SELECTION OF ANIMAL FORAGE TO BE USED IN THE CULTURE OF CHANNEL CATFISH

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INTRODUCTION

The use of animal forage in fish farming should produce healthier, faster-growing fish with fewer spawning failures. It is probable that by use of animal forage the cost of artificial feeding can be reduced both by changes in the quantity and quality of food required. However, we have yet to understand what forage organisms are the most desirable for a given purpose. In determining the suitability of a forage organism, we are concerned with a number of considerations, as for example:

1. Can the organism be produced in large quantities with little or no cost and trouble?
2. Does the organism seriously compete with or is it predaceous upon the primary species?
3. Is the organism utilized by the primary species?

The latter question involves a consideration of both the degree of vulnerability and in some cases the palatability of the forage organism.

The present data is especially concerned with the variation in vulnerability between several common forage species.

METHOD

In a series of one-seventh acre hatchery ponds feeding trials were conducted over a two-year period. In a typical trial three ponds were stocked with an equal number of one forage organism or a combination of two or more organisms. In two of the ponds ten 1.5 to 2.5 pound channel catfish were stocked. At the end of ten days the ponds were drained and the forage organisms remaining were counted. The recovery from the experimental ponds was compared to the recovery from the control pond. The differences were considered to be the number of forage organisms eaten by the catfish with the exception of trials in which tadpoles were used as forage. The appearance of numerous dead and mutilated tadpoles in the experimental ponds indicated that the catfish killed the tadpoles but ate few if any of them.

There is some question as to whether or not the experimental set-up resulted in an adequate measure of the normal rate of forage consumption. Thus, the amount of forage eaten daily, as a percent of the body weight of the catfish, is quite low (Tables 1 and 2). It appears best to confine our use of the data to a comparison of the relative utilization of the different forage organisms.

RESULTS AND DISCUSSION

Crayfish were utilized to a much greater extent than was any other forage organism. The fathead minnow was the second best utilized, but even so the lowest utilization of crayfish was almost three times greater while the higher utilization of crayfish was four times greater (Table 1). The utilization of fingerling bluegill and green sunfish was similar (Table 1) except when the two were offered independently in which case bluegill fingerlings were more heavily utilized (Table 2). Consumption of golden shiners was about the same as the utilization of the bluegill and green sunfish (Tables 1 and 2). Fingerling carp and bullheads were very poorly utilized. As pointed out above, tadpoles were considered to have been killed but not eaten.

A study of the forage utilization of the largemouth bass was being conducted concurrently with the present study. The conditions of the experiment were essentially identical. It is thus interesting to make a comparison between utilization of the different forage organisms by the channel catfish and largemouth bass (Tables 3 and 4). There are two

Table 1. Channel catfish utilization of different forage organisms offered in combination.[1,2]

Forage	Average Weight of Individual Forage Organism (gms.)	No. of Trials	Total No. of Days	Total No. of Forage Offered	No. Forage Eaten/Fish/Day	Percent Body Weight Eaten/Day
Crayfish	2.4	8	90	3094	1.61	0.63
Tadpole	3.2			3094	0.80	0.42
Bluegill	4.7	2	38	1000	0.21	0.18
Tadpole	3.4			1000	0.37	0.23
Bluegill	2.3	8	80	5200	0.12	0.03
Crayfish	8.3			3500	2.52	2.24
Bluegill	3.8	2	20	800	0.23	0.09
Crayfish	5.7			800	2.37	1.36
Tadpole	4.1			800	0.14	0.06
Golden Shiner	1.9	6	60	2400	0.36	0.09
Fathead	1.6			2400	0.62	0.12
Bluegill	1.1	2	20	400	0.26	0.04
Carp	3.4			400	0.00	0.00
Bullheads	1.1			400	0.04	0.01
Carp	3.4	1	10	250	0.03	0.01
Bullheads	2.6			250	0.05	0.01

[1] Data from Mr. Anthony's doctoral dissertation, Department of Zoology, Southern Illinois University.
[2] Tadpoles killed but apparently not eaten.

Table 2. Channel catfish utilization of different forage organisms offered individually.[1,2]

Forage	Average Weight of Individual Forage Organism (gms.)	No. of Trials	Total No. of Days	Total No. of Forage Offered	No. Forage Eaten/Fish/Day	Percent Body Weight Eaten/Day
Tadpole	5.8	3	35	1050	0.28	0.31[3]
Bluegill	2.4	5	68	3050	0.58	0.18
Golden shiner	2.0	4	62	1800	0.26	0.07
Green sunfish	1.4	3	30	1350	0.24	0.04
Fathead	1.6	2	20	800	0.46	0.10

[1] Data from Mr. Anthony's doctoral dissertation, Department of Zoology, Southern Illinois University.
[2] One trial involved the use of 20 catfish rather than the usual number of 10.
[3] Tadpoles killed but apparently not eaten.

Table 3. Largemouth bass utilization of different forage organisms offered individually.

Forage	Average Weight of Individual Forage Organism (gms.)	No. of Trials	Total No. of Days	Total No. of Forage Offered	No. Forage Eaten/Fish/Day	Percent Body Weight Eaten/Day
Tadpole	11.62	1	10	500	3.80	5.38
Tadpole	4.42	1	10	1000	7.30	3.73
Bluegill	7.26	1	10	500	0.27	0.24
Bluegill	2.43	1	10	1000	0.00	0.00
Crayfish	2.54	1	10	500	3.25	0.91

striking differences between the feeding behavior of the two species. The bass heavily utilized tadpoles, and there was no indication that they were not eaten. The second point of interest is that the bass ate more crayfish per day than did the catfish.

The forage utilization studies which we have conducted over the past several years indicate that vulnerability of the forage organism is, with few exceptions, the most important consideration in the degree of utilization of any particular kind or size of forage. In tanks bass intensively utilize shiners and other fishes (Lewis, et al., 1961), while in ponds tadpoles and crayfish are more heavily utilized (Tables 3 and 4). Moehn (M.S. thesis, Southern Illinois University) found that when gizzard shad were drugged even larger shad were heavily utilized by channel catfish.

To obtain satisfactory utilization of the forage by the primary species it appears desirable to use a highly vulnerable forage organism, but this presents other complications, the principal one being that a highly vulnerable organism cannot maintain a high population density in the presence of a predator species. It appears desirable that we recognize different procedures for utilizing forage. We can treat the forage as pasture, in which case we would have to adjust the catfish population to a density that the vulnerable forage population could support without being too drastically reduced. The obvious objection to this method is the inefficient use of the water area available. However, it might still be practical for brood fish. Highly vulnerable forage could be produced in separate ponds and periodically added to the catfish rearing ponds. However, this method would probably not be practical unless the forage ponds could be drained directly into the catfish rearing ponds. It might at first appear that such a program would be wasteful of pond acreage, but it is not greatly different from our present arrangement in producing feed grains for cattle and probably would prove to be more efficient than the pasture idea. A third approach for supplying highly vulnerable forage would be to permit a build-up of forage prior to the introduction of the catfish. The greatest objection to this method is that if forage is to be in constant supply the catfish would have to be moved when the forage became depleted.

As we learn more about the vulnerability of different forage fishes at different sizes we may find a fish that has an ideal level of vulnerability. We may also find that we can alter vulnerability of forage fishes by use of drugging agents. In fact this latter possibility is probably the most promising. This procedure would likely make pos-

Table 4. Largemouth bass utilization of different forage organisms offered in combination.

Forage	Average Weight of Individual Forage Organism (gms.)	No. of Trials	Total No. of Days	Total No. of Forage Offered	No. Forage Eaten/ Fish/Day	Percent Body Weight Eaten/Day
Crayfish	4.8	2	15	1000	5.40	3.28
Tadpole	4.4			1000	3.58	1.98
Bluegill (large)	7.7	1	10	500	0.58	0.50
Tadpole (large)	11.9			500	4.73	6.37
Bluegill (small)	4.1	2	20	1000	0.00	0.00
Tadpole (small)	4.1			1000	1.84	0.83
Bluegill	3.7	2	20	1000	0.15	0.06
Crayfish (large)	10.5			1000	1.16	1.36
Bluegill	4.3	2	20	1000	0.14	0.06
Crayfish (small)	4.7			1000	5.80	3.05
Fathead	1.8	2	20	1000	2.24	0.41
Golden shiner	2.3			1000	1.00	0.23

sible the use of such highly productive fishes as the gizzard shad and threadfin shad.

At present it is our opinion that crayfish and probably other invertebrates are the only animal forage that is reasonably vulnerable to the channel catfish. Further investigation may demonstrate the fathead to be reasonably satisfactory. On basis of the present data the policy of permitting the build-up of dense populations of sunfishes, bullheads, and similar fishes is of questionable value and may encourage oxygen depletion during critical periods.

LITERATURE CITED

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TWO-YEAR STUDY OF A BASS, SUNFISH, CHANNEL CATFISH POPULATION EXPOSED TO FLOODING AND ANGLING[1]

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Introduction

Methods of raising channel catfish have reached a degree of development where it is possible to stock farm ponds with this species. Therefore, it is pertinent to know the effects of introducing this species into the bass-bluegill-redear stocking combination. This study was designed to evaluate a particular bass-bluegill-redear-catfish stocking combination in detail.

A flood occurred midway in this study period, causing a large amount of escapement of fish over the spillway. This circumstance provided an opportunity to evaluate the effects of such a large removal of fish from the original population.

To accomplish these objectives, records were kept of the initial stocking. plus all fish removed by angling. Extensive sampling by seining, trapping, angling, and electric shocking was done throughout the study period, June 1960 through October 1961, to follow trends in the fish population. The experiment was concluded with draining the pond.

Pond S-6, built in 1946, has an area of 25.5 acres, a maximum depth of 15 feet, and a dam 742 feet in length. S-6 used in several earlier experiments, was drained in the fall of 1959 before the present investigation was begun. Management of the pond during the period of this study consisted of standard fertilization (Swingle and Smith, 1947) and *Microcystis* control with copper sulphate.

During normal conditions, water flowing out of S-6 passed over a cement apron that was screened. Flow over the spillway from normal rainfall was no deeper than 2 inches. Flooding on February 24 and 25, 1961, was the greatest in the history of farm ponds investigations at Auburn. Rainfall at Auburn in the month of February in 1961 was 20.5 inches, and 8.0 inches fell February 25, 1961 (Annual Report, Farm Ponds Project, Auburn University, 1961). At the peak of the flood, water flowed over the emergency spillway at a depth of about 6 inches and a width of 200 feet.

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[1] Presented as a thesis to the Graduate Faculty of Auburn University in partial fulfillment of the requirements for the Master of Science Degree.
[2] Now with the U. S. Fish and Wildlife Service, Woods Hole, Mass.