FOOD HABITS OF ADULT FLATHEAD CATFISH, *PYLODICTUS OLIVARIS* (RAFINESQUE), IN OKLAHOMA RESERVOIRS[1]

by

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ABSTRACT

Food items were found in 47.0% of 1329 flathead catfish stomachs collected by gill and trammel nets from six Oklahoma reservoirs: Carl Blackwell, Eufaula, Fort Gibson, Grand, Hudson, and Texoma. The average number of food items was 1.6 per stomach and the average volume per stomach was 26.4 ml in stomachs with food. Fish comprised more than 95% of total food volume and total number of food items in all six reservoirs. Gizzard shad contributed from 49.5 to 91.7% of total stomach volumes. Freshwater drum were second in importance as forage, accounting for 3.3 to 38.2% of total volumes. Carp contributed 23.2 and 42.0% of total stomach volumes on lakes Eufaula and Hudson, respectively, but were not found elsewhere. Channel catfish comprised 13.8% of the stomach volume in flatheads from Fort Gibson Reservoir where they were very abundant. All species of centrarchids comprised only 5.4 to 10.0% of total stomach volumes in three reservoirs. The average standard length of 467 measurable forage fish was 127 mm. The average lengths of gizzard shad (age I+), freshwater drum, and channel catfish were similar, ranging from 134 to 147 mm (S. L.). Of 718 identifiable fish, only two white crappie and one channel catfish were of harvestable size. Flathead catfish feeding activity was greatest in September through October and April through May. Feeding activity was less during the winter months and in June and July when spawning occurred. Feeding activity increased in August following spawning. Gizzard shad decreased in importance as forage during spring and summer months in most reservoirs. Centrarchids and channel catfish were more important during late spring and summer. Flathead catfish predation in reservoirs is probably determined by the availability of suitable-sized forage species near the reservoir bottom in water depths inhabited by flathead catfish. The desirability of flathead catfish as a predator in Oklahoma reservoirs is related to their predation on large forage fishes which are non-vulnerable to the average size piscivorous game fish.

INTRODUCTION

The extent of utilization of fish as forage by flathead catfish in rivers varies with the size of the flathead catfish (Brown and Dendy, 1961), with availability of forage fish (Langemeier, 1965), or relative abundance of forage fish to invertebrates (Minckley and Deacon, 1959). Swingle (1954) tentatively included only 406 mm (16-inch) and larger flathead catfish in the piscivorous "C" classification, but subsequent pond experiments (Swingle, 1967) indicated all flathead catfish should be included in the "C" group for population analysis.

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Because of their predatory habits, flathead catfish have been used experimentally for thinning stunted forage fish in ponds and small lakes with the objective of obtaining faster growth in the survivors. When stocked in stunted populations of black bullheads *(Ictalurus melas)*, flathead catfish preyed on bullheads of all sizes (Kendle, 1970). Pond experiments by Hackney (1966) and Swingle (1967) indicated that flathead catfish selected the larger forage fishes *(Lepomis macrochirus* and *Tilapia* spp.*)*, implying competition with sport fishermen for harvestable fish.

Knowledge of flathead catfish food habits in reservoirs is limited to observations by Clemens (1954) on six flathead catfish from two Oklahoma reservoirs (Fort Gibson and Tenkiller) where the stomachs contained fish, chironomids and mayflies.

Knowledge of flathead catfish predation on game fishes and the nature of competition between flathead catfish and game fishes is valuable for assessment of dynamics of reservoir fish populations. This report examines the relative composition of the various forage species in the diet and seasonal trends in feeding activity of 1,329 primary adult flathead catfish $>$ 500 mm (19.7 inches), from six Oklahoma reservoirs. Size composition of the fishes was determined. Results are stratified to compare inter-reservoir and seasonal variation.

PROCEDURES

Collection Methods

Flathead catfish food habits were examined as one segment of a larger study on food habits of eight commercial fishes. A discussion of methods used in collecting fish stomachs from commercial fisherment and descriptions of the sampled reservoirs has been given by Summerfelt, Mauck and Mensinger (in press). A survey of seasonal characteristics and annual harvest of Oklahoma's commercial fishery was made during the food habits study (Parrack, Brown and Mensinger, 1970. Flathead catfish from Eufaula, Fort Gibson, Grand, Hudson and Texoma reservoirs were collected by commercial fishermen using gill and trammel nets. Collections from Lake Blackwell were made by the authors.

The number of flathead catfish alimentary tracts collected varied from 21 to 236 per month (Table 1). Commercial fishermen stopped collecting stomachs after October from Lake Hudson (Markham Ferry), a 10,400-acre mainstream reservoir between Grand and Fort Gibson reservoirs. In addition, very few flathead catfish were caught December through February. However, a total of 1,181 alimentary tracts were purchased from commercial fishermen.

Mean total lengths of flathead catfish collected by commercial fishermen were 647 mm (25.5 inches) in Lake Texoma; 597 mm (23.5 inches) in Grand Lake; 647 mm (25.5 inches) in Eufaula Reservoir; 595 mm (23.4 inches) in Fort Gibson Reservoir. There were no significant differences in mean size of flathead catfish caught in different quarters of the year from these four riverine reservoirs. Oklahoma's commercial fishermen were restricted by law to mesh sizes of at least 76 mm (3-inch) square which eliminated flathead catfish less than 500 mm. Because most fishermen used 76 or 89 mm (3½-inch) mesh netting, very large flathead catfish were generally excluded from the catch. Assuming flathead catfish in the riverine reservoirs mature at similar sizes as those in Lake Carl Blackwell, all males and the majority of females examined were sexually mature.

One hundred forty-eight flathead catfish ($>$480 mm total length) were examined from Lake Carl Blackwell. These fish were collected in gill nets of 76 to 121 mm (3 to 5-inch) bar mesh. Average total length and weight of all flathead catfish collected from Carl Blackwell was 697 mm (27.5 inches) and 5.24 kg (10.6 lbs.). The average length of fish taken in 76 mm square mesh gill netting was 603 mm (23.7 inches). Of flathead catfish collected in the 76 mm netting, 84 of 85 fish were greater than 500 mm. In Lake Carl Blackwell all males were mature at 425 mm and all females had reached sexual maturity at 580 mm. Only 25% of the females in the 500-600 mm range were still immature.

Laboratory Examination

Commercial fishermen placed entire alimentary tracts into cottom soil-sample bags (178 by 267 mm or 254 by 432 mm). Samples were collected monthly from commercial fishermen. Analyses were made of individual stomach contents which were identified, counted and recorded. Total volume of the food items was measured to the nearest 0.1 ml by water displacement. Intestinal contents were examined to aid in the identification of partially digested forage fish. For example, drum *(Aplodinotus grunniens)* otoliths or shad *(Dorosoma* sp.*)* gizzards were used occasionally to identify fish remains in the stomach. Items found in the intestines were not used in the numerical or volumetric analyses.

Standard lengths of undigested forage fish were measured to the nearest millimeter. Standard length is used throughout this report when discussing forage fish. Lengths of decapitated gizzard shad *(Dorosoma cepedianum)* were derived from measurements of lengths of the vertebral column. Gizzard shad vertebral column length (V. L.) was converted to standard length from the empirical equation: S. L. = 1.20 V.L.

Percentage frequency of occurrence, percentage numerical occurrence, and percentage total volume were calculated for each monthly sample from each reservoir.

RESULTS

Organic and inorganic debris, fish, and invertebrates were found in the stomachs of 50.8% (675) of 1,329 flathead catfish stomachs. This percentage was less than percentages reported for river populations of flathead catfish collected with electric fishing gear (Minckley and Deacon, 1959; Brown and Dendy, 1961; and Langemeier, 1965). However, the majority of fish examined in these earlier studies were immature, while in this study the flathead catfish usually were mature.

Forty-seven percent of all flathead stomachs contained one or more food items. An additional 3.8% of the stomachs contained various types of debris (mud, sand, gravel and pieces of wood and leaves), and 49.2% were empty except for a few stomachs which contained one or two fish scales.

Inter-Reservoir Comparisons

Food habits characteristics were compared for flathead catfish collected from the following Oklahoma reservoirs: Carl Blackwell, Eufaula, Fort Gibson, Grand, Hudson and Texoma (Table 2). Percentage of flathead catfish stomachs containing food items ranged from 33.8% at Lake Carl Blackwell to 56.1% at Lake Hudson (Markham Ferry). Flathead catfish stomachs from Lake Carl Blackwell were examined only if the net had been previously raised within 24 hours. Assuming the time interval between net raises and the percentage occurrence of food were correlated, cooperating commercial fishermen were apparently conscientious in raising their nets. Fishermen were a desirable source for large numbers of flathead catfish for food habits analysis.

Average volume of food in stomachs containing $>$ .1 ml was 26.4 cc, range from 23.9 to 37.4 cc, with the exception of the samples from Fort Gibson Reservoir (Table 2). The 11.3 ml average volume per stomach in Fort Gibson Reservoir may have resulted from a greater time interval between net raises or smaller average size of the forage. Unidentified fish remains in flathead stomachs had greatest volumetric and numerical occurrence in Fort Gibson

TABLE 1

NUMBERS OF FLATHEAD STOMACHS EXAMINED FROM SIX OKLAHOMA RESERVOIRS, 1967-68.

Month	Blackwell	Eufaula	Ft. Gibson	Grand	Hudson	Texoma	Total
1967							
July	4	18	14	-	-	7	43
Aug.	4	-	17	-	-	-	21
Sep.	1	17	49	30	25	7	129
Oct.	2	13	53	104	16	16	204
Nov.	-	21	34	27	-	20	102
Dec.	2	5	25	4	-	-	36
1968							
Jan.	-	15	-	9	-	-	24
Feb.	3	6	-	16	-	1	26
Mar.	11	25	6	3	-	1	46
Apr.	18	28	-	-	-	3	49
May.	42	100	50	32	-	12	236
June	26	64	7	23	-	10	130
July	17	67	-	50	-	2	136
Aug.	18	53	-	40	-	15	126
Total	148	453[1]	255	338	41	94	1329[1]

[1]This total includes one sample of 21 stomachs for which the month was unknown.

TABLE 2

VARIATION IN THE PERCENTAGES OF THE TOTAL STOMACH VOLUMES OF FLATHEAD CATFISH COLLECTED FROM SIX OKLAHOMA RESERVOIRS.

Item	Percentages of total volume					
	Blackwell	Eufaula	Ft. Gibson	Grand	Hudson	Texoma
Gizzard shad	49.5	50.7	60.7	91.7	50.4	55.1[1]
Freshwater drum	38.2	12.9	20.4	4.9	3.3	33.6
Carp	-	23.2	-	-	42.0	-
Channel catfish	4.7	-	13.8	1.8	1.6	-
Bullhead (*Ictalurus* sp.)	-	Tr[2]	Tr	-	-	-
Flathead catfish	-	-	-	0.1	-	-
Largemouth bass	-	-	-	-	-	2.1
Bluegill	5.1	1.4	-	-	-	-
Sunfish (*Lepomis* sp.)	-	3.1	-	-	-	3.9
White crappie	-	5.1	-	-	-	-
Unidentified Centrarchidae	0.3	0.4	-	-	-	0.1
White bass	0.4	-	-	-	-	-
Darter (*Percina* ap.)	-	-	-	-	-	0.5
Unidentified fish remains	1.0	2.6	3.5	1.3	2.3	3.5
Total of all fish	99.2	99.4	98.4	99.8	99.6	98.7
Decapoda	-	0.3	0.6	Tr	-	-
Ephemeroptera (*Hexagenia* sp.)	-	-	Tr	Tr	-	-
Detritua	0.7	0.2	0.6	0.2	0.4	1.3
Plant remains	0.1	Tr.	0.2	-	-	Tr.
No. stomachs examined	148	453	255	338	41	94
Percentage of stomachs with $\geq$ .1 ml of contents	33.8	46.6	44.3	54.7	56.1	45.7
Avg. vol. (ml)[3]	29.7	23.9	11.3	37.4	25.4	34.2
Avg. no. of items[3]	2.0	1.7	1.4	1.4	1.3	1.6

[1]Sisteen of twenty shad were identified as *D. cepedianum*.

[2]Trace (Tr) indicates volumes less than 0.1 percent.

[3]In stomachs containing food.

and Texoma reservoirs. Average volumes of stomach contents from Grand Lake (37.4 ml) and Lake Texoma (34.2 ml) flathead catfish were three times greater than those found in Fort Gibson Reservoir, suggesting greater time intervals between net raises in Fort Gibson Reservoir. This confirms the conclusion by Summerfelt *et al.* (1971) regarding the deteriorated condition of carp alimentary contents from Fort Gibson Reservoir.

Average number of food items found in stomachs with food was 1.6 with a range of 1.3 (Lake Hudson) to 2.0 (Lake Carl Blackwell). The maximum number of food items in a stomach was 12 small gizzard shad found in a flathead catfish collected in December from Lake Eufaula. Eleven gizzard shad were found in a single flathead catfish collected in December from Grand Lake. Stomachs with more than five forage fish always contained small or young-of-the-year gizzard shad.

Types of Food Organisms

Fish comprised 98.4 to 99.8% of the total volume of stomach contents (Table 2) and 95.5 to 100.0% of the total number of food items in stomachs of flathead catfish in the six reservoirs. Crayfish (Decapoda) were found in flathead catfish stomachs from Eufaula, Fort Gibson and Grand reservoirs, but contributed < 1.0% of the total volume or total number of items in flathead catfish in these reservoirs. Although contributing <0.1% of the total volumes, Ephemeroptera *(Hexagenia* sp.*)* comprised 0.6 and 4.2% of the total number of food items in Fort Gibson and Grand reservoirs, respectively. Percentages of total volume and total number of the major forage fish species were compared for the six reservoirs (Figure 1). Percentages of frequency of occurrence differed only slightly from percentages of numerical occurrence. Percentages of numerical occurrence of gizzard shad and *Hexagenia* sp. were usually greater or about equal to percentages of frequency of occurrence. Most other food organisms had slightly greater percentages of frequency of occurrence than numerical occurrence.

Gizzard Shad: Gizzard shad were the major forage species in all six reservoirs (Figure 1). They comprised 50.2 to 60.7% of the total food volume in flathead catfish in all but Grand Lake where they contributed 91.7% of the total volume and 70.1% of the total number of organisms. Percentage of numerical occurrence (60.4%) of gizzard shad exceeded percentage of total volume (49.5%) only in flathead catfish from Lake Carl Blackwell. Although threadfin shad *(Dorosoma pentenense)* were common in Texoma, the 16 shad, indentifiable to species, found in flathead catfish stomachs from Lake Texoma were gizzard shad. The four shad identified only to genus could have been threadfin shad, however, based on the 94 flathead catfish stomachs examined from Lake Texoma, threadfin shad were not an important forage species. The epipelagic habitat of the threadfin shad may have contributed to their absence in the stomachs of the bottom-dwelling flathead. By contrast, gizzard shad have been reported to feed more extensively on bottom organisms as they grow older (Cross, 1967).

Freshwater Drum: The drum was volumetrically second in importance in flathead catfish stomachs in Fort Gibson (20.4%), Texoma (33.6%), and Carl Blackwell (38.2%). In Lake Eufaula freshwater drum ranked third in total volume (12.9%), but second in numerical occurrence (14.3%). Percentages of numerical occurrence were less than percentages of total volume in all reservoirs. Generally, only a single drum occurred in an individual flathead catfish stomach, but on a few occasions two or three occurred. The bottom-feeding characteristics of yearling and adult drum (Swedberg, 1968) probably accounted for their importance in the food habits of flathead catfish.

Importance of freshwater drum in flathead catfish stomachs from Lake Carl Blackwell was paralleled by its abundance in the 25 mm (1-inch) mesh of experimental gill nets which caught gizzard shad and freshwater drum of the same size as those found in flathead catfish stomachs. The distribution of drum and gizzard shad in gill net catches in Lake Carl Blackwell were positively correlated with catch rates of flathead catfish (Summerfelt, unpublished report). report).

Carp: Carp *(Cyprinus carpio)* were found in flathead catfish from Eufaula and Hudson reservoirs where they made up 23.2 and 42.0% of the total food volume, respectively. Numerically, carp comprised less than 7% in both reservoirs because of their large average size. A large (>400 mm total length) carp was found in a flathead catfish from Lake Carl Blackwell in a sample collected after preparation of Table 1.

*Channel catfish:*Channel catfish *(Ictalurus punctatus)* comprised 4.7 and 13.8% of total stomach volumes in Carl Blackwell and Fort Gibson reservoirs,

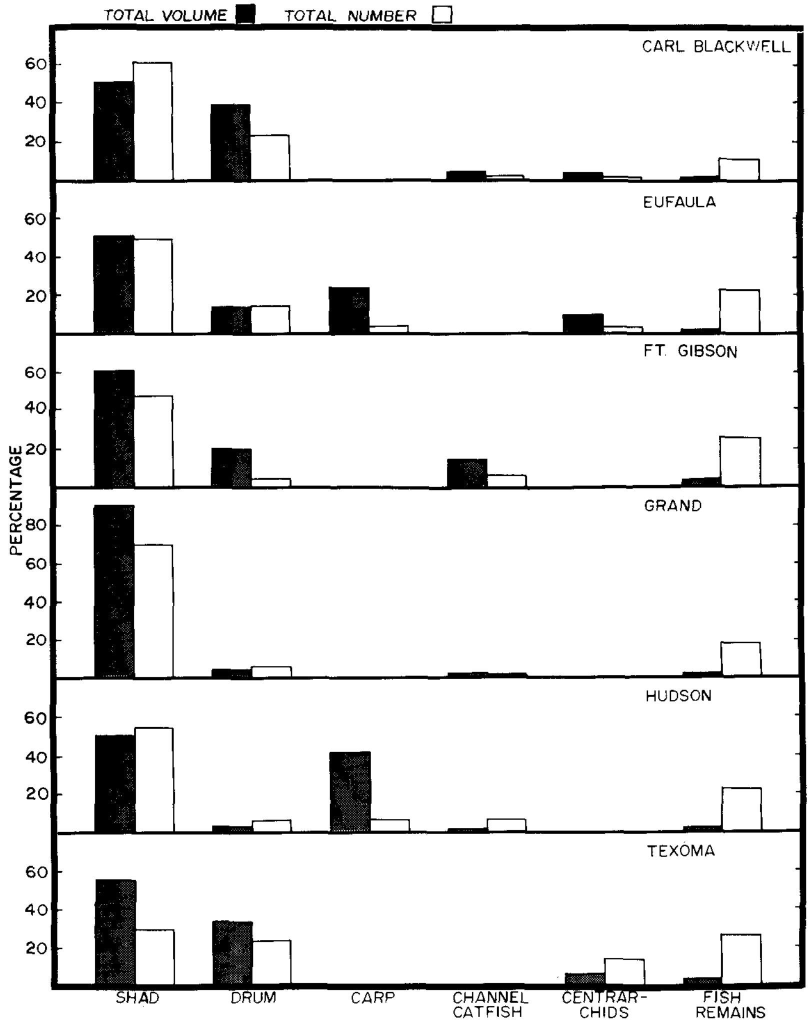

FIGURE 1. Percentage total stomach volume and percentage total number of food items contributed by forage fish in flathead catfish stomachs from six Oklahoma reservoirs.

respectively. They comprised less than 2% of the volume of stomach contents in Grand and Hudson reservoirs. The importance of channel catfish in Blackwell and Gibson reservoirs is apparently related to their abundance. Channel catfish comprised 18.1% of the gill net catch by commercial fishermen in Fort Gibson (Parrack, *et al.* 1970), and extensive gill netting by the authors in Lake Carl Blackwell indicated a substantial population of small channel catfish in that reservoir.

Centrarchids: Centrarchids comprised 5.4, 10.0 and 6.1% of the total stomach volumes in flathead catfish from Carl Blackwell, Eufaula and Texoma reservoirs, respectively. Percentage numerical occurrences in Lake Carl Blackwell (3.0%) and Eufaula Reservoir (3.9%) were less than percentage total volume. Young-of-the-year largemouth bass and sunfish *(Lepomis* sp.*)* found in flathead stomachs in Lake Texoma resulted in a greater numerical occurrence (13.2%) of centrarchids. Two white crappie *(Pomoxis annularis)* indentified in stomachs from Eufaula were the only harvestable centrarchids found during this study.

Although commercial netting in the five riverine reservoirs was restricted to water at least 100 yards from shore, netting by the Oklahoma Cooperative Fishery Unit in Lake Carl Blackwell was limited only to water depths of at least ten feet. This allowed netting much closer to shore and may have accounted for the larger number of bluegill *(Lepomis macrochirus)* found in flathead catfish stomachs in this reservoir. Bluegill were found to be more common in cove samples than open water samples in an evaluation of rotenone sampling at Douglas Reservoir, Tennessee (Hayne, Hall and Nichols, 1967). Bluegill were the most abundant centrarchid recovered in four rotenone cove samples at Lake Carl Blackwell in 1967-68.

Miscellaneous species: Other forage fish found in flathead stomachs included a single flathead catfish from Grand Lake and six *Percina* sp. from Lake Texoma. Several bullhead *(Ictalurus* sp.*)* and channel catfish spines, identified according to techniques described by Paloumpis (1963), were found imbedded in the stomach wall or mesenteries of flathead catfish. An adult river carpsucker *(Carpiodes carpio)* was observed in a flathead catfish stomach from Lake Carl Blackwell after termination of food habit studies.

Size of Forage Fish

Average standard length and range in length of each taxon of forage fish was determined for the combined samples (Table 3). Gizzard shad were classified as either young-of-the-year (considered age I after December 31) or older. Young-of-the-year gizzard shad averaged 66 mm, while older gizzard shad had an average standard length of 147 mm. Although young-of-the-year freshwater drum, channel catfish and sunfish *(Lepomis* sp.*)* were found, they occurred in small numbers and were not classified separately.

Average standard lengths of freshwater drum, carp and channel catfish found in flathead catfish stomachs were 142, 231 and 134 mm, respectively (Table 3). Three bluegill and two white crappie averaged 119 and 188 mm, respectively. The only largemouth bass identified were young-of-the-year from Lake Texoma (average length 84 mm).

Two white crappie from Lake Eufaula and a partially digested channel catfish from Grand Reservoir were the only harvestable game fish found among 718 fish identified during this study. Several specimens of partially digested carp found in stomachs from Lake Eufaula probably exceeded 360 mm (S. L.).

Ranges in averages of standard length of gizzard shad occurring in flathead catfish stomachs from the six reservoirs were 58 to 76 mm for young-of-the-year fish 132 to 165 mm for age I+ fish (Table 4). Adult shad in stomachs of flathead catfish from the two older riverine reservoirs, Grand and Texoma, averaged 165 mm. Adult shad in stomachs from the 2-year-old Lake Eufaula and Lake Carl Blackwell averaged 132 mm. Average lengths of freshwater drum in stomachs of flathead catfish were generally similar for the reservoirs with sample sizes > 5 fish (ranging from 127 to 152 mm). Other species occurred in stomachs in too few numbers to make meaningful comparisons between reservoirs.

Seasonal Variation in Food Habits

Monthly trends in feeding activity were examined using the parameters of percentage of monthly samples containing food and average food volume per stomach. Interpretation of these parameters was confounded by the monthly variation in water temperature, the time interval vetween net raises by commercial fishermen, and the influence of spawning.

Spring and Summer Feeding Activity: In Lake Carl Blackwell the time interval between net raises averaged 24 hours for the flathead catfish stomachs examined during March through August (Table 1). Values for average volume of food per stomach and percentage of stomachs containing food were low in March, but increased to highest vlaues in April (Figure 2). Percentage of stomachs with food remained high in May although average food volume per stomach decreased. Low values for both parameters during June and July were probably related to spawning which occurred in late July and early August. Langemeier (1965) also noted a decrease in flathead catfish feeding prior to and during the spawning period. The 1968 spawning period was apparently delayed in Lake Carl Blackwell as maximum ovary weights and oocyte diameters were reached by late June in most adult fish. Spawning in the riverine reservoirs occurred in June and early July (Gary Mensinger, personal communication). Feeding activity increased in August following spawning. However, in Texoma, the percentage of stomachs containing food was the highest in August, and variation in average food volume or percentage occurrence was not clearly related to spawning. Spring and summer trends in feeding activity for the riverine reservoirs were generally similar to those observed for Lake Carl Blackwell (Figure 2).

Variation in time interval between net raises by commercial fishermen on Lake Texoma averaged 1.1 to 1.2 days July through September 1967 to 2.1 to 2.2 days from December 1967 through March 1968 and then decreased from 1.5 days in April to 1.2 days in June 1968 (Parrack, Brown and Mensinger, 1970). Variation in frequency of net raises on Eufaula, Grand and Fort Gibson reservoirs probably had similar patterns although the magnitude of variation may have varied. Frequency of net raises was directly correlated with increasing water temperatures and was probably related to increased net-mortality at increased water temperatures. Water temperatures in the riverine reservoirs averaged from 20 to 25 C from June to September and 5 to 10 C from November through March.

Fall and Winter Feeding Activity: Feeding activity in the fall and winter is limited to data from the riverine reservoirs as few fish were collected from Lake Carl Blackwell during these months. In flathead catfish from Grand Lake the average volume of food and percentage of stomachs with food decreased from September 1967 through January 1968 (Figure 2). Average food volumes remained low during February and March although 2 of 3 stomachs available for examination in March contained food.

Monthly variation in feeding activity for Lake Eufaula flathead catfish contrasted sharply with the variation in Grand Lake. In Grand Lake the average food volume and percentage of stomachs with food increased September through December 1967. Large average stomach volumes during November and December were caused by large food volumes found in 3 to 5 and 3 of 15 stomachs, respectively.

In Fort Gibson Reservoir the average food volumes in September and October were greater than in November and December, although the percentages of stomachs with food was similar September through December. Six stomachs examined in March were empty. Average food volumes and percentages of stomachs with food were uniformly high for September, October and November collections from Lake Texoma. However, the uniformity probably indicates a decrease in feeding activity because the increasing time interval betwwen net raises probably did not balance the decreasing digestive rate caused by dropping water temperature during this period.

Relative Composition of Forage Species

Seasonal variation in composition of forage species was evaluated for all reservoirs. Lake Eufaula and Grand Lake have been emphasized in this report because samples were available for all months with the exception of April 1968 when commercial fishing was not allowed on Grand Lake. Unfortunately, samples from winter months were usually small in size (Table 1).

*Grand Lake:*The relative abundance of the various forage species in flathead catfish from Grand Lake exhibited little monthly variation. Gizzard shad always contributed>75% of total stomach volume. Freshwater drum were the only other forage species of importance, comprising from 3.0 to 20.6% of total stomach volumes in 6 of the 11 monthly samples. Most freshwater drum were found in fall stomach samples. *Hexagenia* sp. was found only in June and July.

The large numbers of gizzard shad found in stomachs from Grand Lake were analyzed for monthly variation in average size of both age groups. Average standard lengths of age I+ gizzard shad increased from 155 to 177 mm (September through November 1967) and from 142 to 177 mm (May through August 1968). Young-of-the-year gizzard shad in flathead stomachs increased in length from 56 to 75 mm and in numerical and volumetric importance from August through December.

TABLE 3

STANDARD LENGTHS IN MILLIMETERS OF MEASURABLE FORAGE FISH CONSUMED BY FLATHEAD CATFISH FROM SIX OKLAHOMA RESERVOIRS.

Forage fish	Number measured	Average S.L.	Range in S.L.
Gizzard shad *(Dorosoma cepedianum*			
age I and older	276	147	63-249
Young-of-the-year	107	66	35- 96
Freshwater drum *(Aplodinotus grunniens)*	53	142	35-322
Carp *(Cyprinus carpio)*	5	231	211-266
Channel catfish *(Ictalurus punctatus)*	7	134	35-193
White crappie *(Pomoxis annularis)*	2	188	165-208
Bluegill sunfish *(Lepomis macrochirus)*	3	119	101-134
Sunfish *(Lepomis* sp.*)*	5	79	23-139
Largemouth bass *(Micropterus salmoides)*	4	84	45-147
White bass *(Roccus chrysops)*	1	94	94
Darter *(Percina* sp.*)*	4	61	51- 68
All species combined	467	127	23-322

TABLE 4

COMPARISON OF THE AVERAGE STANDARD LENGTHS IN MILLIMETERS OF MEASURABLE GIZZARD SHAD AND FRESHWATER DRUM CONSUMED BY FLATHEAD CATFISH FROM SIX OKLAHOMA RESERVOIRS.

	Gizzard shad						Freshwater drum		
	Young-of-the-year			Age 1 and older			All fish		
Reservoir	No.	Avg. S.L.	Range	No.	Avg. S.L.	Range	No.	Avg. S.L.	Range
Carl Blackwell	15	63	51-73	35	132	73-188	12	152	76-264
Eufaula	24	58	38-84	96	132	91-190	22	127	35-206
Ft. Gibson	21	76	35-96	19	145	76-183	3	165	114-203
Grand	40	68	51-84	105	165	63-203	8	132	58-322
Hudson	6	61	40-66	6	157	101-193	2	81	51-109
Texoma	1	40	40	15	165	119-249	8	150	68-208

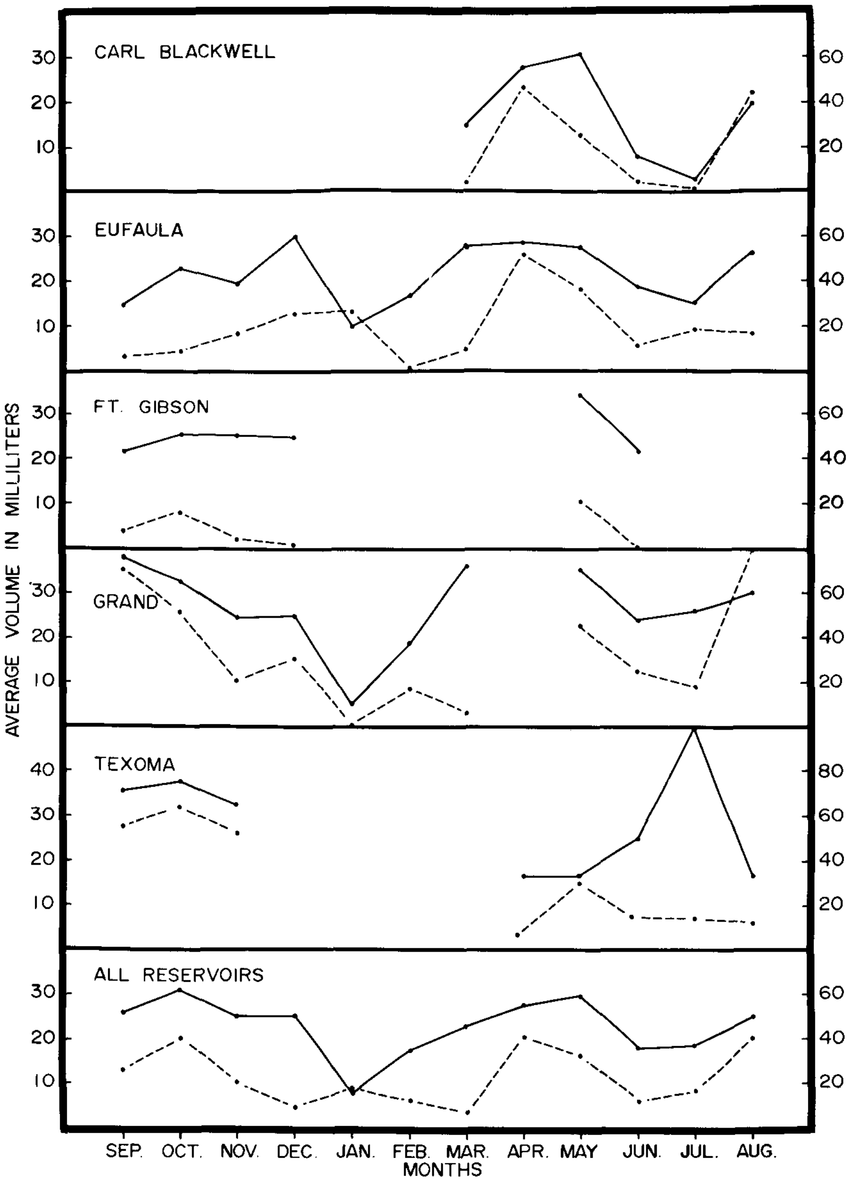

FIGURE 2. Monthly variation in average food volume per stomach (-------) and percentage of stomachs containing food (--------) of flathead catfish from five Oklahoma reservoirs.

Lake Eugaula: Flathead catfish stomach contents from Lake Eufaula differed from Grand Lake stomach contents in both composition and seasonal trends. A major change in food habits occurred in the spring months of 1968. Gizzard shad had been the major forage fish from July 1967 through February 1968 as only a single centrarchid was found in September and October stomach samples. Beginning in March, the importance of freshwater drum, carp and centrarchids began to increase. This trend produced a major mode in June when these species comprised 83.8% of total stomach volume compared with only 6.4% for gizzard shad.

Other Reservoirs: Samples from Lake Carl Blackwell, Fort Gibson Reservoir and Lake Texoma, although not available for all months (Table 1), showed trends similar to those observed in Lake Eufaula. Gizzard shad were numerically the most abundant fish consumed in Fort Gibson Reservoir from July through December 1968, but freshwater drum comprised greater total volumes in August and October. Channel catfish were found in 6 of the 7 larger samples and were most abundant in summer months.

Gizzard shad were found only in late summer and fall months in Lake Texoma. Freshwater drum and centrarchids were the most important forage species in May, June, and both July samples. *Percina* sp. were found only in stomachs collected during July and August.

Decreasing relative importance of gizzard shad from March through July in Lake Carl Blackwell was paralleled by increasing importance of freshwater drum. Centrarchids and channel catfish were found only in May and June.

DISCUSSION

Selectivity by a predator for specific kinds of forage fish is measured by comparison of percentage composition of specific forage species in the environment to their composition in the diet (Ivlev, 1961). In the present tstudy, percentage composition of the stomach contents of the flathead catfish is compared with percentage composition of gizzard shad in cove rotenone samples reported by Jenkins (1967) for Fort Gibson, Grand and Texoma reservoirs, and percentage composition of gizzard shad and freshwater drum from cove rotenone samples of Lake Carl Blackwell conducted by the authors. Percentage composition of total standing crop of clupeids in Fort Gibson, Grand and Texoma reservoirs was 38, 53, and 17%, respectively. In a July 1967 sample in Lake Carl Blackwell gizzard shad and drum comprised 75.7 and 3.5% of total standing crop, respectively. The abundance of gizzard shad may be less than these data indicated and drum may be more abundant than indicated because cove rotenone samples have been shown to overestimate biomass of gizzard shad by 216% and underestimate biomass of drum by 250% (Hayne, Hall and Nichols, 1967).

We adjusted the estimated population data as indicated to be necessary by Hayne, Hall and Nichols (1967) and compared the relative abundance of the forage in the habitat with the occurrence of the forage in the diet of flathead catfish. This comparison indicated that the electivity index for the drum and gizzard shad is positive, that is, they are consumed by the flathead in a greater proportion than their relative abundance. In river studies of the flathead, occurrence of the most important items in the stomach varied closely,with the relative abundance of the forage in the habitat (Minckley and Deacon, 1959; Langemeier, 1965). Relating our findings with others seems to indicate that in the reservoirs from which flathead catfish were collected, the horizontal and vertical distribution of the flathead catfish limits the available forage to primarily gizzard shad and drum. The greatest diversity in the flathead catfish stomach contents occurred in the spring and summer.

Reliance of flathead catfish on gizzard shad as forage places them in apparent competition with other game fish large enough to prey on the averaged size shad. Gizzard shad were the major forage of largemouth bass (Schneidermeyer and Lewis, 1956) and large channel catfish (Busbee, 1968) in Illinois and Georgia reservoirs, respectively. Dendy (1946) reported gizzard shad were the major food of eight game species in Norris Reservoir, Tennessee. However, Dendy deduced that competition among the predators was lessened because of the great range in depth distribution of the shad and various game species during the growing season. Findings of Applegate, Mullan, and Morais (1967) and Dendy (1946) indicate differences in habitat preference between flathead catfish and other predators may reduce competition for gizzard shad.

Flathead catfish probably consume a larger average size of forage than other predators. Lawrence (1958) tabulated size ranges of several species of forage fish which can be swallowed by largemouth bass of various sizes. Only largemouth bass greater than 406 mm could have swallowed the average age I+ gizzard shad consumed by flathead catfish in the Oklahoma reservoirs studied. Lawrence (1958) noted that largemouth bass preferred gizzard shad smaller than those approaching the estimated maximum size. Other basses, i.e., smallmouth and spotted bass, and white bass probably consume similar or smaller gizzard shad than the average largemouth bass or flathead catfish. Flathead catfish consumption of young-of-the-year gizzard shad occurred mostly in late fall when feeding activity was low. Adult flathead catfish in Oklahoma reservoirs are probably competitive only with the game fishes of very large size.

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PREDATION ON STOCKED RAINBOW TROUT BY CHAIN PICKEREL AND LARGEMOUTH BASS IN LAKE OUACHITA, ARKANSAS

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ABSTRACT

In many reservoirs predation on stocked fish has been considered as one of the major limiting factors in establishing a particular population.

Following several years of water quality determinations it was found that Lake Ouachita maintained a sufficiently oxygenated hypolimnion to support trout. As a result several thousand catchable rainbow trout, *Salmo gairdneri,* were stocked into the lake. The results of this attempt to establish a trout fishery have been disappointing for a combination of reasons; however, while collectint for brookstock chain pickerel, *Esox niger,* and from fisherman reports, it became evident that predation on the stocked trout must be very high.

Collections of largemouth bass, *Micropterus salmoides,* and chain pickerel were made with a boom-type electro-shocker during January and February, 1970. Sampling was done at night within an approximate 100-acre area adjacent to a trout stocking point. Two separate areas were collected and collections were made the date on which trout were stocked, one day after stocking, two days after stocking, and eight days after stocking.