	40
	Female	6	3.7	78	0.39	
	Both	174	3.3	71	0.28	
I	Male	77	6.3	130	1.80	53
	Female	67	7.1	148	2.61	
	Both	321	6.1	127	1.65	
II	Male	139	9.0	190	5.58	49
	Female	142	8.8	186	5.18	
	Both	419	8.7	184	4.91	
III	Male	169	10.5	219	8.30	51
	Female	163	9.7	205	6.95	
	Both	505	10.0	211	7.53	
IV	Male	92	11.4	240	11.14	45
	Female	112	12.1	252	12.78	
	Both	368	12.1	252	12.78	
V	Male	74	13.3	280	17.64	51
	Female	70	13.6	284	18.31	
	Both	285	13.7	287	19.01	
VI	Male	25	14.7	309	23.70	48
	Female	27	15.1	314	24.87	
	Both	111	15.1	314	24.87	
VII	Male	10	15.7	329	28.60	40
	Female	15	16.7	358	36.82	
	Both	71	16.1	348	34.71	
VIII	Male	5	17.1	362	38.78	36
	Female	9	19.0	402	50.83	
	Both	33	17.7	372	42.04	
IX	Male	1	18.0	389	46.76	17
	Female	5	17.7	372	42.04	
	Both	20	17.9	386	46.29	
Total	Male	596	49
	Female	617	...	...	...
	Both	2,307	...	...	...

Table 7.--The average size for the various age-groups, the calculated weight and the sex ratio for the smallmouth black bass in Michigan. (Based on 620 specimens from 88 lakes).

Age-group	Sex	Number of specimens	Total length (inches)	Standard length (millimeters)	Calculated weight (ounces)	Percentage of males
0	Male	2	3.5	75	0.34	40
	Female	3	3.2	68	0.25	
	Both	33	3.3	71	0.28	
I	Male	20	6.3	130	1.94	61
	Female	13	6.3	130	1.94	
	Both	53	5.9	124	1.65	
II	Male	40	9.5	196	6.70	57
	Female	30	9.6	198	6.81	
	Both	95	9.0	189	5.78	
III	Male	51	11.2	233	11.13	49
	Female	53	11.2	233	11.13	
	Both	158	11.2	233	11.13	
IV	Male	48	13.6	283	20.02	44
	Female	62	12.8	265	16.45	
	Both	128	13.3	278	19.12	
V	Male	28	15.1	315	27.72	41
	Female	40	15.0	312	26.79	
	Both	79	15.0	312	26.79	
VI	Male	14	15.7	330	32.27	42
	Female	19	15.3	318	28.80	
	Both	45	15.3	318	28.80	
VII	Male	8	16.7	348	38.04	47
	Female	9	17.0	354	40.12	
	Both	20	16.4	339	34.93	
VIII	Male	2	17.4	361	42.43	25
	Female	6	16.9	353	39.90	
	Both	9	16.8	351	38.71	
Total	Male	213	47
	Female	236	...	...	...
	Both	620	...	...	...

The smallmouth black bass in Michigan grew at a rate about equal to that exhibited in Wisconsin (Bennett, 1938) and better than those reported from Maine (Fuller and Cooper, 1946) and Connecticut (Webster, 1942), but again were behind those from Minnesota (Eddy and Carlander, 1942). Age-group III in Michigan averaged 11.2 inches in total length, those from Maine, 7.8 inches; Connecticut, 9.5 inches; Wisconsin 11.4 inches; and Minnesota, 13.0 inches.

The yellow perch also were slower growing than those reported from Connecticut and Minnesota where a total length of 7.9 inches was reported for age-group III (Eddy and Carlander, 1942; Webster, 1942), whereas age-group III in Michigan averaged 6.4 inches. For comparisons between the rock bass, black crappie and pumpkinseeds only figures from Minnesota (Eddy and Carlander, 1942) covered a sufficient number of waters to give comparable data. In each species the growth rate was better in Minnesota than in Michigan waters.

Sex Ratio

Sex data were available for 18,985 of the fish for which age determinations were made. Tables 1 - 7 present the numbers of each sex and the percentage of males for each age-group. The general trend was toward a decreased percentage of males with increase in age. For all ages combined the yellow perch has the lowest percentage of males (39 percent). This phenomenon has been noted by others (Weller, 1938; Nile and Jobes, 1942) with varying percentages of males. The older age-groups had higher percentages of females. The pumpkinseed and black crappie had the highest percentage of males with 52 percent each.

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