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Food Conversion and Growth Rates for Largemouth and Smallmouth Bass in Laboratory Aquaria

Wells E. Williams

Department of Natural Science, Michigan State University, East Lansing, Michigan

ABSTRACT

A laboratory and feeding experiment measuring the food conversion and growth rates of five largemouth bass (*Micropterus salmoides*) ranging in length from 117 to 312 millimeters (4.6 to 12.3 inches) and sixteen smallmouth bass (*Micropterus dolomieu*) ranging in length from 83 to 202 millimeters (3.3 to 7.9 inches) gave average food conversion values of 4.5 for the smallmouth bass, and 3.8 for the largemouth bass when an excess of small, live fish were fed, and average aquarium temperature was 70.3 degrees F. Individual bass consumed from 2.5 to 13.3 percent of their initial body weight daily, with highest consumption usually by the smaller bass. Average daily increase in weight in proportion to initial weight varied considerably, but was also greatest for the smaller fish.

EXPERIMENTAL PROCEDURES

Experimental feeding was conducted in the laboratory of the Department of Fisheries and Wildlife at Michigan State University for a period of fourteen weeks, beginning December 1, 1953, and ending March 9, 1954. Sixteen smallmouth bass (*Micropterus dolomieu*) and five largemouth bass (*Micropterus salmoides*) were collected from the Red Cedar and Looking Glass Rivers near East Lansing. The five largemouth bass ranged in length from 117 to 312 millimeters (4.6 to 12.3 inches), and the sixteen smallmouth bass ranged in length from 83 to 202 millimeters (3.3 to 7.9 inches). Individual weights ranged from 19 to 454 grams for the largemouth bass and from 4 to 112 grams for the smallmouth bass (Table 1).

The captured bass were placed in glass-sided aquaria in the laboratory, and were fed approximately all the food they were able to consume for one week before the feeding program began. During this "adjustment period", weights of forage species fed were not recorded. The aquaria were divided into individual compartments by glass "spacer" plates held in place by means of short lengths of rubber tubing, so placed as to allow oxygen diffusion to all compartments. The individual compartments were of approximately 12.5 gallons in capacity for the smallmouth bass, and 14 gallons for the largemouth bass, with the exception that the largest bass in the sample was placed in a large, museum-type display aquarium having a capacity of 100 gallons. The spacers were installed to prevent cannibalism and to allow individual observation and feeding of the experimental bass. All aquaria were covered to prevent introduction of foreign materials and escape of fish by leaping. One aerating hose attached to a central compressor was placed in an end compartment of each aquarium. Water was added only when necessary to keep aquaria filled to capacity, and once each week, excrement and accumulated materials were siphoned out.

Individual bass were weighed in water to the nearest 0.1 gram at the beginning of the experiment, three times during its course, and again at its conclusion. Bass weighed were first anesthetized in a one-percent solution (by weight) of ethyl ether. Four bass died while under the anesthesia; data for these bass were recorded up to the time of death, and are included in the results. Forage species were also weighed in water to the nearest 0.1 gram. Length measurements in millimeters were obtained by the use of an ordinary fish-measuring board.

Bass were fed live forage fish twice daily, at 7:30 a.m. and 5:30 p.m. Excess forage fish not consumed in subsequent feeding periods were removed, weighed, and subtracted from the record. It was observed during feedings that the larger bass consistently refused small prey items and often would not feed until larger food species were introduced. This is in agreement with the conclusion reached by Lagler and Kruse (1953) from data taken

[1]Portion of a Master's thesis submitted to the Graduate Faculty of Michigan State University, June, 1954.

from a similar study using fewer fish. Water temperature in degrees Fahrenheit was recorded at each feeding. During the experimental period, water temperature ranged from 67.0 to 77.0 degrees F.

Forage fishes were held in cement tanks in the laboratory. The species used included the brook stickleback, *Eucalia inconstans;* the fathead minnow, *Pimephales promelas;* northern redbelly dace, *Chrosomus eos;* the common bluegill, *Lepomis macrochirus;* the golden shiner, *Notemigonus crysoleucas auratus;* and three species of the genus *Notropis*. All forage fish were of sizes small enough to be eaten by bass to which they were fed.

FOOD CONVERSION

At a mean water temperature of 70.3 degrees F. (from a low of 67.0 to a high of 77.0 degrees F. during the feeding period) the average food conversion value for smallmouth bass was 4.5, and that for the largemouth bass 3.8 (Table 1). These mean values are somewhat less than the ratio of 5 to 1 suggested by Richardson (1921) for fish living primarily on animal food. Individual bass varied considerably in the ability to convert food to flesh; conversions ranged from 2.1 to 6.9, with a tendency being shown for smaller bass to have lower (more efficient) food conversion ratios. This relationship was not regular enough to admit statistical verification.

The average daily food consumption for all bass studied was 4.3 percent of the initial body weight. This value is slightly more than the optimum rate of 4 percent found by Thompson (1941) for largemouth bass ranging in size from fingerlings to one pound in weight. Prather (1951) stated that daily feedings of more than 5 percent of initial body weight to largemouth bass yearlings were poorly utilized; the present study clearly indicated that efficient conversions (ratios below 3.0) were obtained by feeding from 2.5 to 13.3 percent of the initial body weight daily. It was evident (Table 1) that food requirements of the smaller individuals were greater than for larger fish.

TABLE 1.—*Weight data, feeding rates, food conversion, and growth rates of largemouth and smallmouth bass*

Species	Initial weight (grams)	Final weight (grams)	Weight gained (grams)	Feeding period (days)	Food consumed (grams)	Percentage initial weight consumed per day	Percentage initial weight gained per day	Conversion rate	Daily instantaneous growth rate
Largemouth bass	19	44	25	98	57	3.1	1.4	2.3	0.00857
	20	75	55	98	129	6.6	2.8	2.3	0.01349
	22	72	50	98	107	5.0	2.3	2.1	0.01209
	27	38	11	63	63	6.9	1.2	5.7	0.00542
	464	526	62	62	409	2.0	0.3	6.6	0.00183
							Average:	3.8	
Smallmouth bass	4	24	20	98	52	13.3	5.1	2.6	0.01828
	5	25	20	98	56	11.4	4.1	2.8	0.01642
	8	22	14	98	51	6.5	1.8	3.6	0.01032
	13	33	20	98	82	6.4	1.5	4.1	0.00951
	22	57	35	98	107	6.5	1.6	4.0	0.00971
	24	31	7	52	31	2.0	0.4	4.4	0.00492
	26	33	7	98	55	2.2	0.3	7.9	0.00243
	31	46	15	98	79	2.6	0.5	5.2	0.00403
	34	49	15	98	98	2.9	0.4	6.5	0.00373
	39	66	27	98	120	3.1	0.7	4.4	0.00537
	40	55	15	98	98	2.5	0.4	6.5	0.00325
	55	98	43	98	112	2.1	0.8	2.6	0.00589
	56	84	30	98	154	2.8	0.5	5.5	0.00414
	60	113	53	98	198	3.4	0.9	3.7	0.00789
	111	144	33	34	121	3.2	0.9	3.7	0.00792
	112	177	65	98	309	2.8	0.6	4.8	0.00467
							Average:	4.5	

WEIGHT AND LENGTH GAINS

Total weight gains for individual bass varied widely (Table 1), with the largemouth bass gaining more weight than smallmouth bass of comparable size. One smallmouth bass (the smallest in the sample) gained five times its starting weight during the 14-week period. Average daily length increases ranged from 0.0 to 0.6 millimeters (Table 2), showing an average daily increment of 0.3 millimeters for the entire sample.

Instantaneous rates, expressed as the natural logarithms of the quotients obtained by dividing the terminal or final weight by the initial or starting weight of bass studied were used to represent the relative growth rates (by weight) of fish in the sample. The relationship is expressed by the formula

$$i = \log_e \frac{Y_t}{Y_o}$$

where i is the instantaneous rate of growth, Y_t is the terminal or final weight, and Y_o the initial weight. The values for i were divided by the number of days in the feeding period for individual bass to give *daily* instantaneous growth rates (Table 1).

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TABLE 2.—*Length*[1] *data for bass*

Species	Initial length	Terminal length	Length gain	Number of days for length gain	Daily length gain
Largemouth bass	117	117	60	98	0.6
	121	174	53	98	0.5
	124	134	10	63	0.2
	133	151	18	98	0.2
	312	312	0	62	0.0
Smallmouth bass	83	127	44	98	0.4
	84	126	42	98	0.4
	84	120	36	98	0.4
	109	149	40	98	0.4
	123	139	16	52	0.2
	127	141	14	98	0.1
	127	147	20	98	0.2
	137	156	19	98	0.2
	142	156	14	98	0.1
	150	174	24	98	0.2
	152	160	8	98	0.1
	160	185	25	98	0.3
	167	202	35	98	0.4
	169	207	38	98	0.4
	192	220	28	98	0.3
	202	207	5	34	0.2

[1] Lengths are given as total length in millimeters.

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