albinos, 79.8 percent in one pond and 82.5 in the other, whereas 94.9 and 93.5 percent of the normal catfish survived. Thus, the average mortality of the albinos was higher than that of the normal catfish. The reasons for higher mortality among the albinos are unknown, but it is suspected that the albinos are more susceptible to predators. This higher mortality rate is a distinct disadvantage of the albinos. There appeared to be no real difference in growth rate between the albinos and the normal fish. In one pond the albinos had an average weight gain of 0.04 pound more than the normal fish, whereas in the other pond their average weight gain was 0.06 pound less than the normal fish. Thus, from the standpoint of growth alone, albinos appear just as desirable as the normal channel catfish.

Albinos were caught on baited hooks just as easily as the normal fish.

TABLE 1.

PRODUCTION DATA COMPARING ALBINO AND NORMAL CHANNEL CATFISH WHEN STOCKED TOGETHER IN TWO PONDS.

	Pond E-2		*Pond E-4*	
	Albino	*Normal*	*Albino*	*Normal*
Date stocked	December 4, 1959		December 4, 1959	
Date drained	November 14, 1960		November 15, 1960	
Number stocked	1,000	1,000	1,000	1,000
Number recovered	798	949	825	935
Percent survival	79.8	94.9	82.5	93.5
Pounds stocked	22.0	21.4	22.4	21.8
Pounds recovered	766.2	874.6	844.1	1,007.9
Pounds gained	744.2	853.2	821.7	986.1
Average weight fish stocked (pounds)	0.02	0.02	0.02	0.02
Average weight fish recovered (pounds)	0.96	0.92	1.02	1.08
Gain in average weight, pounds	0.94	0.90	1.00	1.06

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FORAGE FISH PREFERENCE AND GROWTH RATE OF LARGEMOUTH BLACK BASS FINGERLINGS UNDER EXPERIMENTAL CONDITIONS

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ABSTRACT

Experiments to determine the forage species preference of largemouth black bass fingerlings and a few larger bass are described. Data on the amount of food consumed, rate of growth and food conversion are presented. Forage minnows included were goldfish, *Carassius auratus* (Linnaeus), fathead, *Pimephales promelas* (Rafinesque) and bluegill, *Lepomis macrochirus* (Rafinesque). While there was evidence of considerable individual variation in the species of forage minnow preferred, the bass in the experiments preferred fatheads more frequently than the other species, goldfish were second choice and bluegills were last. The degree of preference between bluegills and goldfish did not appear to be great for the limited number of bass included. Food conversion was best on a fathead or bluegill diet.

Where four larger bass, 0.4-0.5 pound in size, were fed equal amounts of bluegills and fathead minnows, one fish showed no preference between the species, two preferred fatheads to a moderate degree while one showed a strong preference for fatheads.

INTRODUCTION

The species of forage minnow used to grow largemouth black bass (*Micropterus salmoides*, Lacepede) brood stock to spawning size varies

considerably from one hatchery to another. Topel (1949) reported feeding adult bass held for spawning on a mixture of animal life which included tadpoles, green sunfish, warmouth bass and suckers. Blosz (1952) described a practice of stocking the summer holding pond for bass brood stock with adult bluegills in the early spring to provide young that comprised the food supply of brood bass that were stocked in the pond after spawning. Davis (1953) stated that goldfish was a suitable forage species for adult largemouth black bass and listed the golden shiner *(Notemigonus crysoleucas)*, blountnosed minnow *(Hyborhynchus notatus)*, and the fathead minnow *(Pimephales promelas)* as being important forage species for rearing small bass to large fingerling size.

From personal observation and communication with bass culturists located throughout the United States, the current practice is to feed the species of forage fish most readily available or one which can be cultured in the largest quantity at the lowest cost. Goldfish, carp, fathead minnows, gizzard shad, golden shiners, bluegills and *Tilapia* are some of the species of forage minnows presently being used.

While availability and low cost are important factors for consideration when choosing a species of forage fish, it would seem that desirability of the food to the consuming bass and the effectiveness of the food in producing bass flesh should also receive some attention. Lewis, et. al. (1961) reported that where largemouth black bass were held under confined conditions some food items were taken in preference to others. Golden shiners were preferred to bluegills while bluegills were eaten in preference to green sunfish.

In an effort to provide additional information on the most suitable species of forage fish for largemouth black bass culture, a series of experiments were conducted at the Marion, Alabama National Fish Hatchery during the years of 1955, 1956 and 1957.

FIRST EXPERIMENT-METHOD

Four concrete holding tanks measuring eight feet long, two feet wide and 20 inches deep were divided with a screen partition to make two equal sized compartments. A small amount of fresh water from a well supply flowed into the two upper tanks and through them to the lower ones. The compartments were stocked with five randomly selected bass fingerlings from a pond reared lot on June 13. Size of the test fish is shown in Table 1. Four treatments replicated twice were outlined as follows:

Food	*Lots*	*Rate*
Goldfish	1 and 6	10 percent of live weight daily
Fatheads	2 and 5	10 percent of live weight daily
Bluegills	3 and 8	10 percent of live weight daily
Equal weights of bluegills, goldfish and fatheads	4 and 7	15 percent of live weight daily

The lots were fed each week day Monday through Friday. Cooler water temperatures reduced the food intake during the fall months and the rate was reduced to 5 percent of the body weight of the test fish the last month of the experiment. Small forage fish of a size which the bass could swallow were weighed on a triple beam laboratory balance graduated to 10 milligrams and placed in a live condition into the compartments with the bass. On the following day, all uneaten forage fish were removed and weighed prior to adding a fresh supply.

The bass were measured and weighed at biweekly intervals except during one month when the weighing period was three weeks in one instance and one week in another. Seven feeding periods of two weeks each were included. The experiment began on July 8 and was teminated October 14.

Water temperature was obtained by means of a recording thermometer in one of the tanks. A mean daily temperature was obtained by taking the recorded readings at 6:00 a.m., 12:00 Noon, 6:00 p.m. and 12 Midnight and averaging them. Water temperatures over the three and a half month period ranged from a high of 26°C. to a low of 15°C. Water temperature data for the periods are shown in Table 2.

Losses of test fish were negligible. Seven fish were missed during the first feeding period and probably were eaten by wild animals. These

TABLE 1.

SIZE OF BASS USED IN FIRST EXPERIMENT.

Lot No.	*Avg. Wt. Gms.*	*Wt. Range*	*Average Total Length in Millimeters*	*Length Range*
1	5.8	4.9-7.5	84	80-91
2	5.1	4.8-5.8	83	81-85
3	5.2	4.7-5.7	83	80-86
4	5.7	4.6-7.6	83	79-88
5	8.0	7.1-9.5	89	84-95
6	6.0	4.4-7.1	85	78-92
7	5.1	4.5-6.3	81	79-83
8	5.6	5.0-6.3	82	77-85
All lots	5.8	4.4-9.5	84	77-95

TABLE 2.

WATER TEMPERATURE FOR THE FEEDING PERIODS OF THE FIRST EXPERIMENT

Dates	*Maximum*	*Minimum*	*Approximate Mean*[1]
6/15-6/24	22.0°C.	19.5°C.	21.0°C
6/25-7/8	24.0	22.0	23.0
7/9-7/22	24.8	23.0	23.8
7/23-8/12	25.8	22.2	24.2
8/13-8/19	25.5	22.5	23.6
8/20-9/2	26.0	22.0	24.5
9/3-9/16	24.0	21.0	22.4
9/17-9/30	24.0	21.0	22.8
10/1-10/14	24.0	15.0	20.2

[1] Chart could be read accurately to 0.5°C. Four daily readings were averaged for the daily temperature, so the mean temperature which was an average of the daily temperatures is mathematically inaccurate since it is an average of an average.

TABLE 3.

SIZE HIERARCHY EFFECT IN A LOT OF 5 LARGEMOUTH BASS FINGERLINGS ILLUSTRATED BY GAIN IN BODY WEIGHT IN GRAMS.

Date Weighed	*Fish 1*	*Fish 2*	*Fish 3*	*Fish 4*	*Fish 5*
7/22	1.7	4.1	5.5	3.4	7.0
8/12	1.2	2.2	2.9	3.2	7.2
8/19	0.0	0.6	-0.5	2.2	2.0
9/2	Removed	2.2	2.4	5.7	7.9
9/16	. .	1.6	3.3	6.3	6.8
9/30	.	1.2	3.6	6.5	7.7

fish were replaced at the end of the first weighing period. Another fish died from unknown causes the third month of the experiment and was not replaced.

After 10 weeks, growth of the smallest fish in each lot had ceased. It appeared that the amount of space available was inadequate to provide the amount of feeding territory needed by the five fish present. Consequently, the dominant individuals monopolized the food supply, preventing the weaker fish from feeding even though they could not consume all of the food themselves.

This size hierarchy effect was described for trout by Brown (1957). Table 3 illustrates size hierarchy effects for Lot 7 composed of five largemouth black bass fingerlings.

Since they were not growing, the smallest fish in each lot was removed on August 19. Thus there were four fish per lot after this date. It was necessary to separate the fish in Lot 2 during late August to protect the weaker fish from the dominant individuals. The same procedure was required later in Lot 8. For later feeding periods, the data for the individual fish was consolidated as the individuals received similar treatment except for a partition which kept them apart.

TABLE 4.
DATA ON FOOD CONSUMPTION, WEIGHT GAINED AND FOOD CONVERSION FOR BASS IN THE FIRST EXPERIMENT.

Lot number	*Diet*	*Weight gain grams*	*Food consumed*	*Percent weight gain*	*Conversion*
1	Goldfish	136.2	589.3	470	4.3
6	Goldfish	75.0	448.3	249	5.6
Average		105.6	518.8	359.5	4.9
2	Fatheads	154.4	498.0	601	3.2
5	Fatheads	114.1	500.2	285	4.4
Average		134.3	499.1	443.0	3.7
3	Bluegills	104.2	510.6	399	4.9
8	Bluegills	63.9	332.1	230	5.2
Average		84.1	421.4	315.0	5.0
4	Mixture	232.7	932.0	811	4.0
7	Mixture	129.7	540.5	509	4.2
Average		181.2	736.3	660.0	4.1

The bluegills fed proved to be difficult to keep alive after the handling involved in collection and weighing. During the summer months, from ⅓ to ½ of the uneaten bluegills were dead the following day. In addition to handling damage, part of the mortality appeared also to be due to the feeding habits of the test fish. Any forage fish not consumed shortly after being fed were pursued and mouthed by the bass even though their desire for food was satisfied. The fatheads and goldfish would escape by choosing an inaccessible spot near the surface or bottom in the corners of the compartment. The bluegills appeared to lack the instinct to seek such protection or were lacking in the energy needed to do so and were more frequently killed.

FIRST EXPERIMENT-RESULTS

The results of the experiment are summarized in Table 4. For the first few weeks, forage minnows at a rate of 10 percent of the starting body weight of the test fish per day was inadequate to satisfy the bass. Also, all forage in the mixed species lots being fed at a rate of 15 percent was consumed for two weeks after the start of the experiment. After this, dead fish were observed the day following feeding. After a month, live forage fish were in evidence. Live fish were seldom found on Monday however at any time during the experiment. The food intake of the four lots in th lower pair tanks decreased appreciably about August 1 and live fish could normally be found on week days in Lots 5-8 as cooler water temperatures developed. In the range of 21-24 degrees C., it appeared that the experimental bass would utilize forage fish of about 15 percent of their body weight daily.

The rate of food conversion for the various lots falls within the range of values reported by Thompson (1941) and Prather (1951). Values from period to period were rather inconsistent except in Lot 2 where the range was 2.4 to 3.2 for seven weighing dates. In Lot 1, conversion ranged from 2.7 to 6.6 while in Lot 3 it was 3.7 to 6.2. The highest conversion value was 8.2, noted in Lot 6 for the period June 25-July 8. The test fish consumed the food provided but did not make appreciable growth for some reason. The fish in Lot 5 had a conversion of 7.9 for the August 12-19 feeding period but here the apparent cause was a failure to consume much of the food supplied.

A noticeable difference in food conversion occurred between the two upper tanks where Lots 1-4 were located and the two lower ones containing Lots 5-8. A temperature difference of one degree centigrade was measured on several occasions which could have had some influence although it is questionable that all of the dissimilarity could be caused by such a small temperature variation. Another influence may have been the fact that water for the lower pair of tanks was supplied from the upper

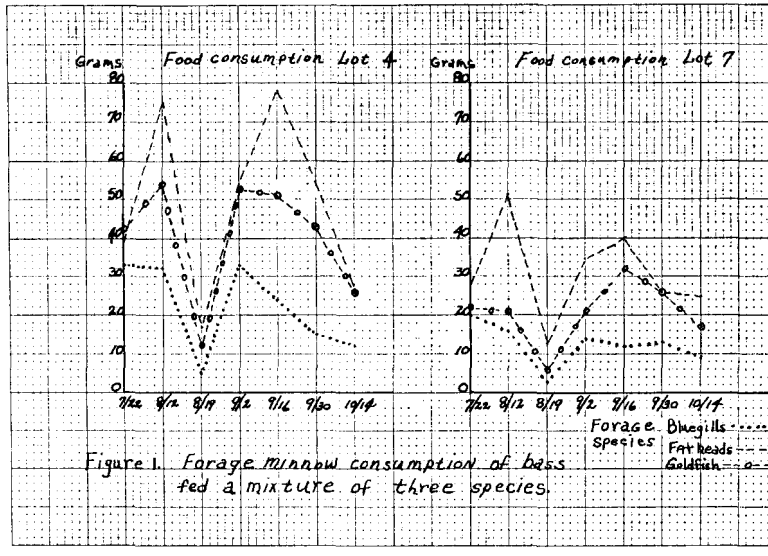

Figure 1. Forage minnow consumption of bass fed a mixture of three species.

ones. Lowered food intake and consistently poorer conversion may have been caused by secretions and discharges from the fish above although this reasoning also is open to question in view of the small number of fish involved.

The greatest weight gain occurred in the lots fed the mixed diet followed by fathead, goldfish and bluegill diets in that order. Food conversion was lowest in the lots fed fatheads with the mixed lots being second. Little difference in food conversion was apparent between the bluegill and goldfish fed lots.

Treatment 4 was included to measure the species preference of largemouth bass fingerlings. Data for this treatment which included Lots 4 and 7 are summarized in Table 5 and illustrated by Figure 1. As illustrated, more fathead minnows were consumed than either goldfish or bluegills is all except one instance, where more goldfish were eaten. The difference between fathead and goldfish consumption was slight in five instances. Generally in this experiment bluegills were third choice as a food item of the test fish. A marked difference was demonstrated between the quantity of goldfish and bluegills consumed in all except two instances.

Undoubtedly utilization of bluegills was influenced by availability of live individuals after the initial feeding. In one lot 54.3 percent of the uneaten bluegills were dead while 29.1 percent were dead in the other. Fathead minnows also showed a high rate of mortality however with 33.1 percent of those uneaten being dead in one lot and 45.9 percent in the other lot. During September and October survival of bluegills was considerably higher possibly due to lower water temperatures. Bluegills constituted the greatest percentage of uneaten forage throughout the experiment with the amount consumed being fairly consistent from one weighing period to another.

It seems probable that since the size hierarchy effect exerted an influence on growth rates among the test animals, this same effect would also influence the type of food consumed. Thus it is possible that as the experiment progressed the food preference being measured was principally that of the larger fish in each lot.

SECOND EXPERIMENT-METHOD

The following year a second experiment was conducted along somewhat the same lines as the one described above. Cages made of plastic

TABLE 5.
FOOD CONSUMPTION OF BASS FED A MIXED DIET OF THREE SPECIES OF FORAGE MINNOWS.

Item	*Lot 4*	*Lot 7*	*Average*
Total weight of food fed (grams)	1,427.0	988.4	1,207.7
Total weight of food consumed	932.0	540.5	736.3
Grams of bluegills consumed	199.7	98.2	149.0
Percentage of total consumption which was bluegills	21.4	18.2	20.2
Percentage of bluegills fed that were eaten	42.0	29.8	...
Grams goldfish consumed	324.4	185.0	254.7
Percentage of total consumption which was goldfish	34.8	34.2	34.6
Percentage of goldfish fed that were eaten	68.2	56.1	...
Grams fatheads consumed	407.8	257.0	332.4
Percentage of total consumption which was fatheads	43.8	47.6	45.1
Percent of fatheads fed that were eaten	85.7	78.0	...

screening material on a wood frame, 2'x2'x2', were suspended to a depth of 18 inches in a concrete pool which measured 8 feet wide, 2½ feet deep and 30 feet long. Two rows of cages were used with each cage being about a foot from the adjoining one in the row. A small amount of well water flowed through the pool.

Initially, 5 uniform size fish were placed in each cage. These fish had been selected by grading from a lot of pond reared bass. Average size at the start was 0.57 grams with a total length of 37 mm. Twenty-one cages were used, divided into seven blocks of three cages each depending on the location of the cage in the pool. Three diets were fed—bluegills, fathead minnows and goldfish; hence, each block contained a replication of each of the three diets. The test fish were fed the forage species at a rate of 30 percent of their live weight daily, five days weekly. No feeding was done on Saturdays, Sundays or holidays. The duration of the experiment was 73 days extending from May 25 to August 6. This time was divided into five feeding periods of about two weeks each for convenience in analyzing the data. Weight measurements were made of the test fish at the beginning of the experiment and each two weeks afterwards. Monday was used as a weighing day so that two days would pass after food was supplied.

The forage fish were weighed to the nearest tenth of a gram on a laboratory balance. On the day following feeding, any dead or uneaten forage fish were removed and weighed to determine food consumption. Uneaten forage was often dead as the test bass killed many of the forage fish which were not consumed at feeding time.

The bass fed readily, adjusting to experimental conditions within a week. Mortality was low, but when a dead bass was observed it was weighed and the ration decreased proportionately. Weight of the dead fish was included in the lot weight for the feeding period. When a new period was started the dead fish was replaced with an individual of a comparable size from a group which had been fed a similar diet as that for the experimental lot.

The hierarchy effect noted the previous year began to exert a noticeable influence on growth of the individual fish after two weeks. Because of this, the smallest of the test bass were removed at the end of the second two-week feeding period. At the end of the next two-week period, the largest fish were still dominating the groups so the three smaller bass were eliminated leaving only one fish per lot for the last two feeding periods.

Water temperatures were obtained as in the first experiment except that the bulb of the recording thermometer was located in the middle of the pool about one foot off the bottom. The range of temperatures for

TABLE 6.
RESULTS OF FEEDING BASS FINGERLINGS THREE SPECIES OF FORAGE FISH—SECOND EXPERIMENT.

Dates in Feeding	5/25-6/11	6/12-6/25	6/26-7/9	7/10-7/23	7/24-8/6
Forage species giving lowest conversion	Bluegill	Bluegill	Bluegill	Fathead	Fathead
Average Food Conversion	3.6	4.7	4.5	3.5	3.7
Food consumption—lowest conversion species[1]	14.7	21.0	17.7	16.9	16.0
Forage species giving next lowest conversion	Fathead	Fathead	Fathead	Bluegill	Bluegill
Average Food Conversion	4.0	5.6	5.5	4.0	3.9
Food consumption—next lowest conversion species[1]	15.0	20.7	19.3	14.0	15.5
Forage species giving highest food conversion	Goldfish	Goldfish	Goldfish	Goldfish	Goldfish
Average food conversion	6.4	6.7	7.5	6.1	4.9
Food consumption—highest food conversion species	14.8	20.8	18.9	18.1	16.7
Approximate Mean Water Temperature Deg. C.	19.7	20.6	21.4	20.9	22.1
Number of bass per lot	5	5	4	1	1
Number of lots in experiment	21	21	21	21	21

[1] Expressed as an average of the percentage of the body weight of the fish in each lot at the start of the two-week feeding period.

the feeding periods were as follows: 17.5-22.5°C., 19.0-23.0°C., 20.5-23.0°C., 19.0-22.0°C., 20.5-23.5°C. Mean water temperatures are shown in Table 6.

SECOND EXPERIMENT-RESULTS

Food utilization for the three diets is shown in Table 6. The bluegill diet gave the lowest food conversion in three of five instances and was second lowest in the two remaining periods. The fathead diet gave the lowest conversion in two of the periods and was next lowest in three instances. The goldfish diet consistently gave the highest conversion and the lowest gain in weight throughout the experiment. As will be noted from the data in Table 6 pertaining to food consumption, goldfish were eaten as readily as the other species. It appears that the failure to gain and convert food to bass flesh was caused either by a deficiency of the forage fish supplied or the failure of the test animals to use the food furnished as efficiently as did those in the other treatments.

An analysis of variance (Snedecor, 1946) was performed on the food conversion data. Differences between diets were statistically significant for the second, third and fourth feeding periods. There also was a highly significant difference between food conversion for the diets over the entire feeding period. An examination of the data indicates that the failure of the goldfish diet to give as low a food conversion value as the bluegill and fathead diets was the cause of the significant variation.

The average gain in weight for each feeding period is illustrated in Figure 2. Gains were highest in all diets the third, second and fifth weighing periods. They were lowest the fourth period for some undetermined reason.

The test fish consumed forage minnows at rates ranging from 14.7 to 21.0 percent of their body weight per day during the course of the experiment. As can be seen in Table 6, there was no marked difference between the amount of food consumed in the three diets, as the average percent of starting body weight ranged from 14.7-15.0 percent for the first period, 20.7 to 21.0 for the second, 17.7 to 19.3 for the third, 14.0 to 18.1 for the fourth, and 15.5 to 16.7 for the last feeding period.

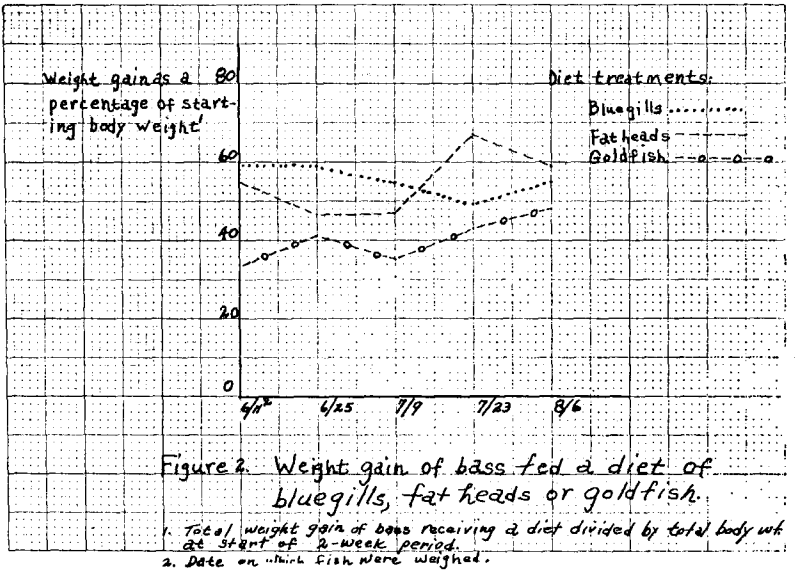

Figure 2. Weight gain of bass fed a diet of bluegills, fat heads or goldfish.

1. Total weight gain of bass receiving a diet divided by total body wt. at start of 2-week period.
2. Date on which fish were weighed.

THIRD EXPERIMENT-METHOD

The cage arrangement described above was utilized in the third experiment to obtain additional data on the preference of largemouth bass fingerlings for bluegill and fathead minnows fed free choice. Also, the weight gain and food conversion of a bluegill forage diet was compared with that of a mixed diet of bluegills and fatheads. An effort was made to include an artificial diet in the comparison but individual fish could not be trained to feed readily under the experimental conditions thus making such a comparison impossible. A group of largemouth black bass fingerlings that had been used previously in another feeding experiment were used in this work. Total length of the fish in the lot varied from 74 to 97 mm while their weight ranged from 4.41 to 11.53 grams. One fish was placed in each cage and fed either bluegills or a mixture of equal parts of bluegills and fathead minnows at a rate of 10 percent of their starting body weight per day three times weekly. The uneaten forage from the previous feeding was removed, counted and weighed on the next feeding day before the new ration was supplied. At the end of each two weeks, the fish were measured and weighed. They were thn returned to the cage for further study. The experiment was started on September 4 and ran until November 6. Four, two-week weighing periods were included. Water temperatures were obtained by means of a recording thermometer with a bulb set in the middle of the pool about one foot off the bottom. Approximate water temperatures were as follows

Period	*Mean temperature*	*Range of temperature*
September 10-24	21.5°C.	18.5-23.0
September 25-Oct. 8	17.7°C.	16.0-19.0
Oct. 9-24	16.9°C.	15.0-18.5
Oct. 25-Nov. 5	14.2°C.	11.0-16.5

THIRD EXPERIMENT-RESULTS

Results of the third experiment were more variable than had been the case in earlier work. Lower water temperatures may have been partially

TABLE 7.

FOOD CONVERSION FOR THE THIRD EXPERIMENT.

Fish	*Diet*	*Food Conversion Obtained* 9/10-9/24	9/25-10/8	10/9-10/24	10/24-11/5	*Average* *
1	Bluegill-Fathead	8.0	Loss	2.0	9.1	7.2
2	Bluegill-Fathead	Loss	**	87.1	6.8	15.8
4	Bluegill-Fathead	69.7	5.6	Loss	2.4	16.4
10	Bluegill-Fathead	60.3	3.7	11.7	1.8	5.7
12	Bluegill-Fathead	6.5	2.3	14.8	5.0	4.6
19	Bluegill-Fathead	7.7	4.6	No. wt. gain	3.0	5.4
20	Bluegill-Fathead	7.4	4.8	44.2	5.4	8.6
Average*		12.3	3.6	22.4	3.9	6.9
3	Bluegill alone	4.4	25.1	3.2	4.4	5.1
5	Bluegill alone	12.7	3.4	Loss	3.6	8.3
8	Bluegill alone	8.9	2.8	Loss	4.7	7.3
9	Bluegill alone	6.1	7.2	33.5	4.0	7.4
15	Bluegill alone	6.2	6.4	12.2	6.9	7.6
16	Bluegill alone	5.6	4.3	13.5	Loss	9.3
18	Bluegill alone	9.1	10.9	Loss	4.4	12.3
Average		7.4	5.5	No wt. gain	7.7	9.7

* Obtained by dividing the total food consumed by the total weight gained.
** Fish disappeared from cage during the feeding period, replaced on 10/9 with new individual.

TABLE 8.

FORAGE MINNOW PREFERENCE OF SEVEN BASS FED EQUAL NUMBERS OF BLUEGILLS AND FATHEAD MINNOWS.

Fish Number	*Percent of bluegills fed that were eaten*	*Percent of fatheads fed that were eaten*	*Forage minnow preference*	*Extent of preference*
1	49.0	82.5	Fathead	Consistent
2	67.9	49.1	Bluegill	Consistent
4	45.9	35.2	Bluegill	Variable
10	59.8	51.4	Bluegill	Variable
12	60.4	62.6	Fathead	Variable
19	56.5	56.0	No preference	Consistent
20	34.5	41.2	Fathead	Variable

responsible for this along with a failure to acclimatize the text fish to the environmental conditions prior to beginning feeding. Food conversion data for individual bass on the two diets are shown in Table 7. The mixed diet of forage minnows gave the lowest average conversion rate for three of the four two-week periods and also the lowest figure for the entire test. The difference does not appear to be statistically significant in view of the variation exhibited by individual fish from one period to another.

During the first feeding period the test fish consumed from 1.1 to 10.0 percent of their starting body weight daily. The relationship between the food intake and weight gain was not very close apparently. The lowest conversion was shown by a fish consuming forage at a 10 percent level. Another fish also eating the same forage fish at this rate showed a conversion value of 29.4. For the final feeding period food intake of all fish was reduced considerably because of lower water temperature, varying from 2.6 to 6.8 percent of the starting body weight of the fish per day. The range was narrower and the variation was much less than for the experiment as a whole. Conversions were also more uniform suggesting much better adjustment of the test fish to the environment.

Preference of the seven individual bass receiving a mixed diet of fathead minnows and bluegills varied from fish to fish and sometimes from one feeding period to the next. In Table 8, the percentage of bluegills or fatheads consumed of the total number fed illustrates the forage minnow species preference. The percentage consumption forms the basis for assuming an apparent forage minnow preference of the fish and

the degree of preference. The degree of preference was expressed as consistent or variable depending upon whether the test fish exhibited the same preference throughout the experiment or varied noticeably in preference from one feeding period to the next.

For the group of seven fish, one consistently preferred fatheads, another preferred bluegills, while a third consistently consumed about the same number of bluegills as fatheads. Four fish were variable in preference, two preferring fatheads and two bluegills.

FOURTH EXPERIMENT-METHOD

Preference of larger bass for either bluegills or fathead minnows was examined in another experiment. Four bass ranging in weight from 172 to 208 grams each were placed in individual concrete tanks. The tanks measured 8 feet long, 2 feet wide and 20 inches deep. Equal numbers of small bluegills and fathead minnows were supplied for food three times weekly. Just prior to the time the fish were fed, dead forage fish were removed and those remaining were counted and returned to the tank. Additional forage minnows of each species were added three times weekly to maintain a surplus of food in equal numbers. Forage not accounted for when the supply was inventoried was presumed to have been eaten by the bass. The experiment was conducted for a period of five weeks. Daily water temperatures during the period ranged from 11.0 to 18.5°C.

FOURTH EXPERIMENT-RESULTS

The food consumption data for the four fish in this experiment are shown in Table 9. Bass Number 1 consistently ate more fatheads than bluegills although it usually ate a few bluegills along with the fatheads. On a numerical basis, about 80 percent of the forage consumed was fatheads. Bass Number 2 did not feed as well as Number 1 and showed no strong preference for either species. Fifty percent of this fish's diet was fatheads and 50 percent bluegills. Bass Number 3 apparently preferred fatheads but not to the degree that Number 1 did. The percentage for this fish was 63 percent fatheads to 37 percent bluegills. Bass Number 4 was more variable in forage preference, ranging from no bluegills on occasion to almost all bluegills and very few fatheads on other occasions. For the period, food consumption was 57 percent fatheads and 43 percent bluegills.

SUMMARY AND CONCLUSIONS

Four experiments were conducted to obtain information on the species of forage minnow preferred by largemouth black bass. Bass were fed diets of bluegill, goldfish and fathead minnows alone, mixed amounts of

TABLE 9.

PREFERENCE OF LARGER BASS FOR BLUEGILLS AND FATHEAD MINNOWS.

	Bass No. 1		*Bass No. 2*		*Bass No. 3*		*Bass No. 4*	
Date of Observation	*Number Eaten*		*Number Eaten*		*Number Eaten*		*Number Eaten*	
	Bluegill	*Fathead*	*Bluegill*	*Fathead*	*Bluegill*	*Fathead*	*Bluegill*	*Fathead*
10/4	0	7	5	3	0	0	0	11
10/7	4	5	6	0	2	2	1	0
10/9	1	3	0	1	0	0	9	4
10/11	2	8	5	0	9	9	11	3
10/14	5	7	1	1	4	4	10	5
10/16	3	12	5	5	0	8	1	4
10/21	2	10	2	2	0	6	0	0
10/23	0	4	0	1	2	0	0	6
10/25	0	7	0	0	0	0	1	1
10/28	0	2	0	6	0	0	0	2
10/30	1	0	0	0	2	2	0	0
11/1	0	4	0	3	0	0	0	5
11/4	3	7	1	1	3	7	0	4
11/6	1	9	0	2	4	7	2	1
TOTAL	22	85	25	25	26	45	35	46

bluegill, goldfish and fatheads, and a mixture of bluegills and fatheads. Measurement of the amount of food consumed provided information on which species of forage minnow the experimental bass utilized most completely. A knowledge of the amount of food eaten and the growth occurring made the calculation of food conversion values possible. These data were then used to evaluate the various diets as to suitability for producing growth of the size bass included in the experiments.

The majority of the bass tested preferred fathead minnows to either bluegills and goldfish or to bluegills only. In the only experiment where all three species were included goldfish were eaten in greater amounts than bluegills. Conversion values were appreciably higher than for bluegills or fathead minnows in a second experiment so they were eliminated from the later tests. Enough individual variation was noted between the experiments and between individuals in an experiment to suggest that an appreciable degree of individuality exists regarding food preference. Some bass demonstrated a consistently strong preference while the preference of others varied from week to week. Such individuality was shown in both experiments where individual fish were being observed.

The species of forage minnow giving the best growth and food conversion also appeared to be the fathead for a majority of the bass studied. The difference between bluegills and fatheads was not appreciable in most instances, but the growth and conversion of bass fed goldfish was significantly lower than fathead minnows in both experiments where this species composed one of the test diets.

While the sample of bass tested was small, the findings suggest that fathead minnows provide a more suitable diet for largemouth bass of the sizes included than do bluegills or goldfish. Bluegills were second to fatheads with goldfish being third based on preference of the bass and ability to produce efficient rates of growth. Further work of this kind employing a wider range of bass sizes and individuals appears to be needed to give a conclusive answer to the question of the most suitable species of forage minnow for largemouth black bass.

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