10. A net of approximately 2,000 lb. of channel catfish per acre of pond were produced in cages in each year 1967 and 1968. In addition, another 200-400-net lb. of fishes were produced in the open water of the same pond each year.

11. In some experiments, channel catfish in cages suspended in ponds were fatally affected by the effects of low oxygen-high carbon dioxide concentrations, whereas channel catfish, largemouth bass and other fishes in open water outside the cages did not appear affected.

12. Observations indicate that bacterial diseases, such as columnaris disease, may be a major limiting factor to culture of channel catfish in cages suspended in ponds.

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STOMACH CONTENT ANALYSIS OF WHITE BASS (Roccus chrysops) IN BEAVER RESERVOIR, ARKANSAS

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ABSTRACT

Qualitative and quantitative analyses of stomach contents of 263 white bass (*Roccus chrysops*) taken from Beaver Reservoir and its tributaries between February 1, 1969 and June 30, 1969 are reported. Fish are classified as pre, mid, and post-spawners based on their migrations into and out of the spawning areas. Stomach contents of white bass are enumerated by frequency occurrence, volumetric and gravimetric methods. Significant differences in the food habits were found between the different periods.

INTRODUCTION

Knowledge of the food habits of fishes, as individuals or as groups, is vital to reservoir understanding (Jenkins, 1964). Martin (1966), working with trout, indicated that growth, longevity, age and size at maturity are affected by the kinds of foods eaten. This in turn determines the character of the fisheries with respect to age and size composition of the catch, availability of the fish, year class strength, numbers of year classes in the fisheries, and long-term yields. Seaburg and Moyle (1964) brought out the need for determining trends in feeding throughout a season.

There has been no work done on the food habits of white bass in Beaver Reservoir. The present study is concerned with determining the food habits of white bass, *Roccus chrysops*, in Beaver Reservoir prior to, during, and following their annual spawning migration.

White bass in Beaver Reservoir have a single spawning season annually, occurring usually in March or April, the time depending mainly upon water temperature. During the spawning period mature white bass, and many immature males, migrate from the open waters of the reservoir to the gravel riffles of streams entering the reservoir. Based upon observations during 1967 and 1968, the spawning season probably does not last much longer than one month in Beaver Reservoir (Newton, 1968).

In Newton's study, no mature 1-year-old white bass were captured, the only mature white bass being either two or three years old. The smallest two-year-old fish taken by Newton was 306 mm. Since the present study is involved with the food habits of mature white bass, only those specimens exceeding 306 mm in length were used.

MATERIALS AND METHODS

Beaver Reservoir, located in Northwestern Arkansas, was impounded in 1963 and reached powerpool level in February, 1968. White bass are an important game fish in Beaver Reservoir, and accounted for 10.5% of the total weight of the sport harvest during the period June 1, 1966 through May 31, 1967 (Houser and Morais, 1967).

For the present study, 263 fish were collected from Beaver Reservoir at the mouths of Hickory and War Eagle Creeks; from Brush, War Eagle and Richland Creeks; and from the main channel of the White River (Figure 1). Those fish captured within the reservoir constituted the majority of the pre and post-spawners while the fish taken within the streams formed the largest part of the mid-spawners.

Examination of gonads and observation of spawning behavior revealed that most of the spawning activity occurred between April 11 and April 28. Therefore, all fish captured prior to April 11 were designated as pre-spawners or mature fish, those captured between April 11 and April 28 as mid-spawners or ripe. Fish captured after April 28 were classified as post-spawners or spent fish.

Fish taken within the reservoir were captured by means of gill nets with mesh sizes 1½, 2 and 2½ inches, and by electroshocking. The fish captured within the streams were obtained by gill nets, electroshocking, and angling with artificial lures. All electroshocking was performed with a boat-mounted 220 volt A. C. generator. Reservoir electroshocking was done at night with the aid of three submerged 300-watt rough service bulbs also running off of the generator. Electroshocking in the streams was done during daylight hours for obvious safety reasons. After being stunned, the fish were retrieved by means of dipnets with 10 foot fiberglass handles.

Soon after the fish were obtained a sharp blow was delivered to the head to help prevent any further digestive processes, and then preserved in 10% formalin. Total length to the nearest millimeter, total weight to the nearest gram, and sex were recorded from the preserved fish. The stomachs along with the other viscera were removed and placed in specimen jars containing 10% formalin. After one week, the stomachs were removed from formalin, washed in cold water and transferred to 40% isopropyl alcohol until analyzed.

The stomachs were cut longitudinally and the contents flushed into a petri dish, and analyzed under a variable power binocular dissection microscope. The stomach contents were analyzed by occurrence, volumetric, and gravimetric methods.

RESULTS

Spawning appeared to cause variation in both the quantity and quality of food consumed by Beaver Reservoir white bass (Tables 1 and 2). Incidence of empty and full stomachs among the mature, ripe, and spent male white bass was significant at the .01 level ($x^2_2 = 48.89$). Further tests revealed a significant difference at the .01 level between the mature and ripe males, and between the ripe and spent males. This describes a trend for male bass to feed before and after spawning, but not during the mid-spawn period.

Chi square test revealed a slightly significant difference in the number of empty stomachs between the mature and spent females at the .01 level ($x^2_1 = 9.46$). Twenty percent of the mid-spawning females had empty stomachs, a value intermediate to the mature and spent females. The number of ripe females is too small to allow comparisons with the mature and spent females.

A quantitative difference also was found between the males and females. The percent of empty stomachs of males exceeded that of females in each period (Table 2).

Fish, crustaceans, and insects were the most important food items in the diet of white bass. Insects were the food item most often consumed by both sexes in all periods. Of the insects eaten, diptera constituted 89.3% of the total number. Ephemeroptera and plecoptera were regularly ingested, and accounted for 8.7% and 2.0% of the total number respectively.

By weight, insects were the most important item in the diet of mature males while fish were the most important item in the diet of the mature females (Figure 2). Crustaceans were the least significant group in both sexes during the pre-spawning period by both weight and occurrence.

During the mid-spawning period the situation was reversed; fish formed 99.8% of the male diet by weight and insects accounted for 82.34% of the weight of the food of females. No crustaceans were found in either males or females during the mid-spawning period.

The diets of spent males and females were essentially identical. By weight, fish accounted for 65.26% of the diet of males and 65.71% of the diet of the females. Crustaceans increased in importance in both sexes following spawning. Decapods, the only measurable crustaceans in the post-spawning diet, accounted for 31.04% of the females diet. Insects formed only 3.71% and 1.16% of the weight of the food of spent males and females respectively during the post-spawning season.

DISCUSSION

The feeding of white bass upon crustaceans, insects, and fish parallels the findings of Bonn (1952) in Lake Texoma. It appears, however, that Beaver Reservoir white bass utilize insects more commonly than do the Lake Texoma white bass.

As stated, organisms were enumerated by occurrence, volume, and weight. In this study weight is considered the best single index for determining the relative importance of the various food organisms. Occasionally large numbers of insect larvae, e. g. chironomidae, bias the results obtained by the occurrence method. In volumetric determinations, organisms displacing less than one-tenth millileter of water were recorded as traces. During analyses of data, these traces were meaningless and no relative value could be ascribed to them. Therefore, weights recorded to the nearest milligram were accepted as the best indicators of the relative value of the food organisms.

Both sexes showed variation in the quantity consumed during each period. These data obviously indicate a tendency for white bass to feed moderately prior to spawning, to nearly cease feeding during spawning, and to resume heavy feeding soon after spawning. This heavy post spawning feeding evidently is in response to the stress of spawning. The twenty percent empty stomachs in females during the mid-spawning season is most likely too small, and is based on only five female specimens. During spawning, the females exhibited a tendency to remain in deeper pools, moving up to the riffles only when ready to spawn immediately. Since fish were difficult to obtain from the pools, this type of behavior accounts for the small number of females taken during the mid-spawning season.

During the spawning period distinct qualitative changes in the food habits of both sexes were observed. The changes in food organisms consumed during mid-spawning are difficult to explain. Poor sampling of mid-spawning females probably is partly responsible. Also, it may be that aquatic insects were more numerous in the pools more commonly occupied by females, while forage fish were more common in the riffles. It is also possible that one sex exhibited selectivity in feeding during this period. More investigations are needed to determine the actual causes of these changes in food habits.

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FIG. 1: MAP OF BEAVER RESERVOIR SHOWING THE AREAS OF WHITE BASS COLLECTIONS.

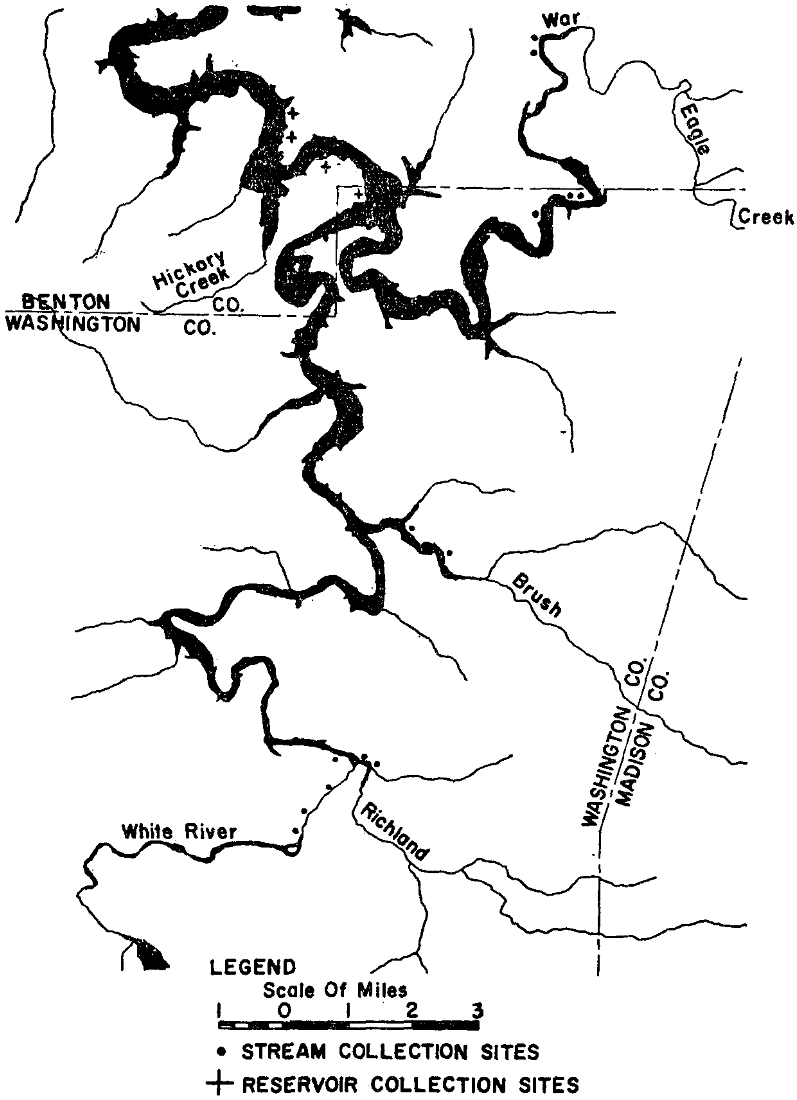

FIG. 2: RELATIVE IMPORTANCE BY PERCENT WEIGHT AND PERCENT OCCURRENCE OF MAJOR FOOD GROUPS IN THE DIET OF BEAVER RESERVOIR WHITE BASS.

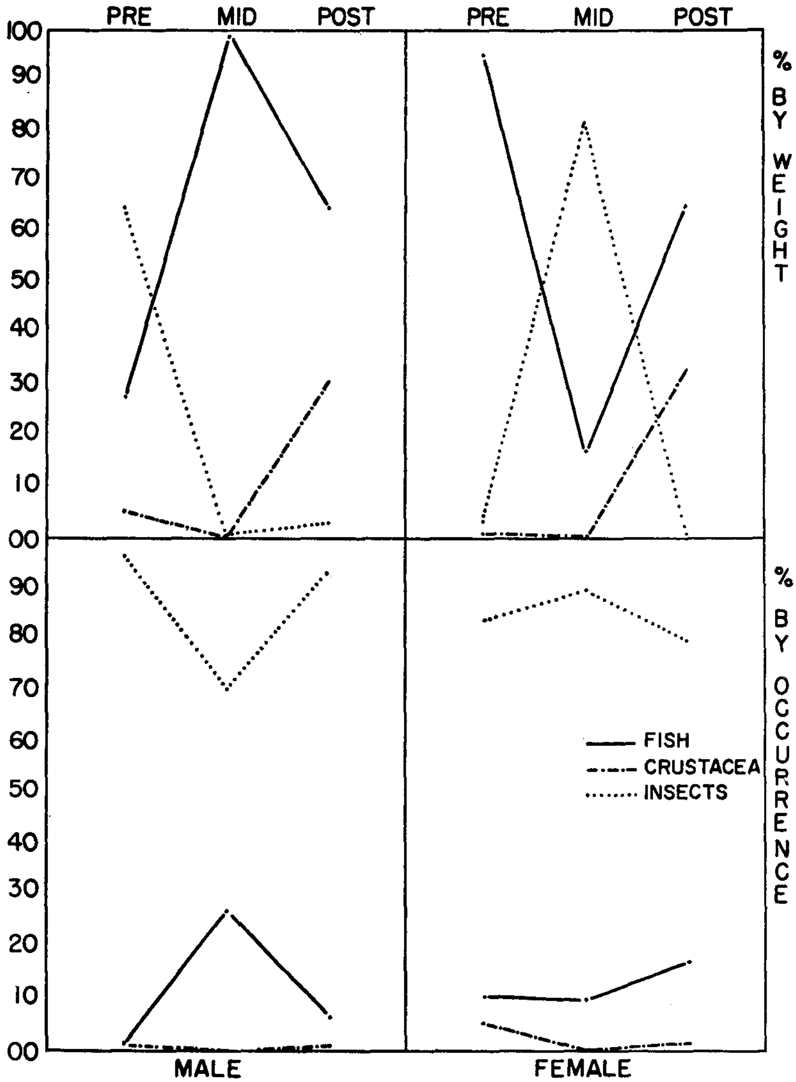

TABLE 1. Percent of total weight and occurrence of foods eaten by white bass collected from Beaver Reservoir, February through June, 1969

	Pre-spawn		Mid-spawn		Post-spawn	
	Weight	Occur	Weight	Occur	Weight	Occur
			MALE			
Clupeidae	0.0	0.0	0.0	0.0	.98	.59
Centrarchidae	0.0	0.0	96.72	12.5	30.74	.39
Unidentified Fish	10.09	1.47	.65	12.5	22.36	5.55
Amphipod	0.0	0.0	0.0	0.0	0.0	.39
Decapod	2.03	1.47	0.0	0.0	25.72	.59
Ephemeroptera	4.65	63.23	.09	25.0	.59	1.98
Plecoptera	17.69	7.35	0.0	0.0	.06	.18
Diptera	.39	22.05	.03	37.5	2.39	90.67
Homoptera	.28	2.94	0.0	0.0	0.0	0.0
Hymenoptera	.17	1.47	0.0	0.0	.02	.18
Hirudinea	0.0	0.0	.09	12.5	0.0	0.0
Digested Matter	13.62	....	.98	....	17.07	....
Detritus	51.05	....	1.39	....	.02	....
			FEMALE			
Cyprinidae	80.09	6.77	0.0	0.0	0.00	0.0
Clupeidae	0.0	0.0	0.0	0.0	1.88	4.37
Centrarchidae	0.0	0.0	0.0	0.0	53.26	4.14
Unidentified Fish	5.42	3.38	7.59	10.0	3.35	9.44
Amphipod	0.0	0.0	0.0	0.0	0.0	.23
Decapod	.75	3.38	0.0	0.0	29.49	1.15
Isopod	0.0	1.69	0.0	0.0	0.0	0.0
Ephemeroptera	2.05	38.98	19.62	40.0	0.0	0.0
Plecoptera	1.42	15.25	12.65	20.0	.01	.23
Diptera	.23	28.81	3.16	30.0	1.01	79.95
Trichoptera	0.0	0.0	0.0	0.0	0.0	.23
Megaloptera	0.0	0.0	0.0	0.0	0.0	.23
Memiptera	0.0	1.69	0.0	0.0	0.0	0.0
Digested Matter	7.97	....	54.11	....	9.30	....
Detritus	2.0	....	2.84	....	1.65	....

TABLE 2. Relationship of quantitative food habits of white bass in Beaver Reservoir to spawning period

	Pre-spawn		Mid-spawn		Post-spawn	
	Male	Female	Male	Female	Male	Female
Number of stomachs	36	36	119	5	38	29
No. of empty stomachs	18	14	98	1	9	1
% of empty stomachs	50	39	82	20	24	4