FOOD HABITS OF THE BIGMOUTH BUFFALO IN A SIMULATED FISH FARMING ENVIRONMENT

By Ron Jarman
Oklahoma Department of Wildlife Conservation

ABSTRACT

Recent growth of commercial fish farming in the South Central United States has stimulated interest in the habits of fish species adaptable to fish farm environments.

In 1964, the food habits of the bigmouth buffalo, *Ictiobus cyprinellus* (Valenciennes), were determined in simulated fish farming ponds by comparison of available food and stomach contents. Results indicated competition with channel catfish for food occurred only when supplemental feed is introduced. In this situation channel catfish appear to be more vigorous competitors than buffalo.

Stomach contents are compared with volumetric measurements of food organisms available in the ponds.

INTRODUCTION

Commercial rearing of the bigmouth buffalo (*Ictiobus cyprinellus*) was attempted on a large scale in the lower Mississippi River Valley from 1957 to 1963. Most of these attempts resulted in financial losses due to poor market conditions and failure to rear a suitable size fish in a reasonable length of time. Post-1963 efforts to rear buffalo in this geographic region have generally been confined to combinations of species in reservoirs that remain filled for extended periods of time.

Food habits of the bigmouth buffalo have been reported from fish in natural populations by Moen, 1954; Johnson, 1963 and McComish, 1967. All authors agree this species feeds primarily on zooplankton of the cladocera and Copepoda groups. Very little effort has been made to determine what food was available to the fish at the time of sampling.

Swingle (1957), outlined a procedure for economically rearing this species by the use of fertilized culture ponds. Fish in his study attained an average weight of 3.6 pounds in 18 months when stocked at 120 fish per acre. Brady and Hulsey (1959), suggested adding commercial fish foods to holding ponds and buffalo brood ponds. They did not feel it would be economical to attempt supplemental feeding for market production.

Since the greatest fish production per acre of water is possible through the utilization of species with short food chains (Riggs, 1957), fish farmers have retained interest in the bigmouth buffalo for commercial production.

PROCEDURES

At the Fish Farming Experimental Station, Stuttgart, Arkansas[1], two one-acre ponds were filled and fertilized according to prevailing fish farming techniques. The ponds were stocked as follows:

	Pond 1 (Not Fed)	*Pond 2 (Fed)*
Bigmouth buffalo	125	350
Channel catfish	50	350
White catfish	50	350
White crappie	100	100
Flathead catfish	70	50
Israeli carp	5	5

[1] United States Bureau of Sport Fisheries and Wildlife, Fisheries Research Division.

Pond 1 received periodic applications of 10-30-0 inorganic fertilizer to maintain a secchi disc reading of approximately 18 inches transparency. Pond 2 received commercial fish food six days a week, at 50 pounds per day from July 1 to August 4 and September 2 to September 30. During the intervening period the ponds received 60 pounds of feed per day.

Weekly sampling was initiated on July 1, 1964 and continued through September 30, 1964. Samples included stomach contents from two buffalo, plankton and benthos.

The stomach and intestine of each fish was removed and preserved in ten percent formalin. Length and weight of each fish was recorded. Moen found the digestive tract to be one continuous tube and considered the entire tract as the stomach. His method is followed in this study.

Volumetric measurements were made by the use of water displacement while the contents were still moist. After several unsuccessful attempts to seperate stomach contents, it was decided to estimate percent volume for each food item. Gross examinations were made for large food items i.e., insect larvae, etc. Two Sedgewick-Rafter slides were filled for microscopic examination and percent volume for each food item was estimated.

Bottom detritus was collected and commercial fish food moistened for microscopic examination to aid the examiner in distinguishing between the two and identifying the same substances when occuring in stomach contents.

All Cladocera, Copepoda and *Ostracoda* were *combined* and *the title* Entomostraca used to facilitate better comparisons with previous work in this field. All other plankters have been grouped for calculations.

Plankton samples consisted of twenty gallons of pond water filtered through Number 25, silk bolting cloth. Organisms collected were identified and enumerated by methods described in Ward and Whipple (1959), and Welch (1948).

Benthos samples were collected with an Ekman dredge and identified according to Ward and Whipple (1959).

RESULTS

Food production was high in both ponds although food organisms were most abundant in the pond receiving feed (Table 1). Benthos organisms were abundant in

TABLE 1.

Plankton organisms per liter and benthos per square foot by sampling date.

		Pond 1			*Pond 2*	
Date	*Ento.*	*Other*	*Benthos*	*Ento.*	*Other*	*Benthos*
July						
1	211.5	234.0	34	46.2	1,222.2	24
8	65.0	3.2	8	363.0	30.0	98
15	29.6	26.4	48	153.4	1,669.7	776
22	3.3	42.9	6	159.6	41.8	1,656
29	11.0	22.0	56	137.8	1,543.1	790
August						
5	5.8	23.2	58	29.5	165.2	362
12	8.0	4.0	86	86.4	591.2	1,082
19	32.4	27.0	24	33.6	205.8	--
26	14.4	14.4	48	48.0	332.4	122
September						
2	36.8	18.4	102	64.9	2,625.5	114
9	13.8	55.2	18	348.1	118.0	34
16	5.1	30.6	32	159.6	501.6	84
23	10.4	10.4	--	224.2	2,230.2	102
30	--	176.0	8	27.5	341.0	202

both ponds although few genera were represented. Four genera of bottom organisms were collected in Pond 1. However, samples were dominated by two genera (*Chironomus, Sparganophilus*). Three genera (*Chaoborus, Chironomus, Sparganophilus*) of equal abundance were found in Pond 2. Benthos samples ranged from 6 to 1,082 organisms per square foot. Although ample benthos was present in both ponds, only two bottom organisms were found in all buffalo stomachs examined. One *Enallagma* and one *Chironomus* were found in two different stomachs from the Pond 2.

Plankton was abundant throughout the study. Total plankters per liter ranged from 12 to 2,690. Entomostraca ranged from 0 to 363 organisms per liter and the remaining plankton from 3.2 to 2,626.5 organisms per liter (Table 1).

A total of 24 stomachs from Pond 1 (unfed) and 25 from Pond 2 (fed) were collected during the study. Seven stomachs were found empty from Pond 1 on four sampling dates. Nine stomachs were found empty in Pond 2 on seven sampling dates. On three of these dates no food was found in any stomach sampled. Of the 49 stomachs examined in this study 33 had food and 16 were empty.

The percent frequency of occurrence (Table 2) indicates the four major food types occurring in most of the stomachs sampled.

In Pond 1 the percent total volume of stomach contents (Table 2) shows Entomostraca occupied nearly twice the volume as any other food type in the average stomach when present. In Pond 2 commercial fish food was most abundant followed by Entomostraca and far more prevalent than other foods.

TABLE 2

Characteristics of food habits of bigmouth buffalo

	Percent Frequency of Occurence by Major Food Types	*Average Total Volume by Major Food Type*	*Percent Volume of Each Food Type When Present*
Feed			
Pond 1	--	--	--
Pond 2	87.5	30.2	65.0
Entomostraca			
Pond 1	70.6	22.9	53.3
Pond 2	62.5	14.6	41.0
Other Plankton			
Pond 1	76.5	14.2	30.7
Pond 2	62.5	6.5	20.0
Debris			
Pond 1	88.2	14.5	27.1
Pond 2	93.8	5.9	11.8

Debris, although not normally abundant, was well represented both in percent volume and percent frequency of occurrence (Table 3).

An "electivity index" was employed to determine any food preference for or against a major group by bigmouth buffalo. This index is represented in the following manner, (Ivlev, 1961):

$$E = \frac{(r_1 - p_1)}{(r_1 + p_1)}$$

Where r_1 is the relative quantity of any ingredient in the ration expressed as percentage of the ration and p_1 is the relative quantity of the same ingredient in the food complex of the environment expressed as a percentage. Values of E may range

TABLE 3.
Growth of bigmouth buffalo in a simulated fish farming environment.

	Stocked, Spring, 1964		*Harvested, Fall, 1964*	
	Lbs.	*In.*	*Lbs.*	*In.*
Pond 1				
Bigmouth buffalo	1.73	13.9	3.32	17.4
Channel catfish	0.51	12.2	0.68	13.1
White catfish	0.33	9.4	0.79	12.6
Crappie	0.25	2.4	0.86	11.0
Flathead catfish	0.51	10.6	1.33	14.6
Isreali carp	5.25	19.3	8.00	23.4
Pond 2				
Bigmouth buffalo	1.95	13.9	3.93	17.5
Channel catfish	1.10	14.0	2.87	19.0
White catfish	0.94	12.3	1.65	14.7
Crappie	0.29	7.9	0.41	9.6
Flathead catfish	0.85	12.7	1.25	14.8
Isreali carp	4.70	18.8	13.70	26.0

within the bounds -1 to +1, the former value indicating negative selection. An E value of zero indicates no selection.

An "electivity index" chart, by sampling period for Pond 1, yielded information indicating positive selection for Entomostraca and selection against all other plankton (Figure 1). Since virtually no benthos organisms were found in the stomachs they were not computed as all dates would indicate negative selection.

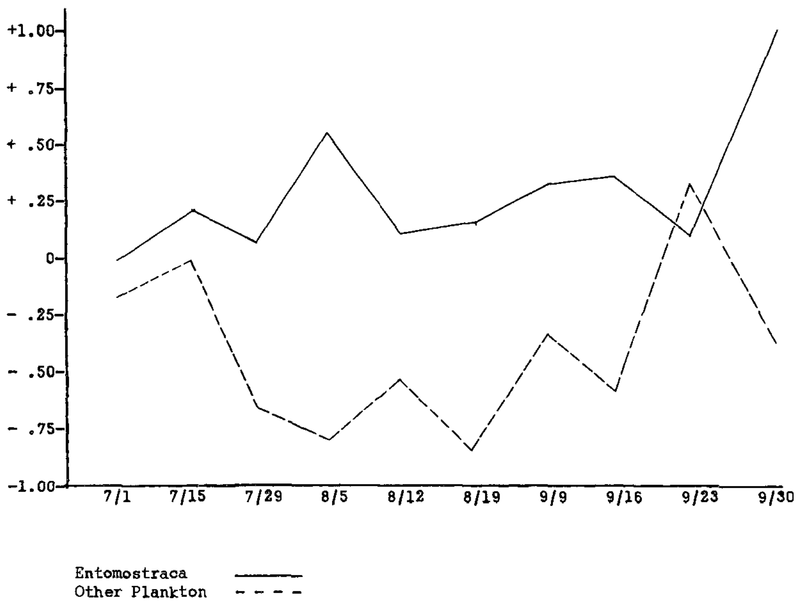

Figure 1. Electivity index of bigmouth buffalo in Pond 1.

The same type of index chart on Pound 2 was not useful in determining food selectivity. The addition of commercial fish food masked the results of this type of table to the point that no interpretations could be made.

Growth rate comparisons can be made to some extent between the two ponds. Table 3 compares the growth rate of all species in the two ponds in this study. The two omnivorous catfish species (white catfish, channel catfish) exhibited much greater growth in Pond 2, even though stocked at a much greater rate than Pond 1. Other species, including the bigmouth buffalo, grew at comparable rates in both ponds.

DISCUSSION

Data from this study indicates bigmouth buffalo retain the food habits of wild fish only when the ponds do not receive supplemental feed. In Pond 2, supplemental feed was found in most of the stomachs and was abundant when found. Buffalo utilize supplemental food when available but increased growth is not as apparent as that observed for channel and white catfishes. It should be pointed out, the stocking rate in Pond 2 was approximately three times greater than in Pond 1.

Both catfish species in Pond 2 outproduced their complement in Pond 1. Since the buffalo produced in both ponds were of similer size it is probable that those in Pond 2 were unable to compete with the catfish for adequate feed to benefit their growth.

The presence of debris in the stomachs of most fish and the apparent preference by buffalo for Entomostraca indicates the bigmouth buffalo is not entirely a pelagic feeder. It is probable feeding occurs in areas associated with pond bottoms where swarms of Entomostraca feed on other organisms. This would account for the presence of both debris and Entomostraca in buffalo stomachs.

CONCLUSIONS

The bigmouth buffalo is a highly prized food fish in the lower Mississippi River valley. Commercial production has not been profitable for fish farmers in the past when used as the primary crop.

The growth of the channel catfish industry in this geographical region opens up new prospects for the culture of this species as a secondary crop in rice reservoirs or catfish ponds. If time is available to rear these fish to a desirable market size (5 to 8 pounds) they will produce additional profit from the same area used for the primary crop.

Findings made by other workers and the results of this study show additional work is needed to determine if secondary crops of buffalo can be reared in conjunction with catfish farming. It would seem a program of frequent feeding of small amounts of suspended feeds could probably be implemented to selectively feed channel catfish in the presence of buffalo. The buffalo would then be forced to utilize the natural food in plankton blooms resulting from channel catfish production. This study shows that buffalo probably grow as well in ponds where no supplemental feed is introduced as in ponds with artificial feeding.

ACKNOWLEDGMENTS

The author would like to express his gratitude to the Fish Farming Experimental Station, Bureau of Sport Fisheries and Wildlife, for furnishing ponds, fish and the author's time for this study. I would also like to thank the Oklahoma Department of Wildlife Conservation Fishery Division for allowing the author time from employment to assemble this paper.

LITERATURE CITED

Brady, Lee and Andrew Hulsey. 1959. Propagation of buffalo fishes. Proc. S. E. Assoc. of Game and Fish Commissioners. pp. 80-90.

Ivler, V. S. 1961. Experimental ecology of the feeding of fishes. Translated from Russian by Douglas Scott. Yale Univ. Press, New Haven. 302 pp.

Johnson, R. P. 1963. Studies on the life history and ecology of the bigmouth buffalo. Jour. Fish. Res. Bd. Canada. 20(6):1397-1429.
Moen, Tom. 1954. Food of the bigmouth buffalo in northwest Iowa lakes. Proc. Iowa Acad. Science. 61:561-569.
McComish, Tom. 1967. Food habits of bigmouth and smallmouth buffalo in Lewis and Clark Lake and the Missouri River. Proc. Am. Fish. Soc. 96:1. pp. 70-74.
Riggs, Carl D. 1957. Unexploited potentials of our freshwater commercial fisheries. Trans. Am. Fish. Soc. 87:299-308.
Swingle, H. S. 1957. Revised procedures for commercial production of bigmouth buffalo fish in ponds in the southeast. Proc. S. E. Assoc. of Game and Fish Commissioners. pp. 62-165.
Ward, H. B. and G. C. Whipple. 1959. Freshwater biology. 2nd edition. Edited by W. T. Edmondson. John Wiley and Sons, Inc. New York.
Welch, Paul S. Limnological Methods. McGraw-Hill. New York.

FISH PRODUCTION AS RELATED TO SOIL CHEMICAL CONSTITUENTS

By Dewey L. Tackett
Bureau of Sport Fisheries and Wildlife
Fish Farming Experimental Station
Stuttgart, Arkansas

ABSTRACT

Catfish production varied 40 per cent among 12 ponds in a uniformity test. Survival, spawning, and trash fish made no significant contribution to this variation. Production was directly related to the amount of certain constituents found in the pond soils, namely, exchangable calcium, electrical conductivity, magnesium content of soil — water (1:2.5) extracts, and nitrate nitrogen.

INTRODUCTION

Variations in responses of fish to certain treatments are of universal occurrence. These variations are caused largely by the huge dependence of fishes on their constantly varying environment. Inherent productive capacities of ponds may account for other variations and, if so, may be related to one or more constituents found in the bottom soil.

The purpose of this study was to determine the magnitude of differences in production of ponds and to relate production to chemical constituents found in the bottom soil.

METHODS

Each of 12 one-tenth acre ponds were stocked on April 5, 1967, with 15 channel catfish (age group II) having a total weight of 10 pounds. The ponds, constructed on soil classified as Crowley slit loam, had remained dry during the preceding winter and were situated in 2 adjacent rows of 6 ponds each. Prior to flooding, soil samples were taken for analyses. Water for the ponds was screened with saran to prevent entry of trash fish. No feed or fertilizer was added to the ponds but a herbicide was used for control of filamentous algae. The fish were harvested after a 196-day growing season.

"Soil Test Values" were obtained for the soil samples by the University of Arkansas Soils Testing Laboratory, Fayetteville, Arkansas. These analyses consisted of pH, organic matter, electrical conductivity, and extractable or available nutrients.

Water soluble constituents were determined on samples at the Fish Farming Experimental Station by analyzing soil: deionized water extracts (1:2.5). Analyses were made on the extracts after being filtered through a Whatman No. 42 filter paper. Potentiometric methods were used for analyses of alkalinity and pH. Calcium and magnesium were determined complexometrically and phosphorus by the phosphomolybdate method.