

THE DISTRIBUTION AND FOOD HABITS
OF BOTTOM FISHES IN TUTTLE CREEK RESERVOIR

by 4589

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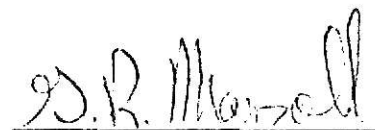
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INTRODUCTION

During recent years many reservoirs have been constructed in the Great Plains region for a variety of reasons including flood control, navigation, water for irrigation, municipal water supplies, and hydro-electric power production. Secondary values that have developed around these reservoirs are fishing, hunting, boating, water skiing, and swimming. The estimated total fishing effort on major public reservoirs reported from 31 states in 1963 was the equivalent of 10 man-days per acre (Jenkins, 1964). Fishermen in 1965 spent an average, nationwide, of \$4.98 per day of fishing (Sports Fisheries and Wildlife Publication, 1965). Furthermore, the percentage of the public that goes fishing is highest in the North Central States running from Minnesota and North Dakota south to Iowa and Kansas. In the North Central States, an average of 28 percent of the population fished, which was the highest in the U.S. (Sports Fisheries and Wildlife Publication, 1965). Fishermen who fished primarily in larger man-made reservoirs made up 24.5 percent of the inland fishermen. These figures for the economic value of recreational fishing give an indication of the use being made of man-made reservoirs for recreation, particularly in the Great Plains area.

To provide a quality recreational opportunity on these reservoirs in the future, sound management procedures must be implemented. A thorough understanding of the ecology of these reservoirs is necessary to make needed management decisions.

The Great Plains region is characterized by low relief, rolling hills, and low stream gradients. The region has a continental climate, wet in the spring and summer and windy the year round. The soil is

fertile and most ground is tilled extensively. Because of these factors, the reservoirs built in the Great Plains region are relatively shallow, turbid, potentially productive, and subject to wind and wave action. These characteristics and resultant problems are unique to the Great Plains.

Because of the relative newness of these reservoirs, and the unique problems they present, these ecosystems are poorly understood. Because of the fishing pressure on these reservoirs and the need for management and understanding of their energy dynamics, the life histories of organisms and the interrelationships of organisms in the reservoirs is needed. Knowledge of these factors and how they affect the fish production will enable the reservoir to be managed to produce the maximum quality of recreational fishing.

The study of the ecology of Tuttle Creek Reservoir is just beginning. Chen (1968) studied the species composition of the bacteria inhabiting the water. Novak (1969) determined seasonal variation of particular organic matter in the water. Cramer and Marzolf (1970) determined the food habits of gizzard shad and this fish's effect on the zooplankton population. Schwartz (1970) worked on relationships between bottom sediment particle size and distribution of bottom organisms. Dufford (1970) determined the factors which affect the turbidity levels on Tuttle Creek Reservoir.

The purpose of the present study, in general, is to add to the knowledge of the ecology of Tuttle Creek Reservoir and Great Plains Reservoirs and specifically to determine the general open water distribution of these fishes and the food habits of the bottom fishes in Tuttle Creek Reservoir.

Since the Great Plains reservoirs are relatively new, there has been little work completed on the factors affecting fish distribution and interrelationships of environment and other organisms. Borges (1950) found the fish of the Lake of the Ozarks to be evenly distributed from the top to bottom of the water column throughout most of the year, but concentrated in a cold oxygenated layer on the bottom or near the surface during August and September. The cold oxygenated layer on the bottom was due to an inflow of spring water pushing under the warmer, oxygen depleted water. Water temperature and oxygen concentration were found to be the main factors affecting vertical distribution of fish in a study by Cady (1945) in Norris Reservoir, Tennessee. He noted that a seasonal spawning migration affected the distribution of most fishes. Another investigation on Norris Reservoir, Tennessee indicated that from 59 to 70 percent of the carp, walleye, and freshwater drum were caught in the lower one-third of an eight foot deep gill net set on the bottom, while channel catfish and gizzard shad catches were evenly distributed from the top to the bottom of the net (Haslbauer, 1945). In the only distribution study done on a Great Plains reservoir, Eley, Carter and Corris (1967) found temperature to be the most important factor influencing vertical distribution of fishes throughout the year in Keystone Reservoir, Oklahoma, except during summer thermal stratification when all fish moved nearer the surface.

Very little work has been done on the interrelationship of fish distribution and biotic factors, but there are many references on general fish population surveys in the Great Plains reservoirs. Bonn (1961), Eschmeyer (1938), Hancock (1956), Houser (1959), Patriarch and Campbell (1958), Thompson (1950), and Walburg (1964) are representative works of this nature.

Food habits studies on fishes taken from Great Plains reservoirs are rare, but studies on these fishes from other waters are available. Food habits of carp were studied by Ewers and Boesel (1935) in Buckeye Lake, Iowa; and Walburg and Nelson (1966) in Lewis and Clark Lake, South Dakota. Brezner (1968) determined the food preferences of the river carpsucker from Lake of the Ozarks; as did Bucholz (1967) from the Des Moines River, Iowa; and Walburg and Nelson (1966) in Lewis and Clark Lake, South Dakota. The food habits of the smallmouth buffalo in Lewis and Clark Lake have been studied in detail by McComish (1967), and Walburg and Nelson (1966). A few of the workers who have reported on the food preferences of the channel catfish are Bailey and Harrison (1948) in the Des Moines River, Iowa; Dendy (1946) in Norris Reservoir, Tennessee; Rice (1941) in Reelfoot Lake, Tennessee; and Clemens (1954) in Tenkiller and Fort Gibson Reservoirs, Oklahoma. The freshwater drum's food habits have been reported by Dendy (1946) in Norris Reservoir, Tennessee; Hoopes (1960) from the Mississippi River in Iowa; and Swedburg (1966) in Lewis and Clark Lake in South Dakota.

There have been other works done on the food habits of these fishes, but because of the lack of similarity to the Great Plains environment, they are not mentioned.

DESCRIPTION OF STUDY AREA

This study was conducted in Tuttle Creek Reservoir, Kansas. The reservoir and dam were a project of the U.S. Army Corp of Engineers on the Big Blue River in Marshall, Pottawatomie, and Riley Counties, Kansas. Closure was on July 21, 1959, and conservation operation began on April 20, 1963. The reservoir provides flood control, augments low water stream flow to the Kansas, lower Missouri, and Mississippi rivers, assists in water quality control, silt retention and provides recreation.

The dam is 19.8 km by river upstream from the confluence of the Kansas and Big Blue Rivers at approximately 39° 15' 30" north latitude and 96° 35' 30" longitude. At conservation level, the reservoir extends some 65 to 80 km in a northerly direction up the Big Blue River Valley.

The Big Blue River drainage basin comprises a total area of 25,080 sq. km. Three-fourths of the basin lies in Nebraska, the balance in Kansas. An estimated 75 percent of the basin is cultivated land. The native soils in the basin were developed from flinty or cherty limestone. The upper portion has loessial soils underlain by glacial fills and alluvial sands (Kansas Water Resources Board, 1964).

The main tributaries, the Big Blue, Little Blue, and the Black Vermillion Rivers, carry a heavy sediment and organic detrital load that is deposited throughout the length of the reservoir (Schwartz, 1970). This factor, in addition to shallowness of the lake and the mixing effect of winds, contribute to the turbid condition during the summer and fall. The reservoir does not normally stratify thermally due to the strong prevailing Kansas winds, relatively low mean depth, and long fetch. The substrate of the reservoir is the original river channel and flood plain, which is covered

with a deposit of sediment. A detailed physical description of the reservoir is given in Table 1.

Table 1. Hydrographic characteristics and morphometry of Tuttle Creek Reservoir based on 327.9 m mean sea level (msl).*

Length (km)	23.20
Greatest width (km)	1.60
Maximum depth (m)	25.00
Average depth (m)	8.00
Shoreline length (km)	209.00
Shoreline development**	7.36
Surface area (ha)	6411.00
Storage capacity (km ³)	0.53
Gross storage elevation (m msl)	
Maximum flood pool	346.50
Normal conservation pool	327.90

* Schwartz (1970)

** Lagler (1956)

MATERIALS AND METHODS

Sampling Stations

During the summer of 1968, a recording echo-sounder was used to make a profile of the bottom of the reservoir approximately every kilometer on transects perpendicular to the long axis of the lake. Several profiles were made in the coves. The reservoir can be separated into two general types of area on the basis of ratio of shoreline to open water, openness and depth of water. These two areas will be referred to as cove area and the open water area of the reservoir. The sampling stations were selected on a basis of the presence of large relatively open flat areas (as shown by the profiles and dragging operations undertaken to locate fences, tree stumps and other obstructions). This type of area was necessary to handle the nets effectively and to have an area large enough and clear enough for trawling. Two sampling stations were selected in the coves and four in the open water area of the reservoir (Figure 1).

Sampling was done at each station, approximately 200 m from shore. This was done to sample the distribution and food habits of fishes in open water and to minimize the effect of shoreline on fish movement.

Sampling Station I was located near the upper end of McIntire Cove, on the east side of the reservoir, about 4 km. north of the dam. This site was a large mud bottomed flat, on the east side of the creek channel and had a depth of 3 to 6 m.

Station II was located on the east side of the reservoir about 0.6 km. north of the north point of McIntire Cove. This was a deep-water site, depth of 12 to 14 m. and mud bottomed.

Station III was located in Carnahan Cove, about 9 km. upstream from the

dam along the east side. This was a mud bottomed cove habitat with a depth of 3 to 4 m.

Station IV was on the east side of the open water area of the reservoir about 14 km. upstream from the dam. It was located on an extensive mud flat with a depth of 6 to 8 m. about 1 km. downstream from the Garrison Park boat ramp.

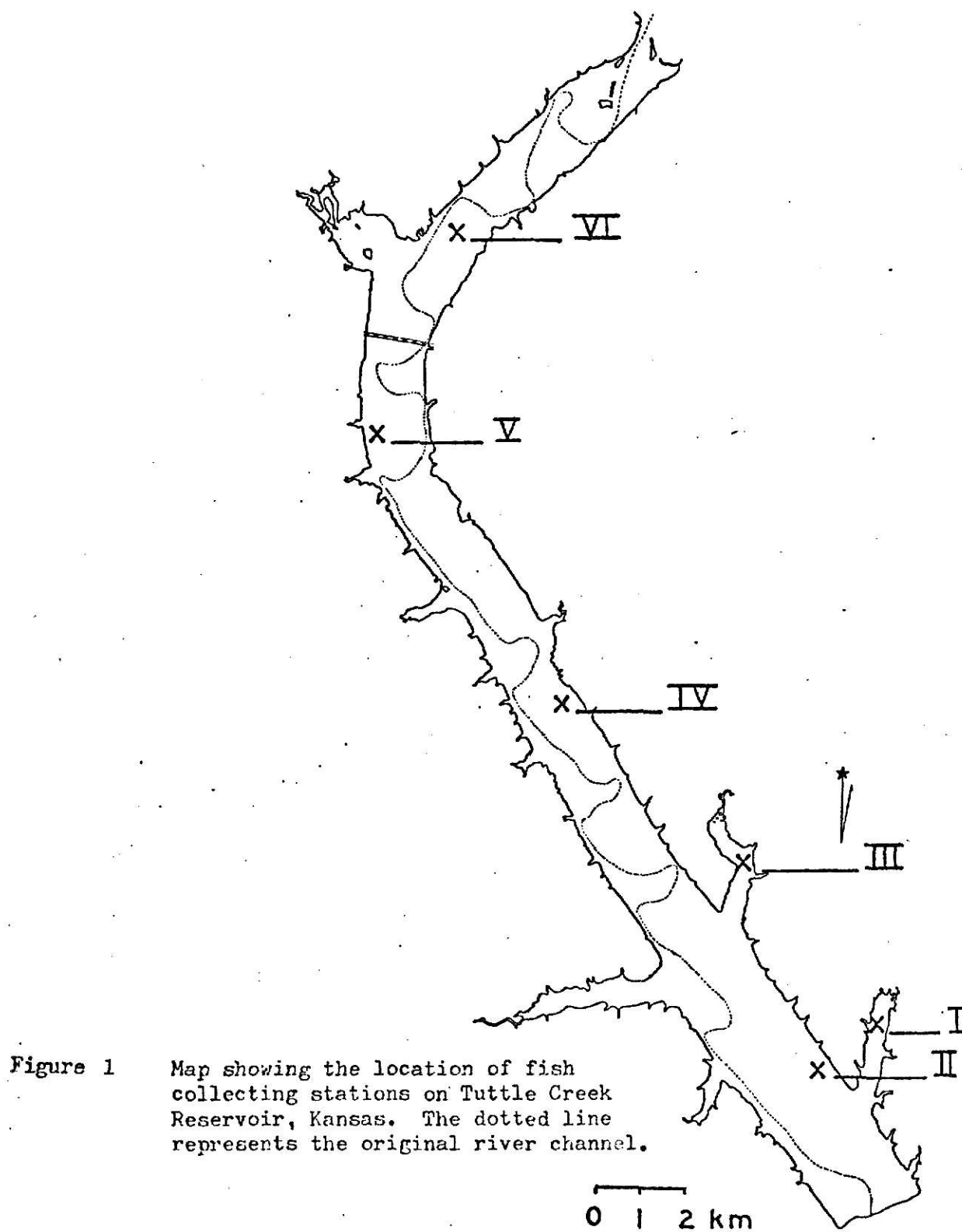
Station V was located on the west side of the reservoir about 2 km. downstream from the Randolph bridge. The depth in this area was 5 to 6 m. This site was mud bottomed also.

Station VI was located almost 3 km. upstream from the Randolph bridge, in the center of the reservoir in water 3 to 4 m. deep. This was a mud bottomed site.

Fish Collecting

Fish sampling gear had to be tested and evaluated for suitability for the sampling program. The problems involved were discussed with the staff at the North Central Reservoir Investigations Laboratory, during early summer 1968, to gain the benefit of their experience. Through these discussions and discussion with Dr. H. E. Klaassen (1968), the decision was made to use gill nets and a bottom trawl for this study.

Two bottom fishing experimental nylon gill nets were then purchased for evaluation of mesh sizes. One of these nets was 120 ft (36.6 m.) long and 6 ft. (1.9 m.) deep with a polyethylene float line on top and a nylon lead core line on the bottom. The net was made of 15 ft. (4.5 m.) sections of each of the following mesh size: 0.5 in. (13 mm.), 0.75 in. (19 mm.), 1 in. (25 mm.), 1.25 in. (31 mm.), 1.5 in. (38 mm.), 2 in. (51 mm.), 2.5 in. (64 mm.), and 3 in. (75 mm.) square mesh. The second net was 200 ft. (61 m.) long and 6 ft. (1.9 m.) deep with a polyethylene float line on top and a



nylon lead core line on the bottom. The net was made of 25 ft. (7.6 m.) sections of each of the following mesh sizes: 0.75 in. (19 mm.), 1 in. (25 mm.), 1.25 in. (31 mm.), 1.5 in. (38 mm.), 2 in. (51 mm.), 2.5 in. (64 mm.), 3 in. (76 mm.), and 4 in. (102 mm.) square mesh measure. Each of the nets had plastic floats attached to the float line at the junctions of different mesh sizes.

Preliminary sampling with these nets revealed that the 0.75 in. (19 mm.) mesh caught approximately the same size range of fish as the 0.5 in. (13 mm.) mesh. Because of this factor, the smaller mesh size was thought to be unnecessary for future sampling. Although no fish were taken in the 4 in. (102 mm.) mesh it was decided to retain this mesh size to sample the larger fish expected to be present in the population.

Six 200 ft. (61 m.) by 6 ft. (1.9 m.) experimental gill nets with the following mesh sequence and netting twine were then purchased:

Length of Section	Mesh Size	Twine Size
25 ft. (7.6 m.)	0.75 in. (19 mm.)	#69
25 ft. (7.6 m.)	1.00 in. (25 mm.)	#69
25 ft. (7.6 m.)	1.25 in. (31 mm.)	#104
25 ft. (7.6 m.)	1.50 in. (38 mm.)	#104
25 ft. (7.6 m.)	2.00 in. (51 mm.)	#139
25 ft. (7.6 m.)	2.50 in. (64 mm.)	#139
25 ft. (7.6 m.)	3.00 in. (76 mm.)	#208
25 ft. (7.6 m.)	4.00 in. (102 mm.)	#208

Two nets were set on the bottom at each sampling station and they were positioned the same way each time. One was set perpendicular to shore with the smaller mesh toward shallow water. The second net was set parallel to shore, downstream 50 to 100 m. from the first net, with the large mesh upstream and centered toward the perpendicular net. The nets were set about 200 m. from shore at each station except Station VI where they were set near

the middle of the reservoir. The nets were set at each sampling station for a total of 48 consecutive hours per month, being pulled and checked every 12 hours when possible. The unit of effort was described as the catch from two nets for two days (48 hours). The lower three sampling sites (I, II and III) were sampled during the same two day period, the upper three sampling sites, (IV, V and VI) were sampled during the subsequent two days. Results are presented with this unit of effort used throughout.

The nets were set with a spreader pole (2 m. by 13 mm. ID metal conduit) attached to each end. This pole had a styrofoam float attached to the top to hold it vertical and a lead weight at the bottom which would sink the pole and its attached float. These poles were attached to the top and bottom lines of the gill net by means of harness snaps attached to the ends of a two-rope bridle. Each bridle, attached at one end, to the top and bottom of the spreader pole, was attached at the other end to a 12 kg. concrete anchor with an attached float line. This attachment was also by means of a harness snap. The bridle and float lines were of 0.25 in. (6 mm.) polyethylene rope.

The nets were set by attaching the anchor to its float line and the end of the bridle, then attaching the bridle to the spreader pole and to one end of the gill net. The anchor was then lowered, paying out the bridle, spreader pole, and net as the boat was slowly backing away. When the other end of the net was reached, the spreader pole, bridle, anchor and anchor float line were attached and slowly lowered overboard. The float line was used to hold the anchor above the bottom until the net assembly became taut. The anchor was then released, leaving the anchor line floats visible at each end. It was

felt that with this method of setting the nets, the spreader poles would keep the net extended to its full height, the pole floats would keep it standing upright in the water, and the pole weights and anchors would hold it securely.

To check the nets, the downwind float was picked up, the anchor raised, placed in the back of the boat, the bridle pulled in and coiled. The spreader pole was placed on the bottom of the boat near the back, and the gill net was pulled in by hand and the fish picked out and the net piled up in the front of the boat. When the end of the net was reached, the boat motor was started and the boat backed away in the original direction, the net being paid out over the front. The spreader pole was handed overboard, and allowed to slowly sink to the bottom, the anchor was dropped to the bottom, and the net was again stretched taut by use of the float line. With this method, the net was pulled, checked, and reset without having to disconnect any of the snaps, and the total time spent per net was generally less than 30 minutes.

The nets were removed at the end of the two day sampling period by reversing the procedure of setting.

The boat used throughout this study was a 16 foot, square front, flat-bottomed boat of fiberglass manufacture. It was equipped with walk-through seats and had a large open area near the front, making it convenient for handling nets. The motor used was a 40 horsepower outboard.

The other item of fish sampling equipment used in this study was a semi-balloon bottom trawl. This is a cone shaped net with the mouth end at the base of the cone, and the cod end as the apex. The mouth of the net was an opening 16 ft. (4.88 m.) wide by 3 ft. (1 m.) deep. The top line of this opening had six evenly spaced, soft plastic floats and the 19 ft. (5.8 m.)

bottom line had 2/0 galvanized chain hung loop style. The main body of the net was No. 09 nylon thread, 1.5 in. (38 mm.) stretch mesh, while the cod end was No. 15 nylon thread, 1.25 in (31 mm.) stretch mesh. The cod end liner was No. 63, 0.5 in. (13 mm.) stretch mesh knotless nylon netting. Two trawl doors, 24 in. (610 mm.) by 12 in. (305 mm.), made of wood reinforced with steel strapping, were attached by short ropes to the ends of the mouth, one on each side of the net. These doors were rigged with a chain harness so that when pulled forward the doors would pull outward and downward to open the net and hold it on the bottom. Each door was equipped with 150 ft. (45 m.) of 0.375 in. (10 mm.) nylon rope for attachment to the boat. To use the trawl, the ropes were tied to eye-bolts on the gunnel towards the back on both sides of the boat and the cod end put overboard. The ropes were tied so the ratio of length of rope from boat to trawl to depth of water was about 4 or 5 to 1. The boat was moved forward slowly while the rest of the net and the ropes were paid out. The towing was done at top speed of the boat, estimated at 5 to 6.5 km. per hour while towing. The length of time (either 3 or 4 min.) spent towing the trawl for each haul depended upon the lack of obstructions on the bottom of the area being sampled. When the haul was finished, the motor was stopped and the ropes were pulled by hand into the boat as rapidly as possible. This was done to prevent the escape of fish by swimming out the front of the trawl. The doors and front of the net were lifted into the boat, trapping the fish in the cod end, and this section of the net was then pulled into the boat. The rope tying the cod end and liner shut was then loosened and the fish dumped into a bucket.

Trawling was done the week immediately following gill netting with five hauls taken at each site sampled. Stations sampled with the trawl were I and

III in July, August, September, October and November. Station II was also sampled in July, but because of the difficulty of sampling at that depth, and the lack of fish taken, sampling at this site was discontinued. Station IV was sampled once in 1968, but not sampled again because of the time involved in traveling to the site and a number of submerged logs and fences in the area.

Stomach Analysis

Fish taken from each gill net or the trawl were placed in plastic buckets and labeled. The fish stomachs were removed as soon as a pair of gill nets were tended or a series of trawl hauls was completed from one sampling station. The stomachs were removed by laying the fish on its right side, and making an incision into the abdominal cavity from the urogenital opening forward and dorsally in a curve, ending in the region of the isthmus. This flap of skin and flesh was then opened downward exposing the body cavity. The stomach of carp, river carpsucker, bigmouth buffalo and smallmouth buffalo was considered to be that portion of the gut from the esophagus to the first major turn of the intestine (Walberg and Nelson, 1966). The stomachs of the other fishes studied were considered to be that portion lying between the esophagus and the pyloric valve. After the stomach was removed from the fish, it was placed in a 20 percent formalin solution in a small bottle. A numbered fishhook was then placed into the flesh of the fish, and this number recorded on a piece of tape on the cap of the bottle. After the stomachs had been removed from the catch, the fish were brought back to the laboratory so other data could be collected. The total length of the fish in millimeters, the weight of the fish (less stomach), in grams, the date caught, the net in which it was caught, and time of day were all recorded for each fish. The number on the fishhook representing the fish's stomach was also recorded with all other

data for that fish.

To determine the food eaten by a fish, the stomach was cut open and the contents flushed into a petri dish. A rough estimate of fullness of stomach was made by visual examination of the contents. Examination of this material was made using a binocular dissecting scope at 10x magnification to identify macroscopic organisms. To identify microscopic material, the scope was adjusted to 45x magnification. After the identification of all food items was complete to order or family, an estimation of the quantity and volume of each food item was made. The frequency of a food item found in a stomach was recorded as few, some, or many. The volume of each food item was recorded as an estimate of the percentage of the total volume of the material in the stomach.

The contents were evaluated on the basis of estimated percentage by volume of food items and percentage frequency of occurrence which is the percentage of fish which contain a food item regardless of the quantity.

Statistical Analysis

Several analyses of variance (ANOV) were performed using a program written by the Statistics Department of Kansas State University (Harvey, 1960). The ANOV were performed to determine the effects of several factors on the kind and volume of food groups ingested by a group of fish (Harvey, 1960). These factors were: species of fish being studied, the area of the reservoir where the fish were taken, the month taken and the size of the fish.

The following transformations were made on the raw data for ANOV. Size classes, small and medium, for each species of fish (Table 3) were grouped as one size for ANOV. This was done because of lack of numbers and the similarity of food habits of these sizes for each species. Grouping was also

done on the factor, stations. Stations I and III, the cove stations, were considered as one type of station and Stations II, IV, V, and VI as another type of station.

During the months of May and November, sampling was done at Stations I, II, and III only. Because of this factor and the corresponding lack of sufficient numbers of fish, these two months' data were dropped from the ANOV. Two species of fish, the white bass and the walleye, were also dropped from the ANOV because of lack of sufficient numbers.

RESULTS AND DISCUSSION

Distribution

Gill Net Catch

Sixteen species of fishes were collected in the gill nets during the study, and these are listed in Table 4. The gill net catch numbers (Figures 2 through 12) are most useful in indicating when and where there is the greatest fish activity. The best comparison of these data are between station catches within one month. These catches were quite variable so only general trends are discussed.

Table 2. Water temperatures in Tuttle Creek Reservoir during the sampling periods.

<u>Sampling Period</u>	<u>Water Temperature</u>
May 12-14, 1969	18°C
June 9-13, 1969	20°C
July 7-11, 1969	21°C
August 4-8, 1969	26°C
September 2-6, 1969	24°C
October 6-10, 1969	20°C
November 11-13, 1969	10°C

Longnose gar were caught (Figure 2) at all stations except Station II. The majority of all gar caught were large (total length 800 mm. and larger) with few medium fish (400 to 800 mm), and only one small (less than 400 mm.) individual taken. The majority of gar caught were taken from Stations I and III, the two cove stations. The largest total number of individuals was taken in the month of August.

Gizzard shad were taken (Figure 3) at all stations sampled. The largest

number of fish was taken during July and August. The majority of fish taken at all stations were large (total length 300 mm. and larger). Very few small individuals were collected, even though many were seen later in the summer. Station III produced the most fish, with Station I producing the second highest total.

The majority of carp caught were taken at Stations I and III, although these fish were caught at all stations (Figure 4). Most carp caught were medium size (total length 200 to 400 mm.). The peak catch in the coves (Station I and III) was made in June, while the peak catch in the open water tended to vary more between stations, with peak catch at Station II in May and Station IV in September, while the other two did not have definite peaks. During this study, carp have been noticed swimming along near the surface of the water with their backs and dorsal fins out of the water. Some behavior of this type has been noticed in each of the sampling months except November. In the late summer of both sampling years, 1968 and 1969, large numbers of carp were noticed on the surface, particularly in McIntire Cove. Maximum numbers seen would approximate one per five square meters. This concentration of fish was apparent throughout the cove which is about 0.5 km. by 3 km. Personal communication with Cole (1970) and Klaassen (1970) indicate the reason for this behavior is not known.

The river carpsucker was taken at all stations except the deepest station Station II, (Figure 5). The majority of the fish were caught in the cove stations, Stations I and III. Of the fish caught at Stations IV, V, and VI, most were of large size (400 mm. and larger), while medium size fish, (200 to 400 mm. long) and large size fish were taken in about equal numbers at I and III. Only two small size class fish (to 200 mm.) were taken, these

TABLE 3. Size categories used to group the Tuttle Creek Reservoir fishes. Sizes are given as total lengths in millimeters.

Species	Small	Medium	Large
Longnose gar	0-400	401-800	801--
Gizzard shad	0-150	151-300	301--
Carp	0-200	201-400	401--
River carpsucker	0-200	201-400	401--
Smallmouth buffalo	0-200	201-400	401--
Bigmouth buffalo	0-200	201-400	401--
Black buffalo	0-200	201-400	401--
Northern redhorse	0-200	201-400	401--
Channel catfish	0-200	201-400	401--
Flathead catfish	0-200	201-400	401--
White bass	0-150	151-300	301--
White crappie	0-150	151-250	251--
Black crappie	0-150	151-250	251--
Walleye	0-250	251-500	501--
Freshwater drum	0-200	201-350	351--

Table 4. List of species and total numbers caught by gill net and bottom trawl, May through November, 1969, in the open water areas of Tuttle Creek Reservoir.

Fish species	Gill net catch	Bottom trawl catch
Longnose gar <u>Lepisosteus osseus</u> (Linnaeus)	122	0
Gizzard shad <u>Dorosoma cepedianum</u> (LeSueur)	141	9,335
Northern pike <u>Esox Lucius</u> Linnaeus	1	0
Carp <u>Cyprinus carpio</u> Linnaeus	293	403
River carpsucker <u>Carpiodes carpio</u> (Rafinesque)	274	18
Smallmouth buffalo <u>Ictiobus bubalus</u> (Rafinesque)	178	26
Bigmouth buffalo <u>Ictiobus cyprinellus</u> (Valenciennes)	11	0
Black buffalo <u>Ictiobus niger</u> (Rafinesque)	2	0
Northern redhorse <u>Moxostoma macrolepidotum</u> (LeSueur)	1	0
Channel catfish <u>Ictalurus punctatus</u> (Rafinesque)	319	22
Flathead catfish <u>Pylodictis olivaris</u> (Rafinesque)	3	0
White bass <u>Roccus chrysops</u> (Rafinesque)	62	44
Sunfish <u>Lepomis sp.</u>	0	1
White crappie <u>Pomoxis annularis</u> Rafinesque	387	247

TABLE 4. Continued

Fish species	Gill net catch	Bottom trawl catch
Black crappie		
<u>Pomoxis nigromaculatus</u> (LeSueur)	1	0
Walleye		
<u>Stizostedion vitreum vitreum</u> (Mitchill)	110	15
Freshwater drum		
<u>Aplodinotus grunniens</u> Rafinesque	582	190
Total	2,487	10,301

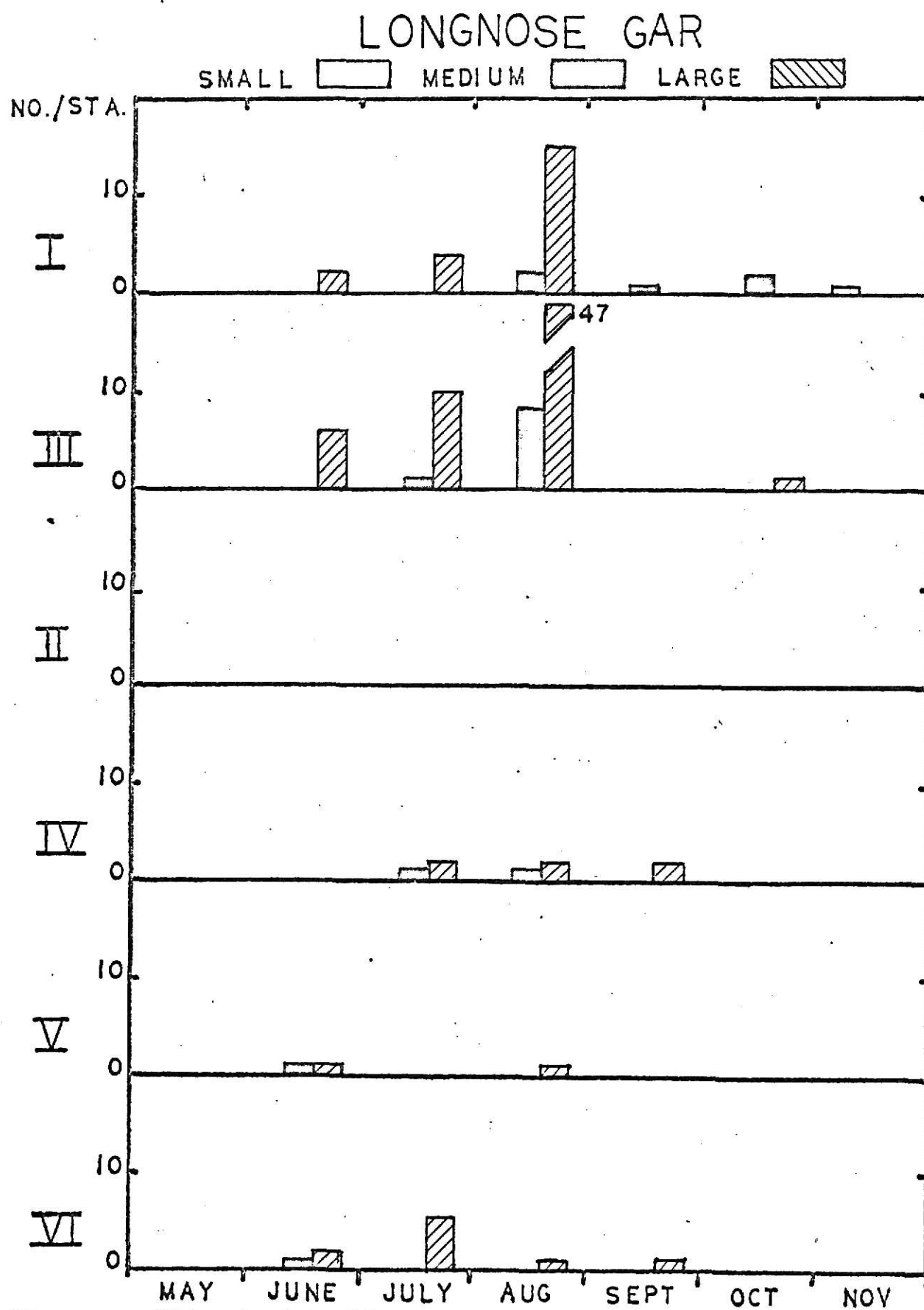


Figure 2. Gill net catch of longnose gar by station, month and size.

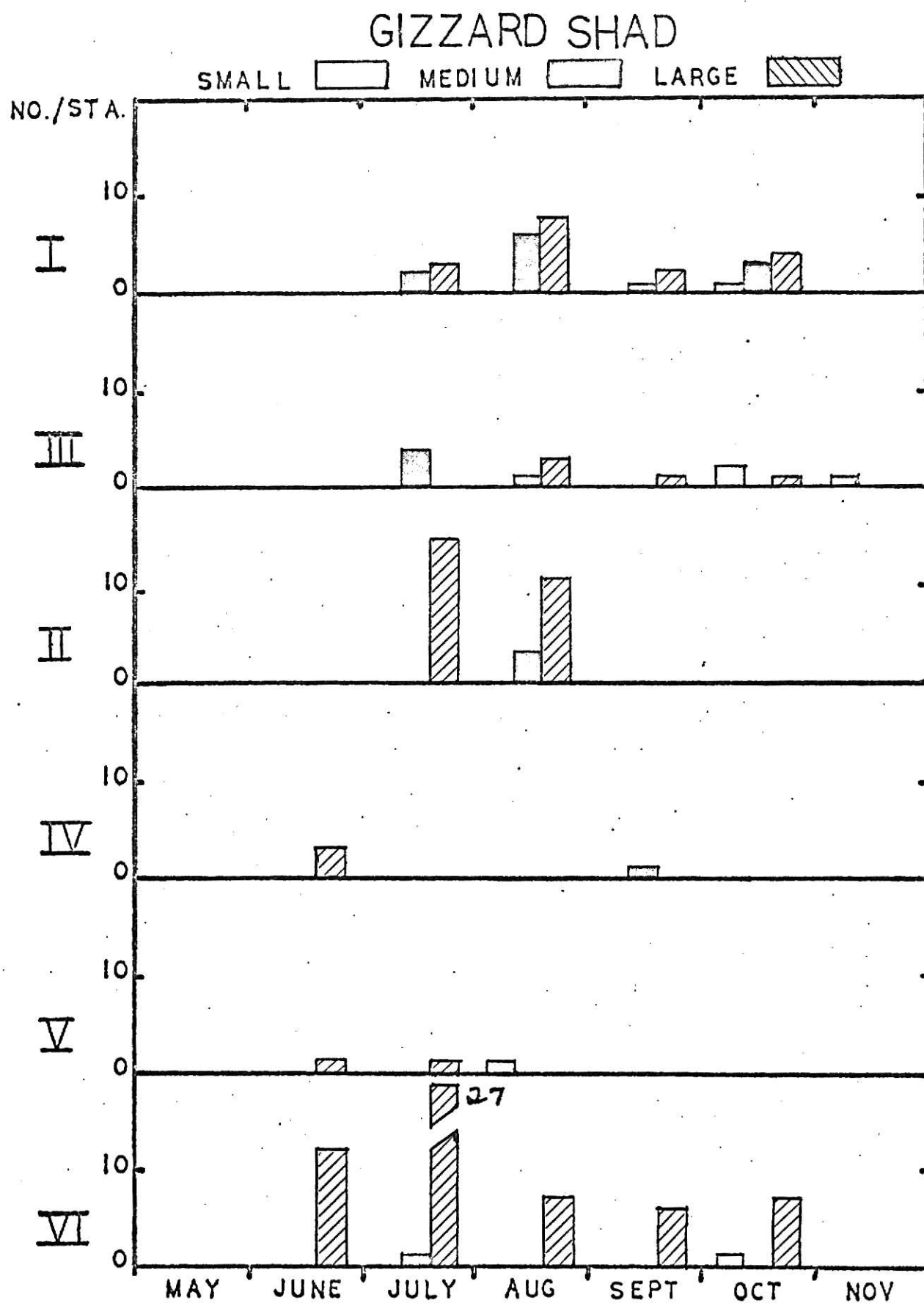


Figure 3. Gill net catch of gizzard shad by station, month and size.

at Station I. Small fish were seldom observed or collected with other sampling gear. When the catches from all stations were added together, the August catch was the largest.

The smallmouth buffalo was caught at all stations with total numbers at each station being nearly equal (Figure 6). All stations except Station III produced more large size fish (400 mm. and larger), than medium size (200 to 400 mm.) or small size class fish. Station III produced more medium than large fish. The number of fish caught at Stations I, II, and III reached a peak in June, while Stations IV, V, and VI produced more of these fish in July than any other month. As with river carpsucker, the collection of small, smallmouth buffalo was very rare regardless of sampling technique used.

Bigmouth buffalo were taken at each station except Station III (Figure 7). The catch is represented by one large (400 mm. and larger) fish at each station except Station VI, where seven large individuals were taken. Not enough were collected to discern any pattern.

Channel catfish were caught at all stations with the peak of the catch in July (Figure 8). Stations IV, I, and III produced the largest numbers of fish in that order most to least. More large (400 mm. and larger) fish were caught at IV than any station and more medium fish (200 to 400 mm.) were caught at Station III. Some small channel catfish (less than 200 mm.) were caught, with the greatest numbers of these being taken at Stations I and III. The catch at all stations remained fairly constant throughout the sampling period except Station IV which showed a peak catch in July and a gradual decrease in numbers until the end of the sampling period.

White bass were caught at only four stations (Figure 9). Most of the fish caught were medium size (150 to 300 mm.), with a few large (300 mm. and

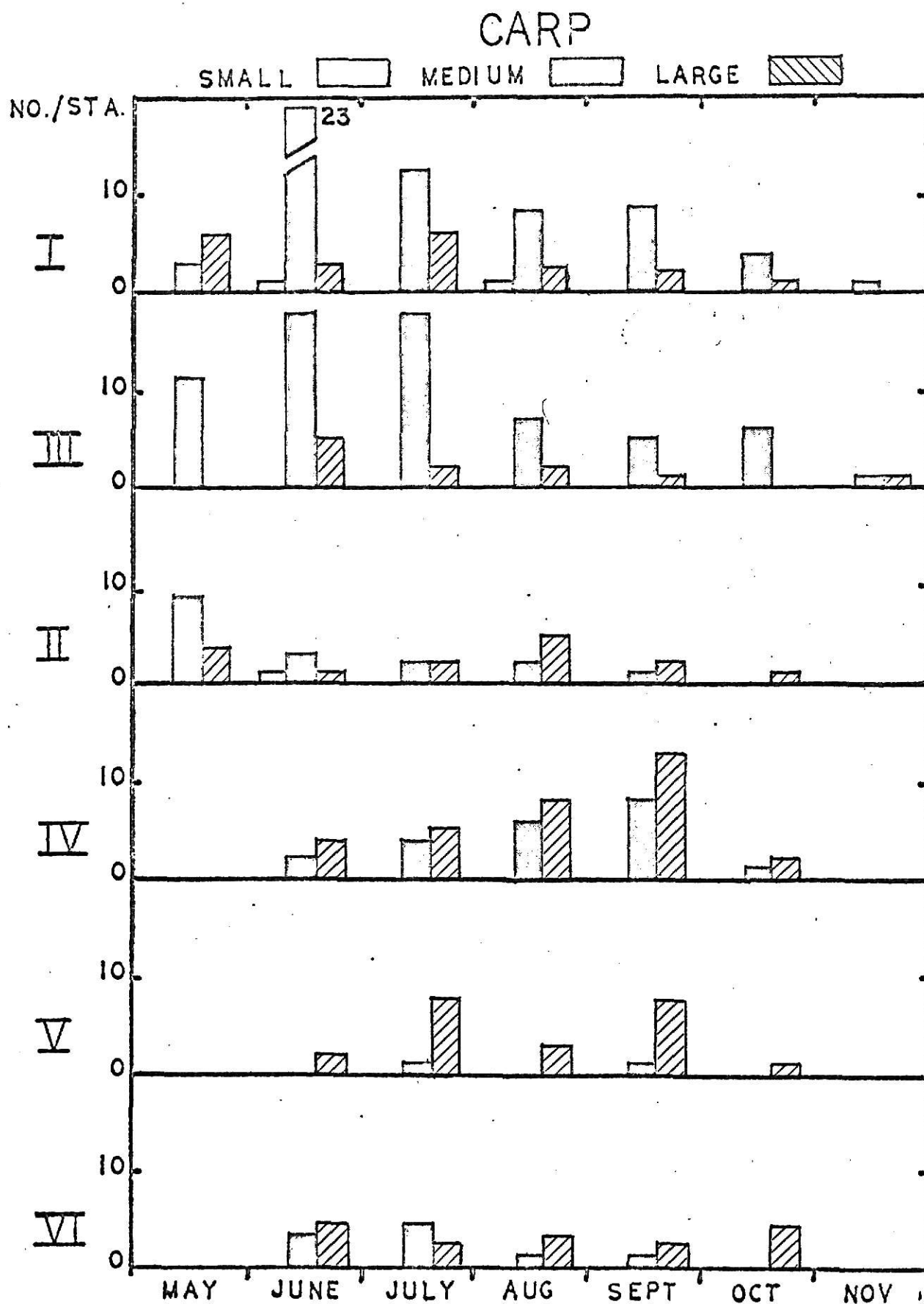


Figure 4. Gill net catch of carp by station, month and size.

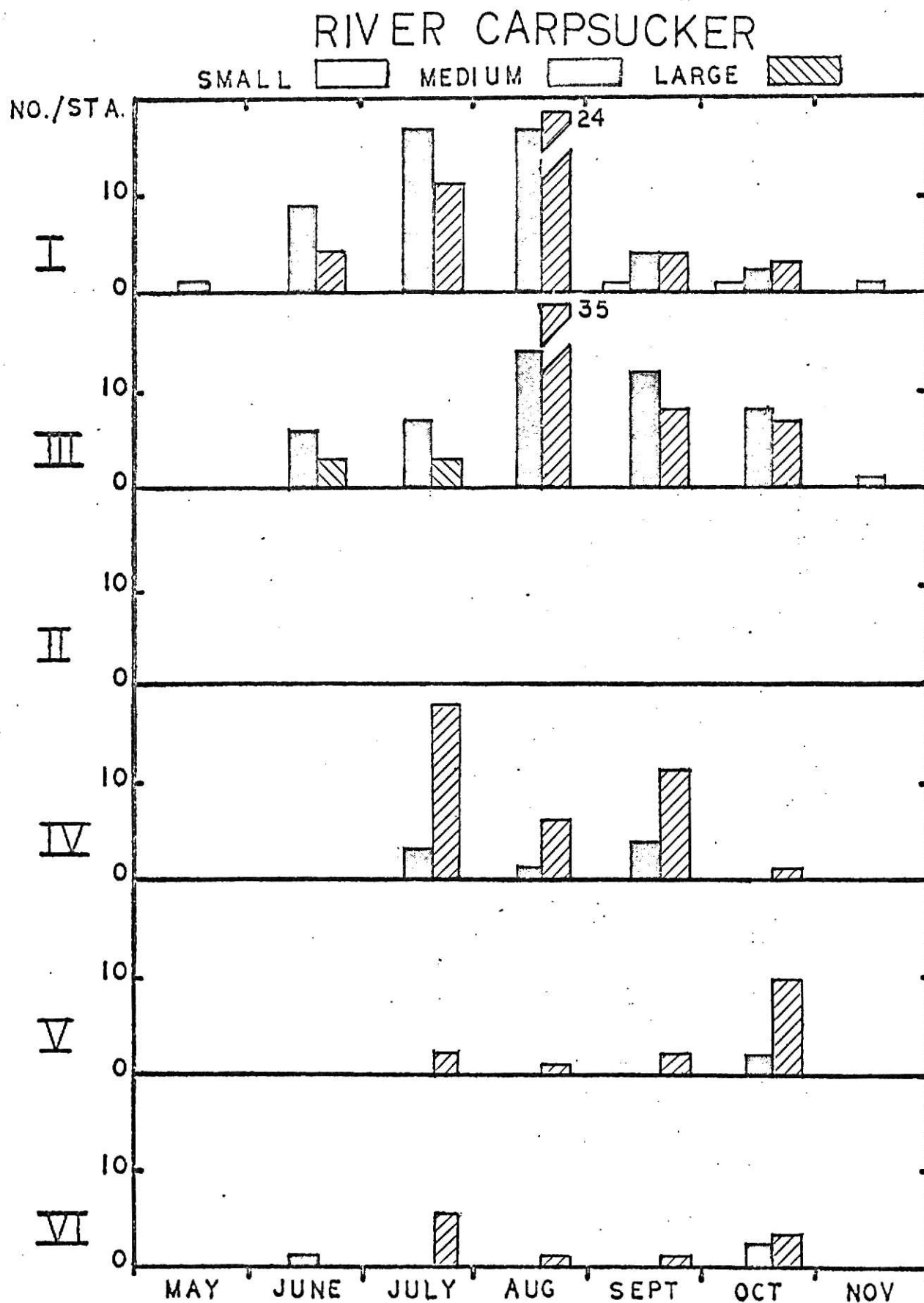


Figure 5. Gill net catch of river carpsucker by station, month and size.

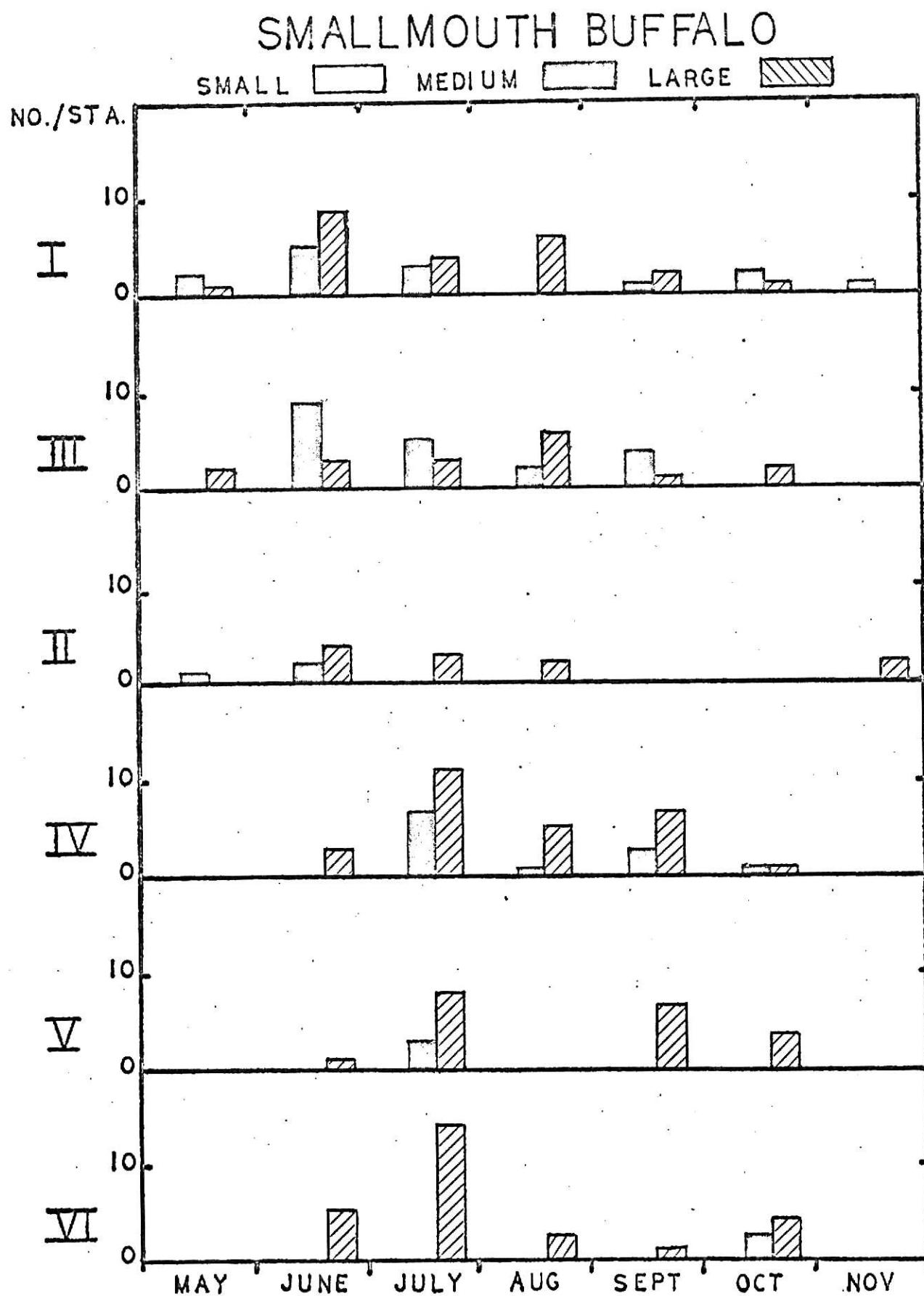


Figure 6. Gill net catch of smallmouth buffalo by station, month and size.

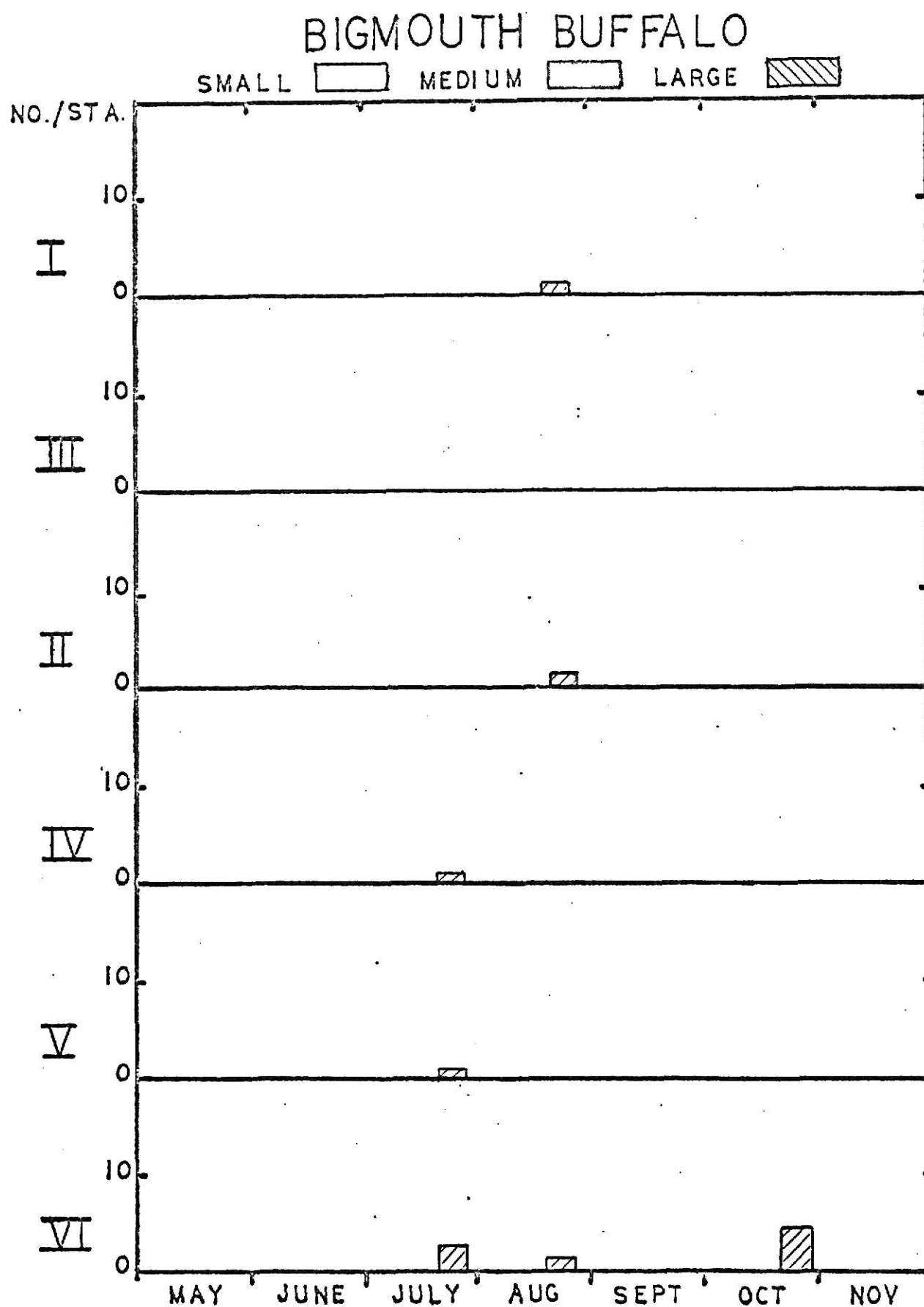


Figure 7. Gill net catch of bigmouth buffalo by station, month and size.

larger) and a few small (less than 150 mm.), being taken. Small numbers were taken in September at Stations V and in October at Station VI. Most white bass were taken from Stations I and III with a peak in October and November.

White crappie were taken at all stations during the sampling season and during all months at most stations. (Figure 10). Most of the crappie caught were of medium size (150 to 250 mm.). Stations I and III produced the largest total number of fish and these totals were nearly the same, with Station I producing more large fish and fewer medium size fish than Station III. The catch at Stations IV, V and VI, remained low and fairly steady throughout the sampling period. The deepest station, II, was the only one that didn't yield white crappie at each sampling time. The overall catch was at a peak when sampling started in May, rose to another peak in August and September and gradually declined until the end of the sampling season.

The abundance and sampling distribution of walleye was very similar to that sampled for white bass. Most of the walleye were caught at Stations I and III with a few individuals taken at Stations IV and VI (Figure 11). No walleye were taken at Stations II and V. The largest number of fish taken at Stations I and III were of medium size (250 to 500 mm.). The lowest catch was in summer and increased in fall with the highest catch in October and November. Small walleye were well represented in the catch from Stations I and III, but were not taken at the other stations. Few large walleye were taken at Stations I, III and VI.

The freshwater drum were taken at all stations, with the largest numbers taken at Stations I and III, and lowest numbers again at Station II (Figure 12).

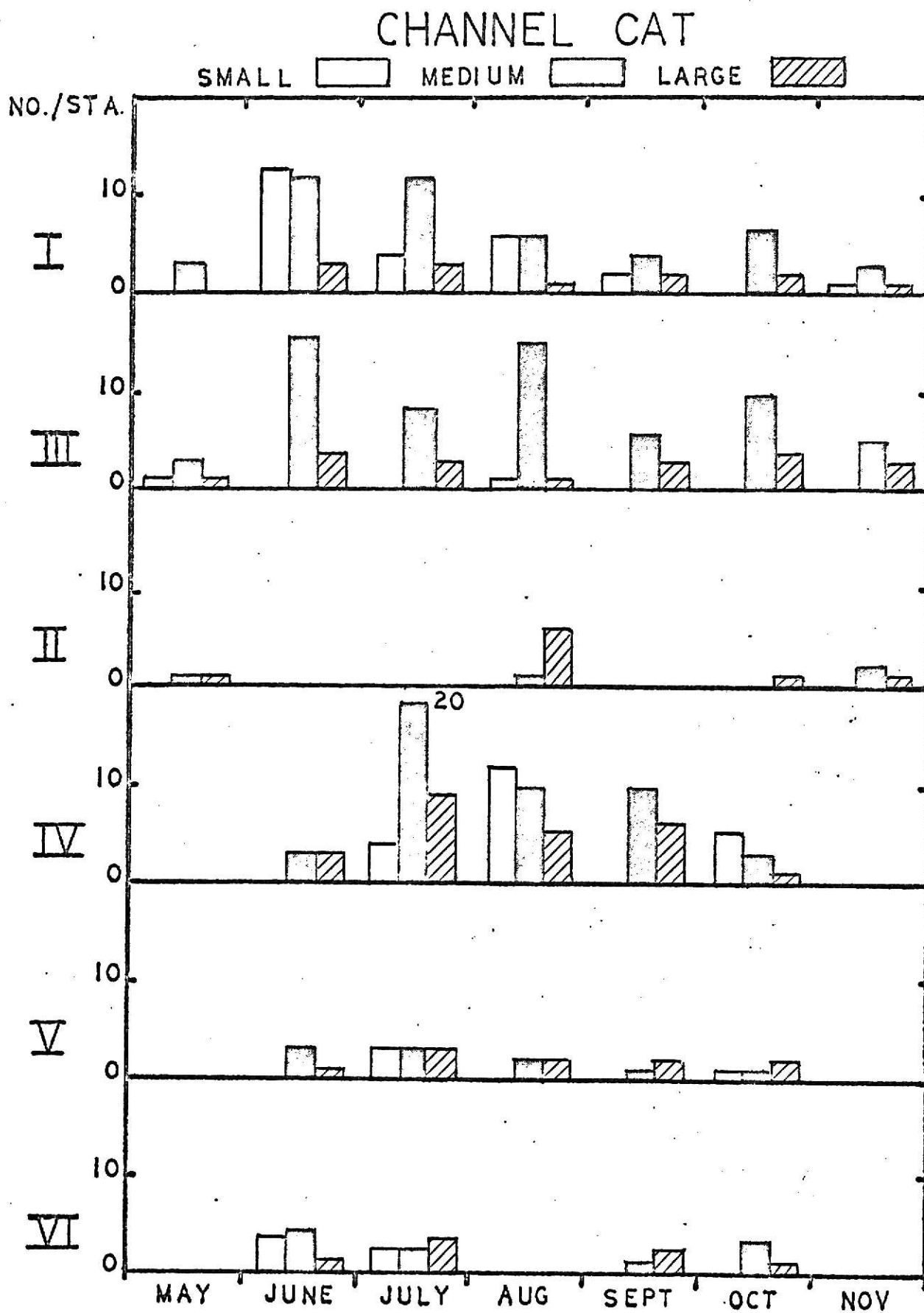


Figure 8. Gill net catch of channel catfish by station, month and size.

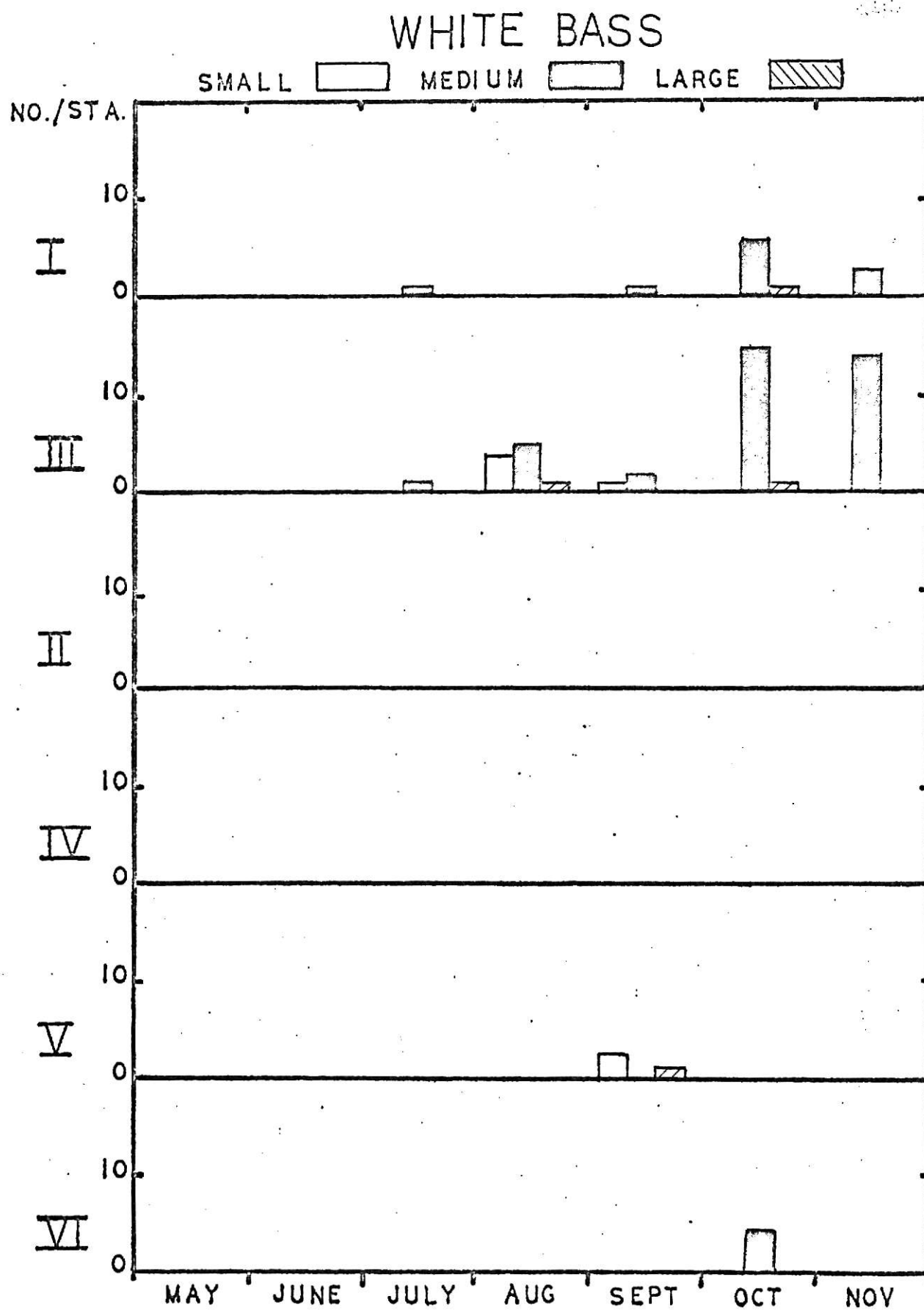


Figure 9. Gill net catch of white bass by station, month and size.

The number of fish taken each month remained fairly constant throughout the sampling season except at Station III. The largest numbers of fish were caught at Stations I and III during July and August, while largest numbers taken at Stations IV were in August and the largest numbers from VI were taken in June. The catch of freshwater drum was unusual in that this was the only species of fish sampled which showed a greater number of small fish (0 to 200 mm.) taken than either medium (200 to 350 mm.) or large fish.

Other species of fish taken included a large northern pike at Station III in October. Two large black buffalo were caught, one at Station I in July and one at Station VI in August. A northern redhorse was caught at Station IV in September. Three flathead catfish, all large, were taken, one at Station II in July, one at Station IV in July and one at Station V in October. A medium black crappie was caught at Station III in July.

Trawl Catch

The bottom trawl caught the same species of fishes as the gill nets (Table 4), with the exception of the longnose gar, northern pike, bigmouth and black buffalo, northern redhorse, flathead catfish and black crappie. A sunfish was also taken with the trawl.

Young-of-the-year gizzard shad, river carpsucker, channel catfish, white bass, sunfish, white crappie, walleye, and freshwater drum were all taken with the trawl. Gizzard shad, the most abundant fish, made up at least 94 percent of the catch (Tables 5 and 7). Young gizzard shad were taken in large numbers from July through September but the number caught decreased rapidly thereafter. Carp was the most abundant species by weight at both stations through the sampling period, 66 percent at Station III and 74 percent at Station I (Tables 6 and 8). White crappie were the next most numerous

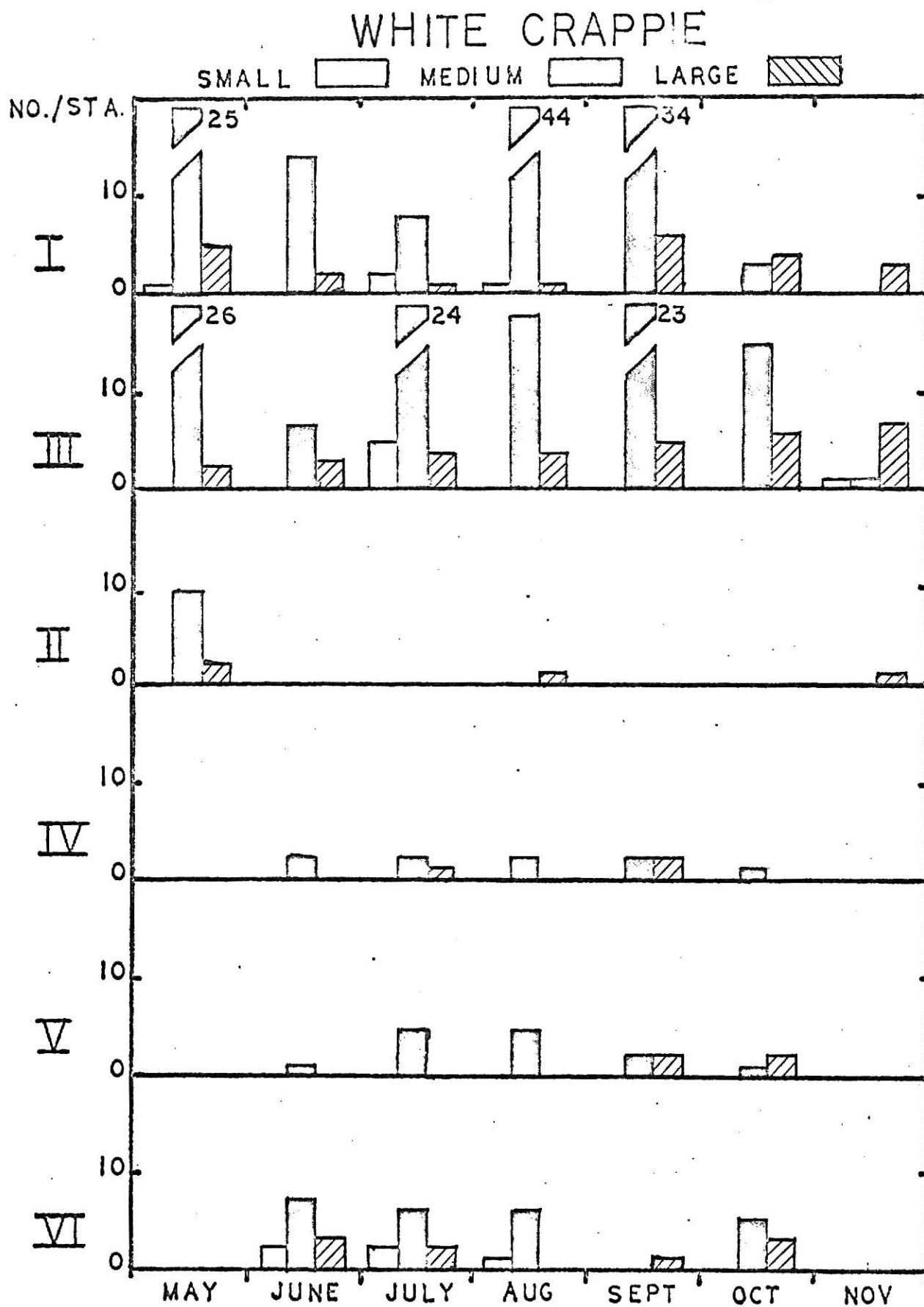


Figure 10. Gill net catch of white crappie by station, month and size.

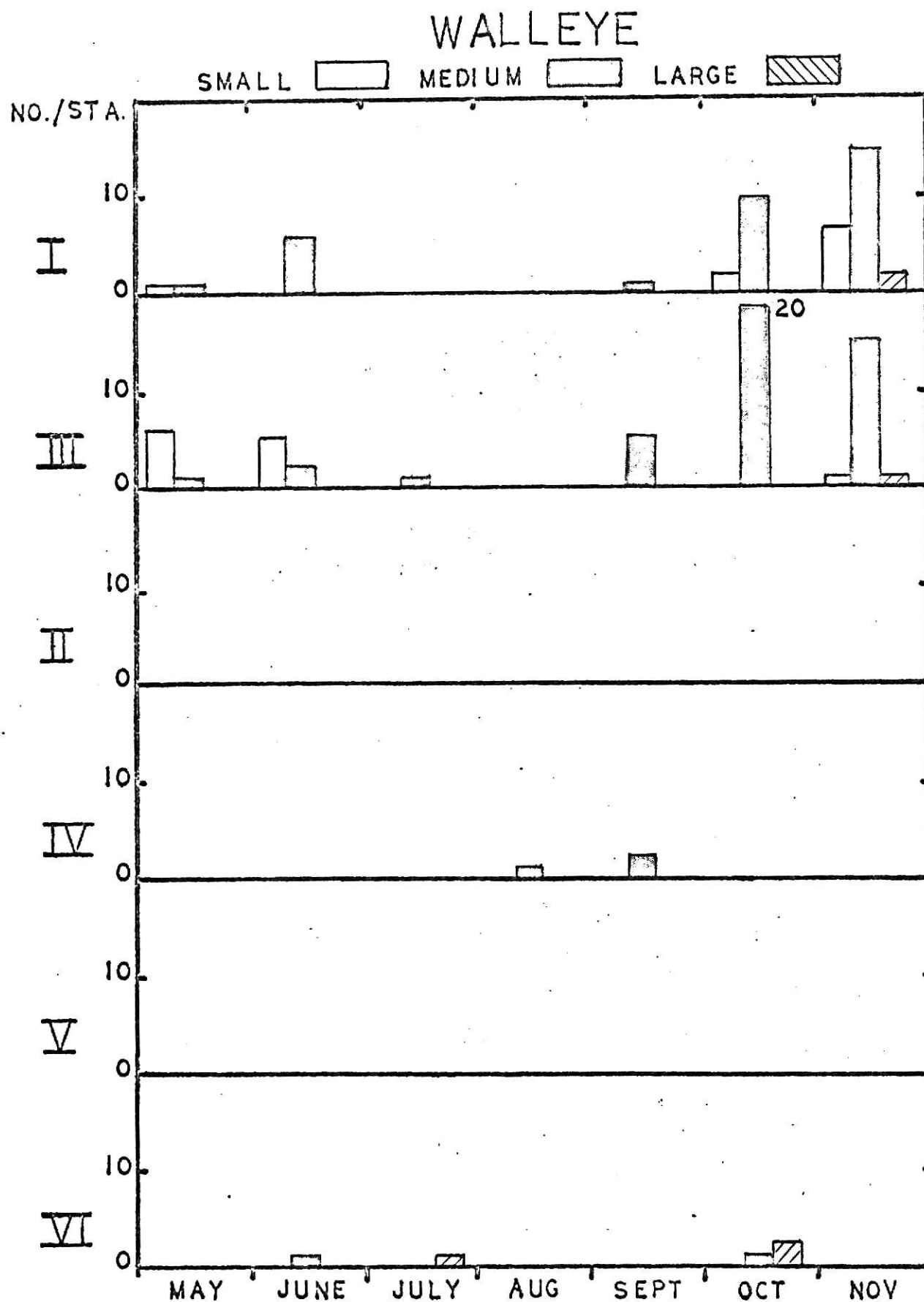


Figure 11. Gill net catch of walleye by station, month and size.

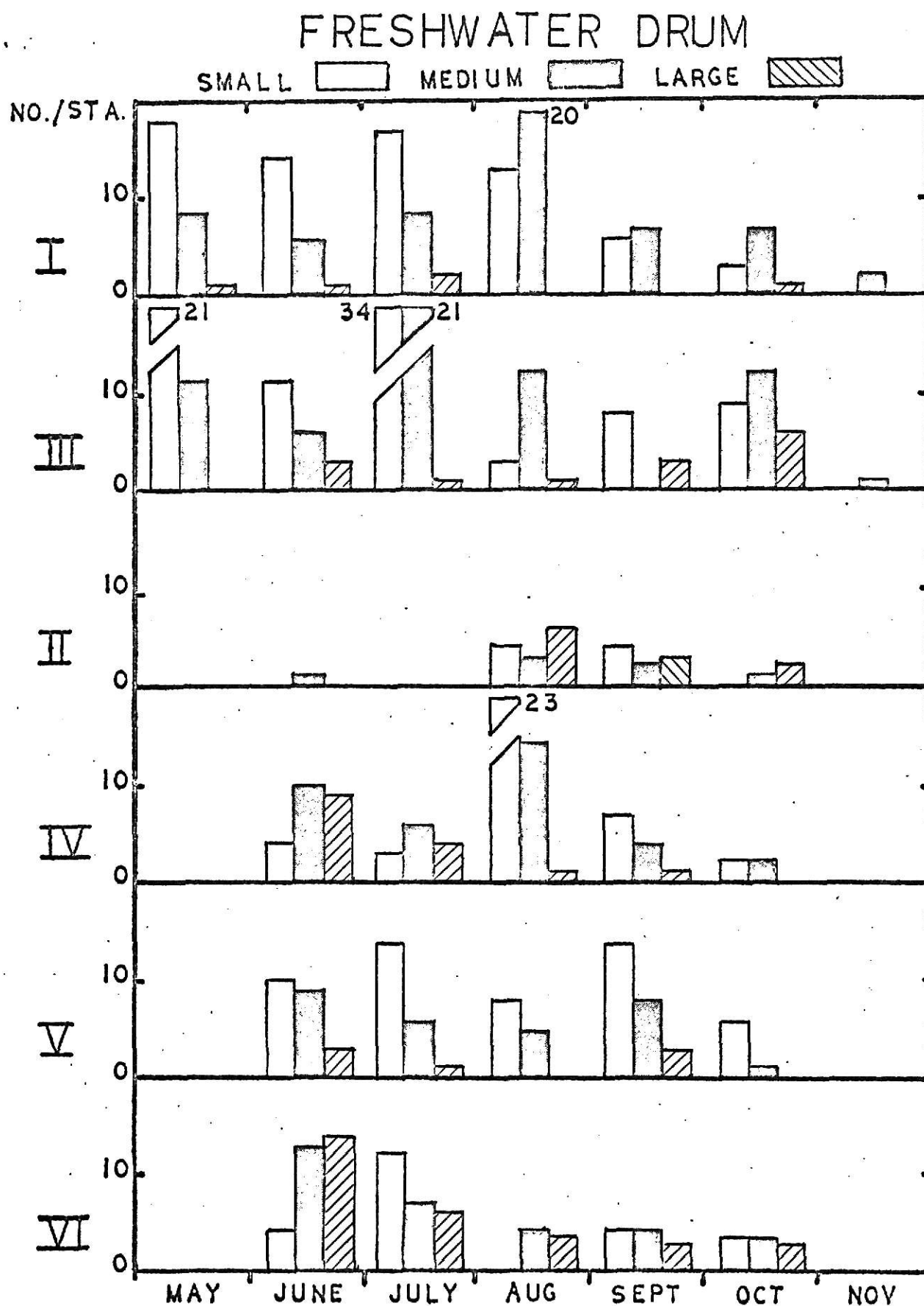


Figure 12. Gill net catch of freshwater drum by station, month and size.

fish by number taken at both stations after gizzard shad and carp, but were of minor importance by weight. The smallmouth buffalo were of little importance at either station numerically, but were 14 percent of the total weight at Station I.

The major difference in the trawl catches from the two coves was in number of gizzard shad and white bass. Station III produced more of both species of fish. This is to be expected as the white bass is a nomadic predator (McNaught and Hasler, 1961) and as such, would be likely to be found where the forage (small gizzard shad) is abundant. The differences in numbers of other fishes caught from the two coves is not large enough to be of interest, except possibly the difference for freshwater drum. More freshwater drum were taken from Station I than Station III, the only species of fish which showed this relationship.

Summary of Distribution

This study sampled the fishes at six stations in Tuttle Creek Reservoir. The greatest number of fish were taken in the two cove sampling stations but these fish tended to be smaller than those caught in the open areas of the reservoir. The eleven most abundant fishes in order of abundance in the gill net catch were: freshwater drum, white crappie, channel catfish, carp, river carpsucker, smallmouth buffalo, gizzard shad, longnose gar, walleye, white bass and bigmouth buffalo. Five other species of fish caught were represented by only a few individuals.

The freshwater drum was the most abundant fish taken by gill nets at four stations: III, IV, and VI and the second most abundant at Station I. Small drum were the most abundant size group of species of fish taken at Station I and the second most abundant at Station III. The channel catfish was

tied with the freshwater drum for the most abundant fish taken at Station IV and tied with the carp for second most abundant fish at Station V. The carp was the most abundant fish taken at Station II, tied for the second most abundant fish at Station V and the third most abundant fish at Station IV. The white crappie and channel catfish taken at most stations were the medium size class fish. The majority of carp caught at Station I, II and III were medium size and of those caught at Station IV, V and VI, the majority were large size fish. Longnose gar were found in abundance only where the small gizzard shad were abundant, at Stations I and III.

Food Habits

The results and discussions in the sections following are concerned with only those fish which had food in their stomachs (Table 9).

Table 9. Species examined for food habits and number of stomachs used in analysis.

Species	Empty Stomachs Percent	Stomachs with Food Number
Carp	33%	250
River Carpsucker	17%	209
Smallmouth Buffalo	22%	138
Channel Catfish	25%	200
White Bass	40%	9
Walleye	24%	32
White Crappie	18%	159
Freshwater Drum	33%	174

The number of empty stomachs was possibly a function of the length of time the fishes spent in the gill net. Assuming a fish does not feed while in the net, digestion would have taken place in the stomach for up to 12 hours. Regurgitation also may have occurred during the fish's struggles to escape.

TABLE 5. Total number and percentage of total number of each species caught in five, 3 minute trawl hauls per month from station I.

	JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		TOTAL	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Gizzard shad	34	16	130	45	269	86	16	52	1	4	450	51
Carp	65	30	41	14	26	8	9	29	17	63	158	18
River carpsucker	4	2	2	1	1	*			2	7	9	1
Smallmouth buffalo	5	2	8	3	1	*					15	2
Channel catfish	4	2	5	2							9	1
White bass	1	*									1	*
White crappie	37	17	75	26	3	1	2	6	4	15	121	14
Walleye	1	*			1	*	3	10			5	1
Freshwater drum	64	30	27	9	16	5	1	3	3	11	111	13
Total	215	99	288	100	318	100	31	100	27	100	879	100

* Indicates less than 1%

TABLE 6. Total Weight and percentage of total weight of each species caught in five, 3 minute trawl hauls per month from station I. Weight is given in grams.

	JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		TOTAL	
	Wt.	%	Wt.	%	Wt.	%	Wt.	%	Wt.	%	Wt.	%
Gizzard shad	99	*	565	2	1,492	11	73	2	13		2,242	3
Carp	26,013	78	15,222	63	10,322	77	3,534	74	8,916	98	64,007	74
River carpsucker	1,768	5	1,329	5	368	3			53	1	3,518	4
Smallmouth buffalo	3,458	10	6,444	27	368	3					11,786	14
Channel catfish	1,007	3	136	*							1,143	1
White bass	1	*									1	*
White crappie	134	*	265	1	424	3	20	*	34	*	877	1
Walleye	12	*			203	2	392	8			607	1
Freshwater drum	766	2	235	1	203	2	769	16	59	1	2,032	2
Total	33,258	98	24,196	99	13,380	101	4,788	100	9,075	100	86,213	100

* Indicates less than 1%

TABLE 7. Total number and percentage of total number of each species caught in five, 4 minute trawl hauls per month from station III.

	JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		TOTAL	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Gizzard shad	2,578	94	2,208	90	3,512	98	584	96	3	8	8,885	94
Carp	74	3	104	4	35	1	3	*	29	78	245	3
River carpsucker	4	*	3	*	1	*			1	3	9	*
Smallmouth buffalo	3	*	7	*					1	3	11	*
Channel catfish	5	*	6	*			1	*	1	3	13	*
White bass	23	1	16	1	3	*	1	*			43	*
Sunfish (<i>Lepomis</i> spp.)			1	*							1	*
White crappie	22	1	73	3	10	*	21	3			126	1
Walleye	5	*			5	*					10	*
Freshwater drum	39	1	35	2	2	*	1	—	2	5	79	1
Total	2,753	100	2,453	100	3,568	99	611	99	37	100	9,422	100

* Indicates less than 1%

TABLE 8. Total weight and percentage of total weight of each species caught in five, 4 minute trawl hauls per month from station III. Weight is given in grams.

	JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		TOTAL	
	Wt.	%	Wt.	%	Wt.	%	Wt.	%	Wt.	%	Wt.	%
Gizzard shad	5,028	13	7,337	16	13,742	49	2,042	52	62	*	28,211	21
Carp	25,040	64	36,491	78	12,470	45	1,004	26	12,532	87	87,537	66
River carpsucker	2,611	7	1,230	3	365	1			10	*	4,216	3
Smallmouth buffalo	3,045	8	9	*					969	7	4,023	3
Channel catfish	913	2	609	1			386	10	750	5	2,658	2
White bass	55	*	180	*	108	*	298	8			641	*
Sunfish (<i>Lepomis</i> spp.)			1	*							1	*
White crappie	660	2	357	1	686	2	139	4			1,842	1
Walleye	163	*			494	2					657	*
Freshwater drum	<u>1,456</u>	<u>4</u>	<u>381</u>	<u>1</u>	<u>25</u>	<u>*</u>	<u>25</u>	<u>1</u>	<u>5</u>	<u>*</u>	<u>1,892</u>	<u>1</u>
Total	38,971	100	46,595	100	27,890	99	3,894	101	14,328	99	131,678	100

* Indicates less than 1%

Statistical Analysis of General Food Habits

Analysis of variance of volume of food groups taken was made of the following main effects: species of fish, sampling period (months), sampling stations, and size of fish. The data tested with the ANOV are adjusted percentage volume of food groups and the results of this testing are listed in Table 11. In all analyses 0.05 was selected at the confidence interval for significance. Food groups and food item in each group are listed in Table 10.

The differences between the volume of food ingested by different species explains a statistically significant difference in the volume of each food group tested. This means that at least some of the species fed at different levels on each food group (Tables 12 through 17). The different size classes are a source of variation in the degree of feeding on three food groups. The smaller and medium size fish (Table 3), fed more heavily on aquatic and terrestrial insects than did the larger fish. The larger fish depended more on fish as a major portion of their diet than did the small and medium fish. This also indicated that all size classes of fish fed at approximately the same rate on the microcrustacea, plant material, and other material.

Some of the variation in the rate of feeding on all food groups, except other material, can be explained by the changing months. This means that the degree of feeding on a food group changes seasonally, for all food groups except other material. Table 11 shows that the average volume of microcrustacea found in fish stomachs was highest in June, dropped to a low in August and raised to a lower peak again in October. Average volume of aquatic insects was highest in June, dropped to a low in August, raised slightly in September, and dropped very low in October. The volume of terrestrial insects taken

TABLE 10. List of organisms found in stomachs of fishes from Tuttle Creek Reservoir, during 1969 and the grouping used in the analysis.

<u>Organism</u>	<u>Food Group</u>
Copepod	Microcrustacea
Cladocera	
Ostracod	
Ephemeridae	Aquatic insects
Baetidae	
Trichoptera	
Chironomidae	
Chaobrus	
Odonata	
Aquatic insect remains	
Homoptera	Terrestrial insects
Terrestrial Hemiptera	
Terrestrial Coleoptera	
Orthoptera	
Hymenoptera	
Thysanoptera	
Terrestrial insect remains	
Fish (identified)	Fish
Fish remains	
Plant material	Plant material*
Crayfish	Other material
Arachnida	
Mollusca	
Annelida (Earthworms)	
Rotifers	
Nematoda	
Sand and silt	
Other organisms	

* Includes small sticks, parts of leaves, algae, diatoms, organic detritus and seeds.

TABLE 11. Least squares means and standard error for percentage volume of food groups found in stomachs. Data are given for six species, two size classes, five months and two stations.

	MICROCRUSTACEA			AQUATIC INSECTS			TERRESTRIAL INSECTS			FISH			PLANT MATERIAL			OTHER MATERIAL		
	Mean	SE		Mean	SE		Mean	SE		Mean	SE		Mean	SE		Mean	SE	
Carp	8.7	1.5		8.3	3.0		4.6	1.7		75.0	2.4		1.8	1.1				
River carpsucker	26.7	1.5		4.8	3.0		1.7	1.8		54.4	2.5		12.6	1.1				
Smallmouth buffalo	37.0	1.7		6.2	3.3		3.1	2.0		49.6	2.7		4.5	1.2				
Channel catfish	0.6	1.3		27.0	2.6		31.2	1.5		35.2	3.7		1.3	2.2		4.4	0.9	
White crappie	0.8	1.7		16.0	3.5		4.4	2.1		77.5	4.8		-0.1	1.2				
Freshwater drum	1.1	1.4		39.4	2.7		-0.1	1.6		55.0	3.9		2.4	1.0				
Sizes small and medium	13.4	0.9		20.5	1.7		9.5	1.0		43.7	2.6		45.2	1.9		3.8	0.6	
Size large	11.6	0.8		13.4	1.7		5.4	1.0		68.1	3.8		45.0	1.6		4.7	0.6	

TABLE 11. Continued.

	MICROCRUSTACEA		AQUATIC INSECTS		TERRESTRIAL INSECTS		FISH		PLANT MATERIAL		OTHER MATERIAL	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
June	26.6	1.6	30.0	3.2	14.5	1.9	15.8	6.7	22.1	2.9	2.7	1.2
July	9.9	1.0	18.0	2.0	4.7	1.2	58.0	4.1	49.1	1.8	4.6	0.7
August	7.1	1.0	13.4	2.9	3.1	1.2	74.8	4.9	50.2	2.0	6.0	0.7
September	7.3	1.1	18.7	2.1	4.2	1.3	58.4	4.3	53.3	2.2	4.6	0.8
October	11.4	1.5	4.6	3.0	10.9	1.8	72.6	5.7	50.7	3.2	3.5	1.1
Stations I and III	12.1	0.8	18.5	1.5	4.9	0.9	55.9	3.2	46.7	1.5	4.8	0.6
Stations II, IV, V, and VI	12.9	0.9	15.4	1.9	10.1	1.1	55.9	3.3	43.5	1.9	3.8	0.7

showed much the same changes as microcrustacea, high in June, low in August, and up again in October. The volume of fish found in stomachs shows an opposite rate of change. The volume taken was low in June, highest in August, dropped in September, and raised again in October. Volume of plant material taken by fish was very much the same throughout the sampling period except for a low in June. Statistical analysis indicates no seasonal change in the degree of feeding on other material.

Variation in the volume of terrestrial insects found in fish stomachs was the only variation attributed to a difference in stations. Fish taken from Stations II, IV, V and VI, fed at a significantly higher level on terrestrial insects, than did the fish taken from the coves, Stations I and III.

The species by size interaction was a source of significant variation in the utilization of all food groups except plant material. This means that grouping all fish into their appropriate species by size classes, the utilization of all food groups except plant material would be different for some of these subclasses.

The species by month interaction was a source of significant variation in the utilization of all food groups by fishes.

The species by station interaction was a source of variation for the utilization of microcrustacea and terrestrial insects.

The month by station interaction was significant in the utilization of aquatic insects, terrestrial insects and plant material.

The data on stomachs of fish taken in May and November were not included in the analysis of variance because only three stations were sampled during these months and the resulting numbers of fish were not sufficient to do a

statistical analysis.

White bass and walleye were taken during only a few months and in small numbers so these fishes were not included in the analysis of variance.

The data given in Table 19 for May and November and the data given in Tables 18 are not comparable. The data for May and November are simple arithmetic averages of the volume of food groups ingested while the data for June, July, August, September, and October are mean volumes adjusted for unequal numbers of fish in each subclass. These two sets of data are comparable by relative proportion only.

Food Habits by Species

Carp

The carp in Tuttle Creek Reservoir changed their feeding habits some throughout the sampling period. The volume of plant material ingested was 41 percent in June, raised to 80 percent in July, and remained near this level the rest of the sampling period (Table 18). The volume of microcrustacea taken by carp was at a high in June, 24 percent, dropped to 10 percent in July, to 3 percent in August, and continued near this level in September and October. The volume of aquatic insects found in carp stomachs dropped from a high in June of 12 percent to 4 percent in October. Terrestrial insects occupied a volume of 17 percent in carp stomachs in June, dropped to about 2 percent in July and remained near this level the remainder of the sampling period.

The station the carp were taken from made no significant difference in the volume of any food item ingested.

Small and medium sized carp fed to a greater extent (12.5 percent) on microcrustacea than did the large carp (4.8 percent).

Grouping all carp from Tuttle Creek Reservoir together, food items in

TABLE 12. Least-squares analysis of variance for the microcrustacea food group.

Source	Mean Squares	df	F-Ratio
Fish species	17168	5	99.1**
Fish size	423	1	2.4
Month	5384	4	31.0**
Station	80	1	0.4
Species x size	387	5	2.3*
Species x month	1780	20	10.2**
Species x station	608	5	3.5**
Size x month	769	4	4.4**
Size x station	235	1	1.3
Month x station	159	4	0.9
Species x size x station	108	5	0.6
Size x month x station	99	4	0.6
Residual	173	1074	

* Indicates significance at the 0.05 level.

** Indicates significance at the 0.01 level.

TABLE 13. Least-squares analysis of variance for the aquatic insects food groups.

Source	Mean Squares	df	F-Ratio
Fish species	15779	5	22.6**
Fish size	6264	1	8.9**
Month	6655	4	9.5**
Station	1234	1	1.7
Species x size	4697	5	6.7**
Species x month	3199	20	4.5**
Species x station	391	5	0.5
Size x month	1598	4	2.2
Size x station	232	1	0.3
Month x station	2251	4	3.2*
Species x size x station	398	5	0.5
Size x month x station	1042	4	1.4
Residual	696	1074	

* Indicates significance at the 0.05 level.

** Indicates significance at the 0.01 level.

TABLE 14. Least-squares analysis of variance for the terrestrial insects food group.

Source	Mean Squares	df	F-Ratio
Fish species	13306	5	55.3**
Fish size	2110	1	8.7**
Month	2318	4	9.6**
Station	3330	1	13.8**
Species x size	1320	5	5.4**
Species x month	1168	20	4.8**
Species x station	1199	5	4.9**
Size x month	774	4	3.2*
Size x station	55	1	0.2
Month x station	1298	4	5.4**
Species x size x station	134	5	0.5
Size x month x station	216	4	0.9
Residual	240	1074	

* Indicates significance at the 0.05 level.

** Indicates significance at the 0.01 level.

TABLE 15. Least-squares analysis of variance for the plant material food group.

Source	Mean Squares	df	F-Ratio
Fish species	89111	3	192.4**
Fish size	5	1	0.0
Month	10276	4	22.1**
Station	809	1	1.7
Species x size	674	3	1.4
Species x month	2464	12	5.3**
Species x station	613	3	1.3
Size x month	300	4	0.6
Size x station	1	1	0.0
Month x station	2482	4	5.3**
Species x size x station	656	3	1.4
Size x month x station	306	4	0.6
Residual	463	714	

* Indicates significance at the 0.05 level.

** Indicates significance at the 0.01 level.

TABLE 16. Least-squares analysis of variance for the fish food group.

Source	Mean Squares	df	F-Ratio
Fish species	32085	2	25.2**
Fish size	38411	1	30.2**
Month	18218	4	14.3**
Station	0	1	0.0
Species x size	4716	2	3.7*
Species x month	5013	8	3.9**
Species x station	544	2	0.4
Size x month	572	4	0.4
Size x station	63	1	0.0
Month x station	1685	4	1.3
Species x size x station	699	2	0.5
Size x month x station	1420	4	1.1
Residual	1269	467	

* Indicates significance at the 0.05 level.

** Indicates significance at the 0.01 level.

TABLE 17. Least-squares analysis of variance for the other material food group.

Source	Mean Squares	df	F-Ratio
Fish species	1415	5	16.2**
Fish size	116	1	1.3
Month	185	4	2.0
Station	125	1	1.4
Species x size	261	5	2.9*
Species x month	544	20	6.1**
Species x station	258	5	2.9*
Size x month	129	4	1.4
Size x station	45	1	0.5
Month x station	106	4	1.2
Species x size x station	117	5	1.3
Size x month x station	59	4	0.6
Residual	88	1074	

* Indicates significance at the 0.05 level.

** Indicates significance at the 0.01 level.

TABLE 18. Least-squares mean volume of food groups ingested by fish species, given by month.

	Micro- crustacea	Aquatic Insects	Terrestrial Insects	Fish	Plant	Other
Carp						
June	24.5	11.8	17.5	T*	41.4	3.4
July	10.2	10.8	1.6		79.8	T
August	3.5	9.1	1.7	T	82.8	1.2
September	2.2	5.9	T		87.3	T
October	3.0	3.7	1.1	T	83.6	3.8
River carpsucker						
June	54.3	4.8	6.6		33.3	T
July	21.7	7.8	T		57.1	15.0
August	19.6	1.6	T		53.0	25.8
September	14.6	5.6	T		60.1	18.3
October	23.6	4.3	1.6		68.7	5.1
Smallmouth buffalo						
June	75.6	T	7.9		13.4	T
July	27.5	7.0	1.8		55.8	7.7
August	18.9	14.1	T		62.2	6.7
September	24.3	6.5	T		64.2	5.5
October	38.7	4.2	7.7		52.4	1.7

* T indicates a volume of less than 1%.

TABLE 18. Continued

	Micro- crustacea	Aquatic insects	Terrestrial insects	Fish	Plant	Other
Channel catfish						
June	T	29.5	36.9	26.2	T	5.6
July	T	42.3	24.0	26.0	3.6	2.7
August	1.1	29.2	14.5	51.6	2.8	2.6
September	T	34.5	21.3	38.5	1.7	3.2
October	1.0	T	59.4	33.5	T	8.1
White crappie						
June	4.8	59.4	21.5	14.0		T
July	T	7.5	T	88.1		T
August	T	T	T	99.7		T
September	T	7.5	2.1	90.8		T
October	T	5.4	T	95.0		T
Freshwater drum						
June	1.2	75.2	T	7.2		7.5
July	T	32.7	T	59.9		2.2
August	T	26.0	2.5	73.0		T
September	1.1	52.0	2.6	45.7		T
October	2.2	11.0	T	89.1		1.6

TABLE 19. Average volume of food groups found in stomachs in May and November.* Volume given as percent of total volume.

		Micro- crustacea	Aquatic insects	Terrestrial insects	Fish	Plant material	Other material
<u>May</u>							
	No.						
Carp	16	5	13	7		55	3
River carpsucker	1	20				80	
Smallmouth buffalo	1	40				60	
Channel catfish	2		45		35	15	5
Freshwater drum	9	Trace	98				
<u>November</u>							
Carp	2	5	10			65	20
River carpsucker	2	19				73	9
Smallmouth buffalo	3	53	3		5	38	
Channel catfish	12		3	49	19	28	
Walleye	15				100		
White crappie	7				100		

* These data not included in the analysis of variance because of insufficient numbers.

order of volumetric importance were plant material (75 percent), microcrustacea (9 percent), aquatic insects (5 percent), terrestrial insects (5 percent), and other material (2 percent), (Table 11). The plant material in early summer was primarily terrestrial plant seeds and detritus, while later it was mostly algae. Only a trace of fish was found in a few carp stomachs. This was very similar to data collected by Walburg and Nelson (1966) in Lewis and Clark Lake, South Dakota. They found that carp were feeding on organic detritus (61 percent), insects (19 percent), microcrustacea (10 percent), and phytoplankton (9 percent). Organic detritus was composed of approximately 80 percent plant material. Ewers and Boesel (1935), in Buckeye Lake, Iowa, found that 51.5 percent of the carp stomachs examined which contained food, contained crustacea, mostly cladocera, and 36.5 percent of the stomachs contained insects, nearly all chironomids. Moore (1952) found food of the adult carp in Jackson Lake, Colorado, to have the following order of abundance, by percent of organisms: microcrustacea (89 percent), plant material (14 percent), and aquatic insects (5 percent). If these food items were expressed as volume of material, these data would be very similar to that found at Tuttle Creek. In Lonetree Reservoir, Colorado, Moore (1952) found that adult carp were feeding on plant material (47 percent), microcrustacea (35 percent), and aquatic insects (30 percent). Converting these data to percent by volume instead of percent of number of organisms, these data are also similar to that reported in this study.

If the percentage frequency of occurrence of all food items ingested by carp in Tuttle Creek Reservoir were compared, as some food items taken by fish increase, other food items were taken less often (Figure 13). During May, microcrustacea were found in only 25 percent of the stomachs, while aquatic

insects were taken by 45 percent of the fish, and plant material was taken by 94 percent of the fish. In June, microcrustacea were found in 68 percent of the stomachs and aquatic insects and plant material occurred in only 30 percent and 68 percent of the stomachs, respectively. During the rest of the sampling period, as the occurrence of microcrustacea decreased the occurrence of aquatic insects increased, plant material occurrence increased to 100 percent and remained at or near this figure. Terrestrial insects were taken by a moderate percentage of the carp in May (31 percent), and June (35 percent), and decreased in occurrence for the rest of the sampling period.

River Carpsucker

Grouping river carpsucker from all stations and for all months together the food items taken in order of volumetric importance were: plant material (54 percent), microcrustacea (27 percent), other material (13 percent), aquatic insects (5 percent) and terrestrial insects (2 percent), (Table 11). Plant material was generally algae and microcrustacea was primarily cladocera and copepods.

The volume of the food items found in the stomach of the river carpsucker in Tuttle Creek Reservoir vary considerably throughout the sampling period. The volume of plant material found varied from a low of 33 percent in June, to 57 percent in July, and reaches a high of 68 percent in October (Table 18). The volume of microcrustacea ingested dropped from a high of 54 percent in June to 15 percent in September, and reached 24 percent in October. The volume of the aquatic insects taken varied from 8 percent in July, to a low of 2 percent in August. There was very limited feeding on terrestrial insects by the carpsucker. The volume taken was 6 percent in June and less than 1 percent until October when a volume of 2 percent was observed. The other material category of food items consisted mainly of nematodes, rotifers,

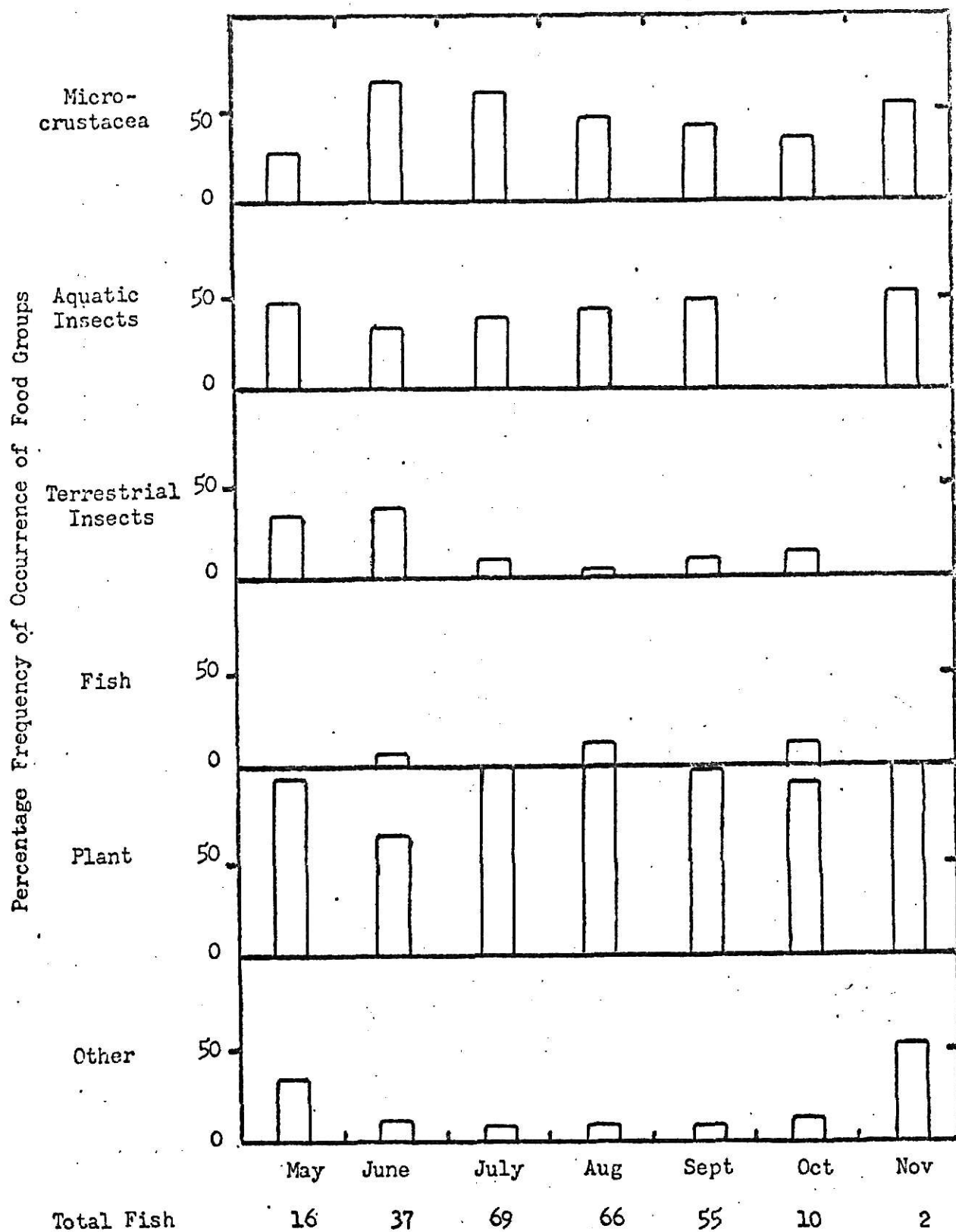


Figure 13. Percentage frequency of occurrence of food groups in all carp, by month.

sand and silt for the river carpsucker. The percentage frequency of occurrence of this item was 0 percent in June to a high of 26 percent in August, and back to a low of 5 percent in October (Figure 14).

The station the river carpsucker was taken from made a difference in the volume of a food item taken from the stomach only in the case of the microcrustacea. The least squares mean volume of this food item found in fish taken from Stations I and III was 21 percent, while that taken from Stations II, IV, V, and VI was 32 percent. This indicates that fish feeding in open water tend to take more microcrustacea than the fish feeding in the coves.

The small and medium size class fish and the large size class fish showed no difference in the utilization of any of the food groups.

The food habits of the river carpsucker would seem to be predictable in terms of percentage frequency of occurrence for this study. Each of the food items were taken at a low level during the month of June and increase to a high in August or September, and remain the same or decrease slightly in October. The volume of microcrustacea ingested was at a high in June and low in September. The occurrence of microcrustacea in stomachs was at its lowest in June and highest in September. This indicated that the individual fish feeding on microcrustacea in June, utilize them extensively. In September nearly all fish take microcrustacea but only in small numbers (Table 18)

The data from this study and the data cited in Table 20 show that the food habits of the river carpsucker are very similar in the lakes and rivers mentioned and Tuttle Creek Reservoir.

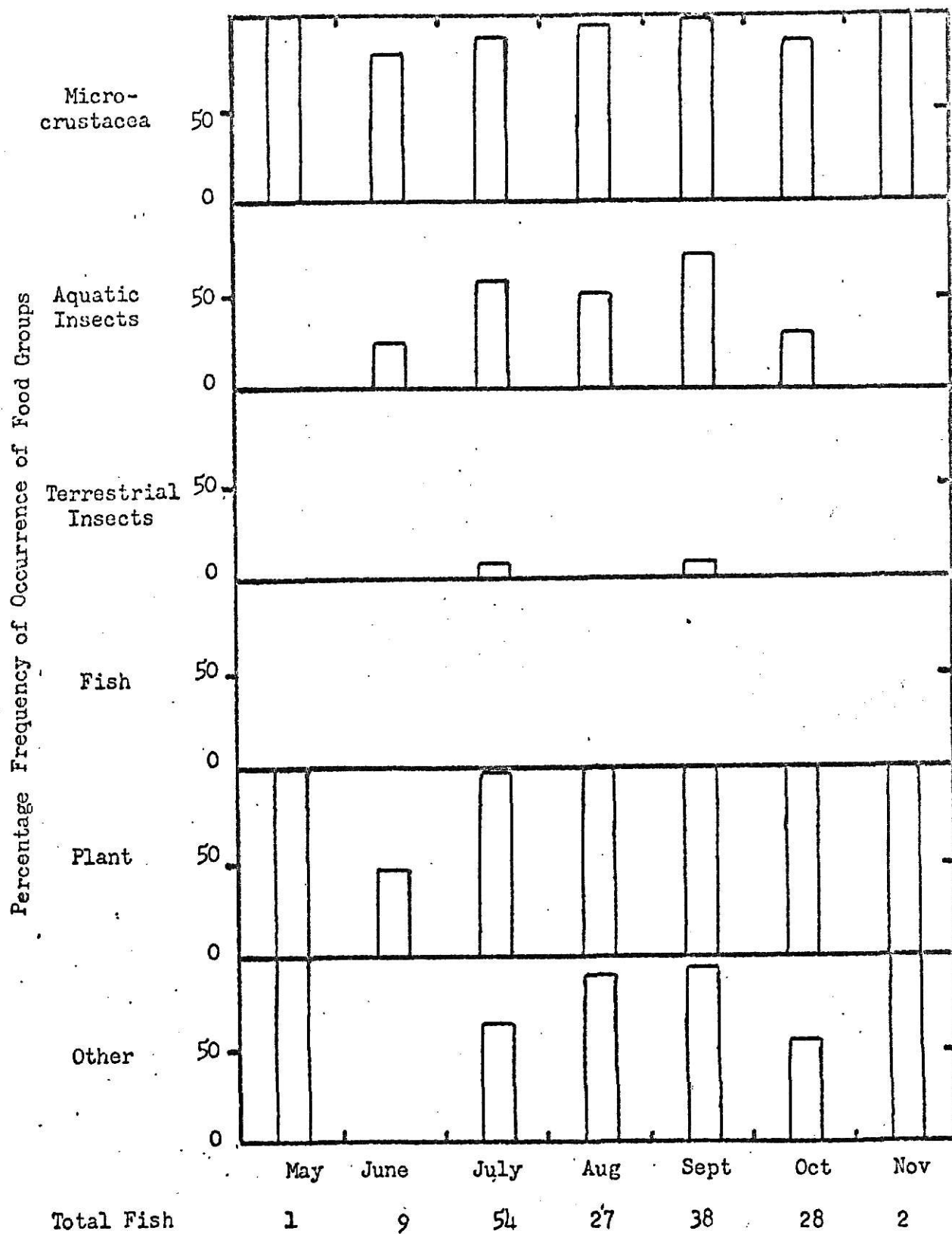


Figure 14. Percentage frequency of occurrence of food groups in all river carpsucker, by months.

Table 20. Percentage occurrence of food items in diet of river carpsucker from Des Moines River, Lake of the Ozarks, and Lewis and Clark Lake. (T = less than 1 percent)*

Food Item	Des Moines River ¹	Lake of the Ozarks ²	Lewis and Clark ³
Diatoms	71	48	66
Green Algae	69	52	30
Bluegreen Algae	55		8
Desmids	54	63	4
Diptera (immature)	41	26	4
Diffugia	37	T	
Rotifera	24	36	33
Copepoda	22	41	38
Cladocera	7	55	21

1 Buchholz (1957)

2 Brezner (1958)

3 Walburg and Nelson (1966)

*Modified from Walburg and Nelson (1966)

Smallmouth Buffalo

The volume of some of the food items found in the stomachs of the smallmouth buffalo on Tuttle Creek Reservoir varied somewhat. The least squares mean volume of plant material varied from 13 percent in June to 56 percent in July, 64 percent in September and down to 52 percent in October. The volume of microcrustacea found in stomachs raised from a trace in June to a high of 14 percent in August and dropped to a low of 19 percent in August, and raised to another high of 39 percent in October (Table 18). The volume of aquatic insects found in the stomachs raised from a trace in June to a high of 14 percent in August and dropped to a low of 4 percent in October. Other materials were found in stomachs from all months but the highest volume was 8 percent in July. Terrestrial insects were found in the

stomachs for three months, June, July, and October, but made up less than 10 percent of the volume each month.

Aquatic insects were fed upon more extensively at Stations I and III than at Stations II, IV, and VI. The proportions were reversed for utilization of terrestrial insects by the river carpsucker. Terrestrials were taken by fish at Stations II, IV, V, and VI more than at Station I and III.

Size of fish made a difference in utilization of aquatic insects and terrestrial insects. The smaller and medium size fish contained 20 percent aquatic insects, while the large size fish contained 13 percent. The smaller and medium size fish contained 10 percent terrestrial insects while the large size class fish contained 5 percent.

Grouping together the fish from all stations, for all months and all sizes, the order of volumetric importance of the food items was: plant materials, 50 percent; microcrustacea, 37 percent; aquatic insects, 6 percent; other material, 5 percent; and terrestrial insects, 3 percent (Table 11). McComish (1967) reported the food of the smallmouth buffalo in Lewis and Clark Lake, South Dakota, in percentage by volume as: unidentified, 48 percent; microcrustacea, 31 percent; algae, 13 percent; insects, 6 percent; and sand and debris, 3 percent. If small sticks, pieces of wood, and plant seeds were identified as plant material as in this study, rather than as unidentified, the data from these two studies would compare very well. The same conclusions can be drawn from data reported by Walburg and Nelson, (1966) from Lewis and Clark Lake. They reported the percentage volume of food items in the stomachs of smallmouth buffalo to be digested material, 49 percent; microcrustacea, 28 percent; phytoplankton, 16 percent; and insects, 4 percent. Minckley, et. al. (1970) reported the following data on the food habits of the smallmouth buffalo from Apache Lake, Arizona: mollusca, 68 percent;

microcrustacea, 10 percent; aquatic insects, 9 percent; diatoms, 11 percent; and organic and inorganic detritus, 46 percent. These figures are given in percentage total relative volume. Mollusca did not occur as a major food item in other studies mentioned, but Minckley, et. al. (1970) states that the bottom fauna in Apache Lake was sparse and limited to a few native chironomids and an abundant introduced Asiatic clam, perhaps accounting for the abundance of clams being taken by these fish.

The food habits of the smallmouth buffalo by percentage frequency of occurrence (Figure 15) are very similar to those of the river carpsucker. Plant material was found in the stomach of nearly 100 percent of the fish, except in June when it was found in only 30 percent of the stomachs. Microcrustacea occurred in nearly 100 percent of the stomachs, dipping to a low of about 83 percent in July and August. Aquatic insects were found in 22 percent of the stomachs in June, raising to a high of 72 percent of the stomachs in August, dropped to 36 percent in September and October and to 33 percent in November. Terrestrial insects were found in 26 percent of the stomachs in June, 15 percent in July, 11 percent in September, 55 percent in October and 67 percent in November. The other material food group (mainly rotifers and nematodes) were found in 52 percent of the stomachs in July, 66 percent in August, 53 percent in September and 35 percent in October.

Channel Catfish

The least squares mean volumes of the food items indicate that fish (gizzard shad) and terrestrial insects (treehoppers) were the most important food items for channel catfish in that order. Furthermore, the comparison of the volume of these two items taken throughout the sampling period indicated they were inversely related, that is, as the volume of fish increased, the

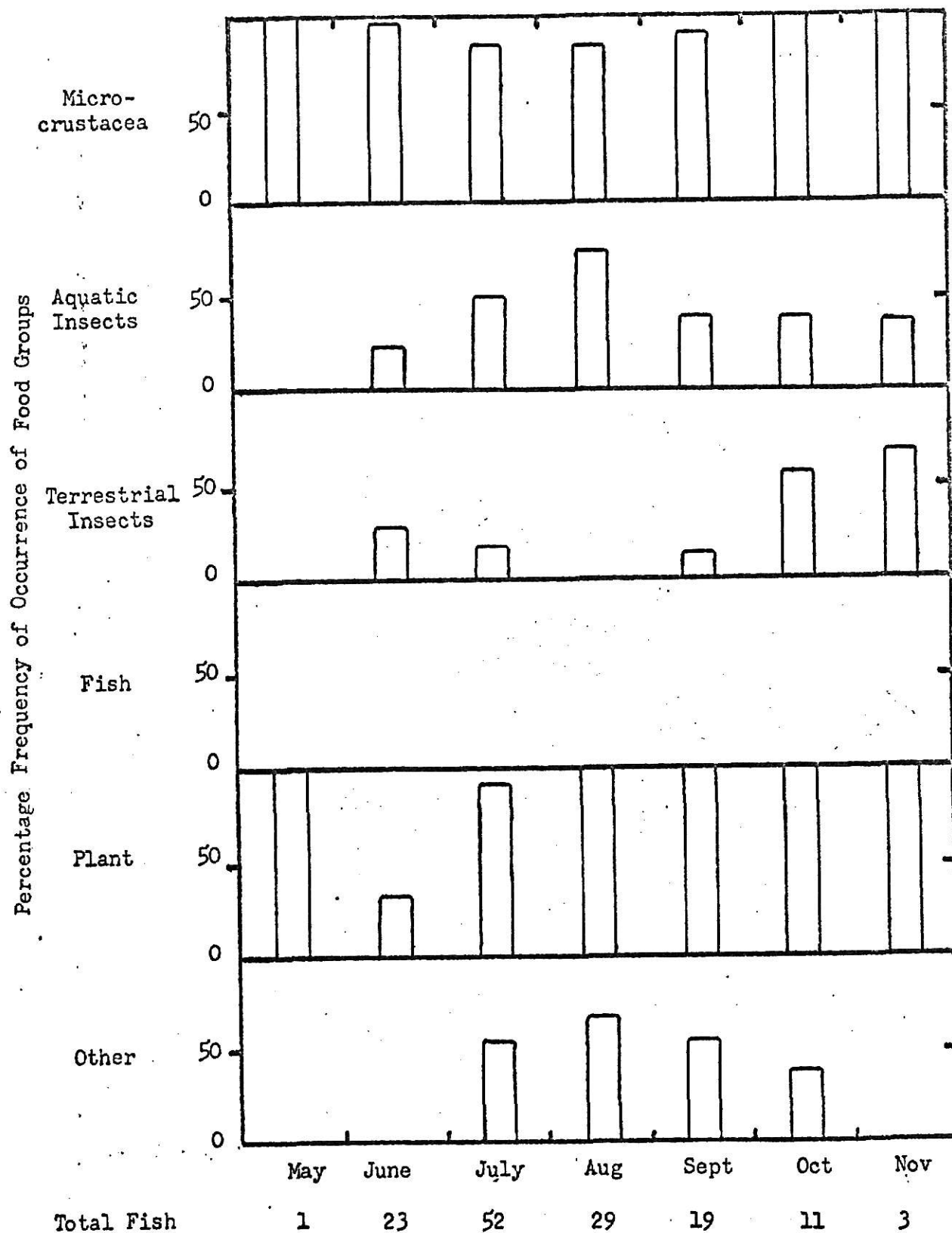


Figure 15. Percentage frequency of occurrence of food groups in all smallmouth buffalo, by months.

volume of terrestrial insects taken decreased. Data from this study indicates that the channel catfish may be an opportunistic feeder. The channel catfish fed heavily on terrestrial insects in the early summer, switched to a diet of mainly fish (young-of-the-year gizzard shad) in the middle summer and back to a diet of terrestrial insects in the fall when the shad populations were down because of predation, or the shad became too large to be utilized except by the largest fish. Throughout the sampling period the channel catfish fed on aquatic insects (mostly Chaoborus spp. and Chironomid larvae) at essentially the same degree (from 30 to 42 percent) except during the month of October when few fish contained aquatic insects. Plant material was taken in all months, but at a low volume (from a trace to 4 percent). Microcrustacea was taken during June, July and August, but only a trace during any month. Other material was taken at all months and the volume ranged from 3 to 8 percent.

Fish taken from Stations I and III fed more extensively on plant material, aquatic insects, and other material, than fish taken from II, IV, V, and VI. Fish at the latter four stations fed more extensively on terrestrial insects than did those fish from Stations I and III.

Small and medium size fish fed more extensively on aquatic and terrestrial insects than did the large fish. The large size fish fed more extensively on fish and other material than did the small and medium size fish.

The least squares mean volumes of food found in the grouped stomachs of channel catfish in Tuttle Creek Reservoir in order of importance were fish 35 percent; terrestrial insects 31 percent; aquatic insects 27 percent; other material 4 percent; plant material and microcrustacea, a trace (Table 11).

The data from Tuttle Creek Reservoir compares very favorably to data reported by Bailey and Harrison (1948). These researchers found that fish

are relatively unimportant as food for small channel catfish, but became more important as the fish becomes larger. The most important food item by volume found in the stomachs of channel catfish from the Mississippi River and Reelfoot Lake, Tennessee, by Hoopes (1960), and Rice (1941), respectively, was aquatic insects, ranging from 64 percent to 75 percent of the total volume. Boesel (1935) found a volume of 53 percent aquatic insects and 33 percent microcrustacea in fish taken from Lake Erie. Ewers and Boesel (1935) determined that Buckeye Lake, Iowa, channel catfish fed on aquatic insects 23 percent and debris 76 percent. Bailey and Harrison (1948) found that small channel catfish had taken 70 percent by volume aquatic and terrestrial insects combined. Clemens (1954) found that 100 percent of the channel catfish taken from Fort Gibson Reservoir, Oklahoma, and 95 percent of the fish taken from Tenkiller Reservoir, Oklahoma, were feeding upon aquatic insects, and 67 percent of the fish from Fort Gibson were also feeding upon fish.

Fish were found in the stomachs of nearly 50 percent of the channel catfish during the sampling period, except October when 25 percent had fed upon fish (Figure 16). Terrestrial insects were not fed upon by fish in May, but 72 percent of the fish in June had fed on this food item, 44 percent in August, and 77 percent in October. Aquatic insects were taken during all months occurring in 50 to 70 percent of the stomachs until October when the occurrence dropped to 15 percent. Plant material was also taken during all months but the level remained relatively low throughout the sampling period.

White Bass

Nine stomachs which contained food were taken from white bass from Tuttle Creek Reservoir during the sampling period. One of these was taken during August, six in September, and two in October. All nine of these stomachs contained fish, generally gizzard shad. No other food items were

found in these stomachs (Figure 17). Nelson and Hasler (1942) found fish in eight and crayfish in four of ten stomachs taken from white bass from Lake Geneva, Wisconsin. Bonn (1935) reported that the largest volume of any item of food ingested by young white bass was fish (gizzard shad), with microcrustaceans and aquatic insects also being taken. Microcrustaceans were the most frequently occurring food item found in the stomachs. Ewers and Boesel (1935) reported white bass from Buckeye Lake, Iowa to feed principally on crustacea (87 percent), insecta (62 percent), and fish (37 percent). McNaught and Hasler (1961) commented that the bulk of the diet of white bass is microcrustacea, but as the fish gets older, an increased utilization of fish is noted. Hoopes (1960) found mayfly naiads to be 54 percent of the total stomach contents of white bass collected.

Walleye

Stomachs were taken from walleye from Tuttle Creek Reservoir during five months. During July, 2 stomachs which contained food were taken, 1 in August, 13 in September, 1 in October, and 15 in November. Each of these stomachs contained only fish, generally gizzard shad (Figure 18). Fish as the most important food taken by walleye is reported by Coney (1935), Dendy (1946), Gassoway (1969), Priegel (1963), Jennings (1969), and Nurnberger (1931). Other food items reported taken by walleye are aquatic insects, leeches, crayfish, and microcrustaceans. The walleye feed on fish, taking the forage fish that is most abundant. If the gizzard shad is abundant, it is taken by walleye in large numbers. Lake emerald shiners (Notropis antherinoides), troutperch (Percopsis omiscomaycus), yellow perch (Perca flavescens), and the freshwater drum are other fish mentioned in the literature as food for the walleye.

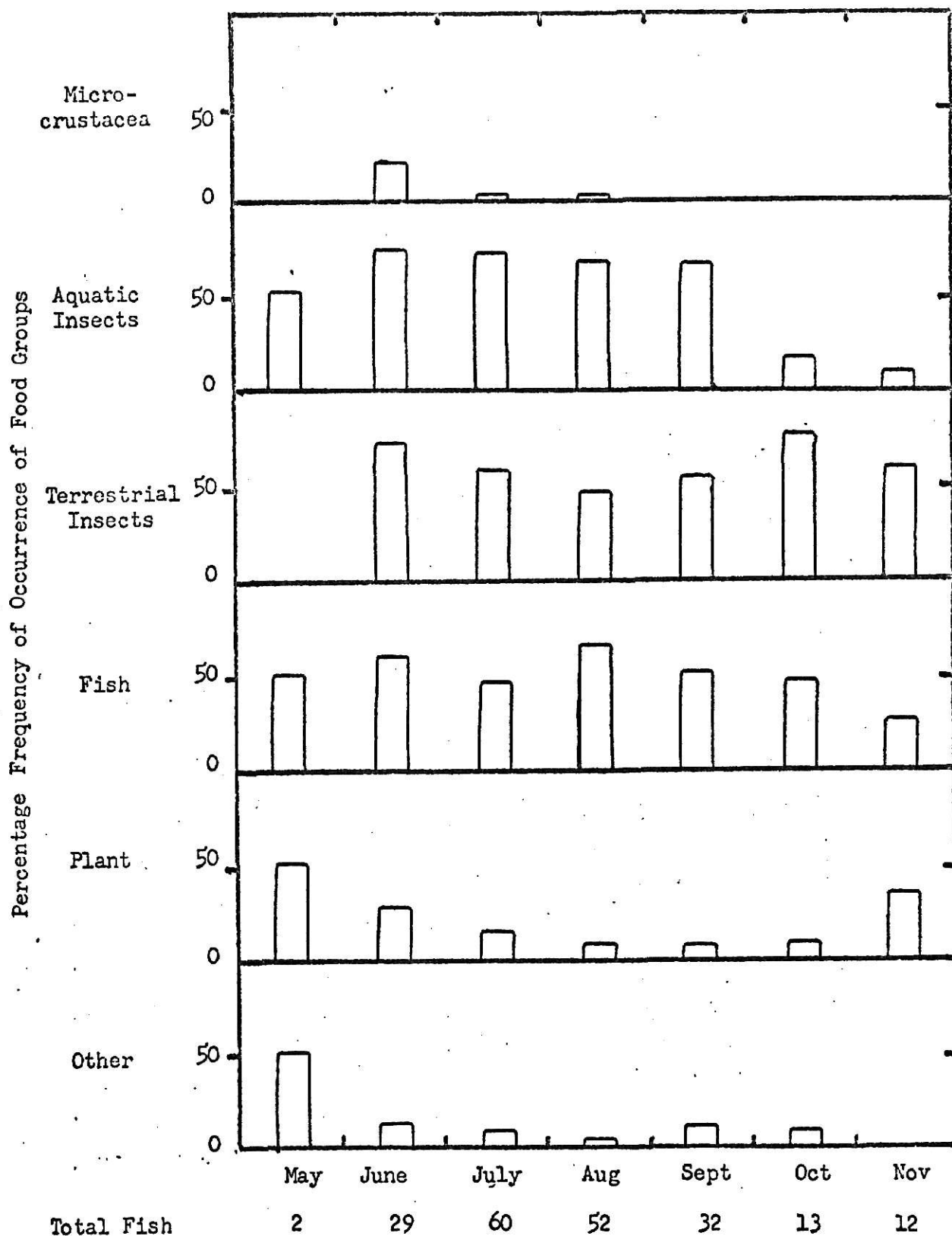


Figure 16. Percentage frequency of occurrence of food groups in all channel catfish, by months.

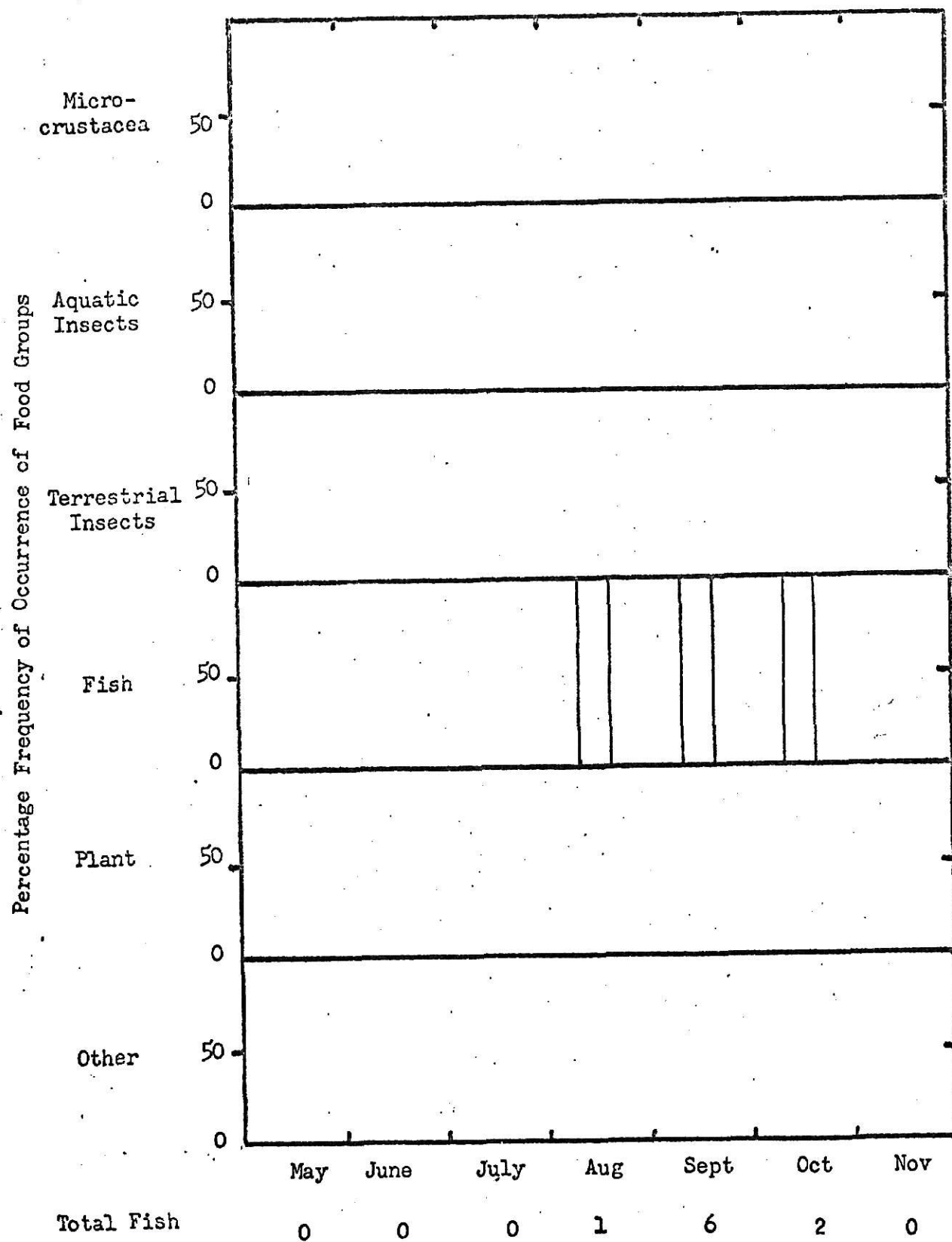


Figure 17. Percentage frequency of occurrence of food groups in all white bass, by months.

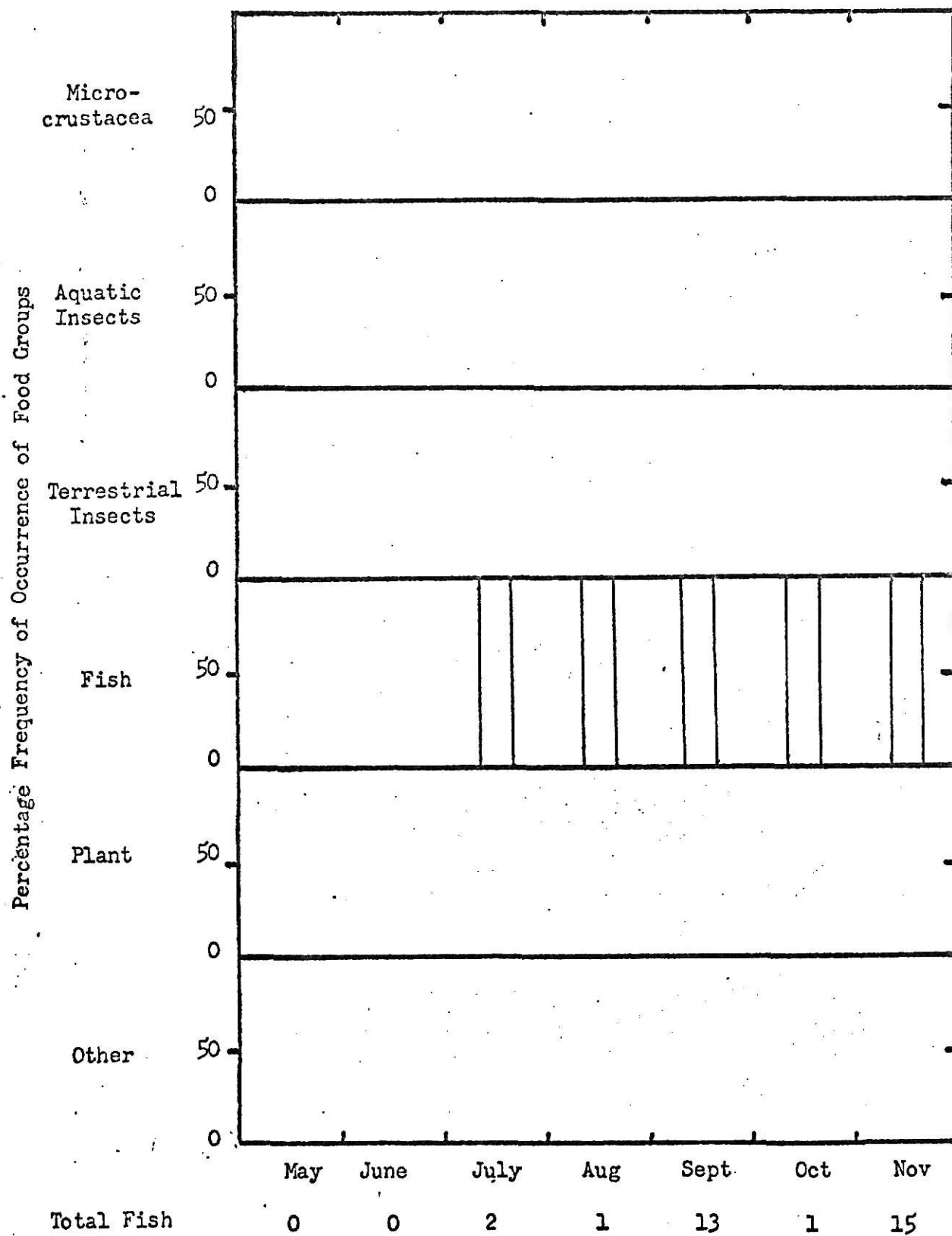


Figure 18. Percentage frequency of occurrence of food groups in all walleye, by months.

White Crappie

The least squares mean volumes of the food items found in white crappie stomachs from Tuttle Creek Reservoir indicate that fish was the most important food item. Gizzard shad made up at least 90 percent of the forage fish taken, which accounts for the low volume (14 percent) of fish being taken in June. Sampling was done during the early part of the month when the young-of-the-year gizzard shad were not yet available in quantities for forage (Cramer and Marzolf, 1970). The major food item taken in the month of June by volume and percentage frequency of occurrence was aquatic insects, mainly Chaoborus spp. and Chironomid larvae (Figure 19). After young gizzard shad became available, the volume of fish in the diet of the white crappie ranged from a low of 88 percent to a high of 100 percent (Table 16). Fish occurred in over 90 percent of the stomachs with food during this same period, July to October. The volume of aquatic insects found in the stomachs remained below 10 percent from July to October. The only terrestrial insects found were a trace in August and September. Microcrustacea were present, 5 percent of the volume in June, and remained below 1 percent in July, and September, the only months this food item was found.

The order of volumetric importance of food items found in the stomachs of white crappie were fish, 78 percent; aquatic insects, 16 percent; terrestrial insects, 4 percent; and microcrustacea, 1 percent (Table 11).

Ewers and Boesel (1935), and Nurmberger (1931) reported that young white crappie (15 to 75 mm. total length) feed most heavily on microcrustacea and older fish fed very extensively on fish. Marcy (1954) states that large fish stomach contents were mostly fish with a few chironomus larvae and adults. Ball and Kilambi (1969) reported that yearling and older crappie took Chaoborus

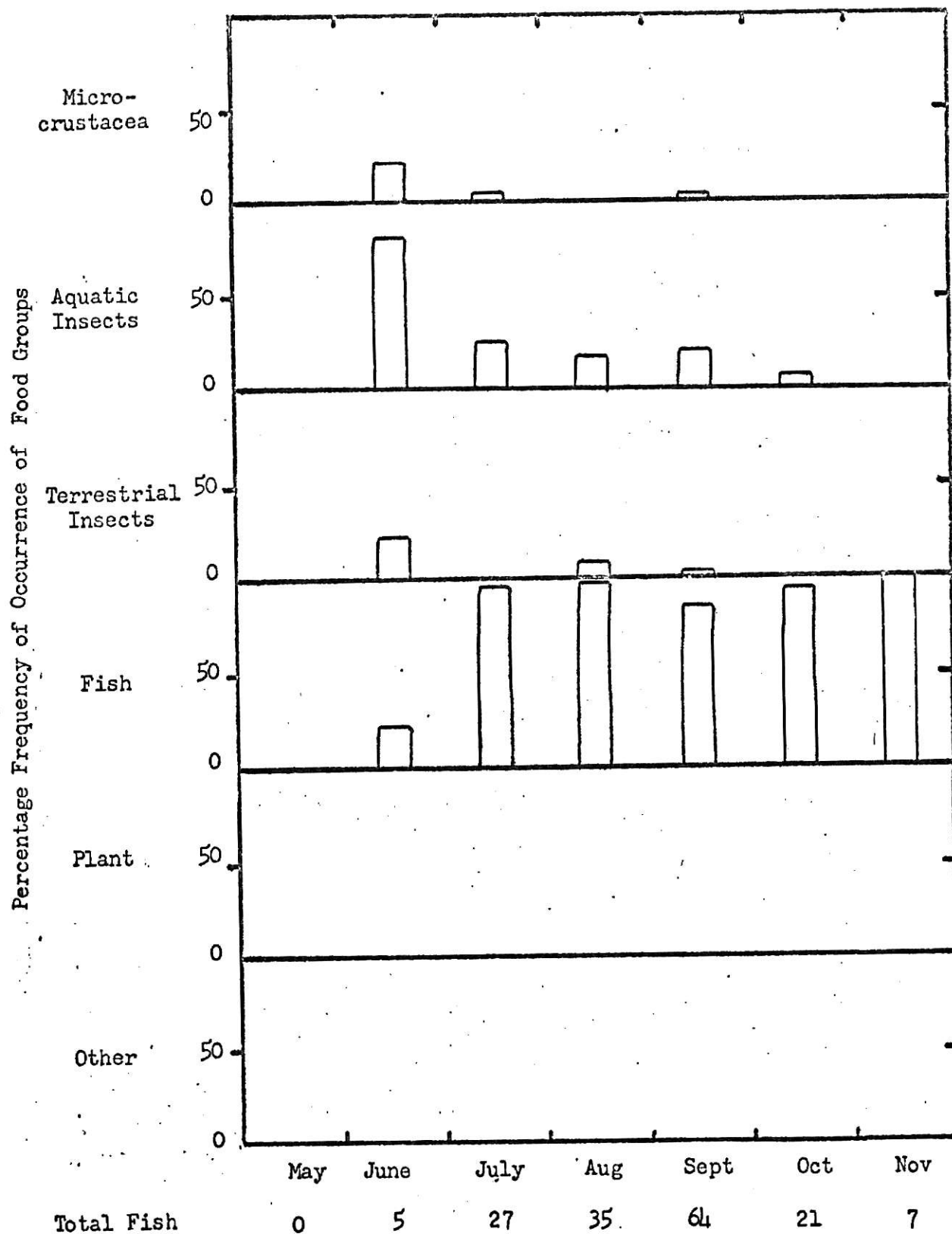


Figure 19. Percentage frequency of occurrence of food groups in all white crappie, by months.

spp. larvae and pupae as the most numerous food item, but threadfin shad, Dorosoma petenense (Gunther), made up the bulk of the diet. The food item found most often by Clemens (1954) was insects, occurring in 100 percent of the stomachs of fish from Fort Gibson and Tenkiller Reservoir, Oklahoma, but the fish were the major food item by volume. Hansen (1951) reported the food of the white crappie to be 58 percent fish and 35 percent aquatic insects by volume. Hoopes (1960) reported that 53 percent of the food of the white crappie was aquatic insects, with fish composing the other 47 percent.

The small to medium size white crappie in Tuttle Creek Reservoir fed on aquatic insects to a slightly greater extent than did the large fish. The volume of aquatic insects found in stomachs of fish taken from Stations I and III (coves) was higher than the volume in stomachs of fish taken from Stations II, IV, V, and VI (open waters). More terrestrial insects by volume were taken by small and medium fish than were taken by large fish, and those fish from the open water stations utilized more terrestrials than the fish from cove stations.

Freshwater Drum

The least squares mean volumes of the food items found in freshwater drum stomachs from Tuttle Creek Reservoir indicate that fish (gizzard shad) was the most important food, with aquatic insects, generally Chaoborus spp. and some chironomids and Hexagenia spp. being taken of next greatest importance (Table 11). Fish were ingested during all months of the sampling period, with a low of 7 percent in June and a high of 89 percent in October (Table 18). Fish were found in more than 50 percent of the stomachs which contained food during July, August, and October (Figure 20). They were found in only 16 percent of the stomachs in June and 35 percent in September. The volume and percentage frequency of occurrence of aquatic insects found in the stomach

is inversely related to the volume of fish found in the stomach. Aquatic insect volume was at its greatest in June, dropped to a low in August, raised in September, and dropped again in October (Table 16). Aquatic insects occurred in 100 percent of the fish stomachs in May, dropped to about 50 percent occurrence in July and August, occurred in 80 percent in September and 20 percent in November. Terrestrial insects, plant material and other material were represented in stomachs during only two months each and collectively were of minor importance as food items.

The small and medium size drum fed more on aquatic insects and the large drum depended on fish for the bulk of their diet. Those fish caught at Stations I and III used slightly more fish in the diet than did those at Stations II, IV, V, and VI, while those fish at the latter four stations used more aquatic insects than did those at Stations I and III.

Dendy (1946) reported that small drum fed on microcrustaceans and small insect larvae. As the fish grew older they gradually changed to a diet of fish. The bulk of the insects were larvae and pupae of Chaoborus spp. and small Chironomids. Swedberg (1966) indicated that Chironomids amounted to 20 percent of the stomach contents of freshwater drum from Lewis and Clark Lake, South Dakota. Insects, nearly all aquatic forms, were found in 100 percent of the stomachs of freshwater drum taken from Fort Gibson and Tenkiller Reservoirs, Oklahoma (Clemens, 1954). Fish were found in only 62 percent and 15 percent of the stomachs from these two reservoirs, respectively.

These data compare favorably to the data from Tuttle Creek Reservoir. The dependence of the freshwater drum on fish may seem to be a little high but the low incidence of Mollusca in Tuttle Creek Reservoir (Schwartz, 1970) might cause this dependence (Dendy, 1946).

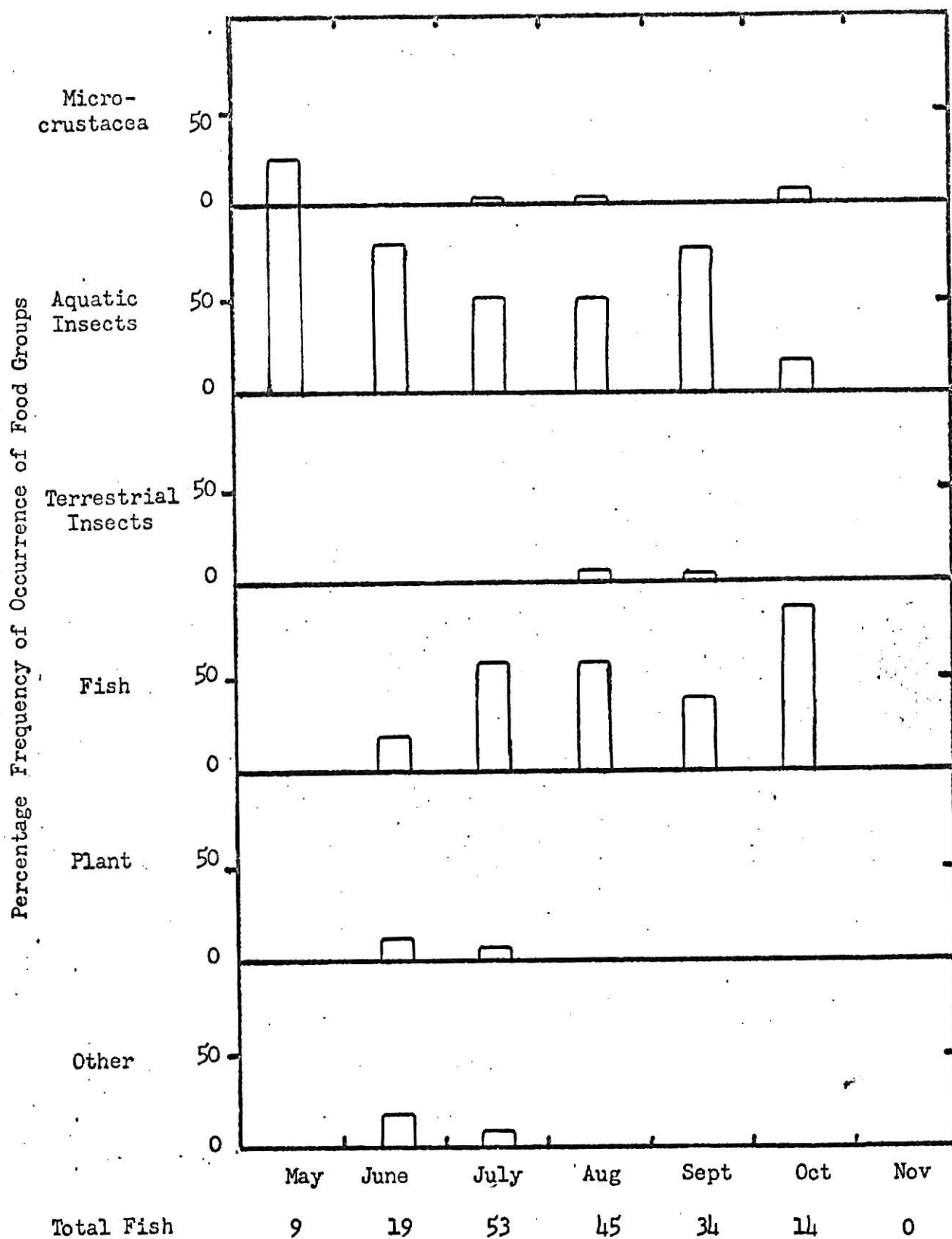


Figure 20. Percentage frequency of occurrence of food groups in all freshwater drum, by months.

Other Species

One stomach was taken from a large flathead catfish in July and one carp (200 mm.) was found in the stomach. No other food item was identified.

Stomachs were taken from six bigmouth buffalo, two of these were empty. One each of the stomachs with food were taken at Station IV, V, and VI, in July and one was taken during August at Station II. Three of these stomachs had a volume of microcrustacea equal to 55 percent, mostly copepods. One of these three had also fed on Chaoborus spp. larvae (45 percent), and the other two had fed on plant material (50 to 60 percent). The fourth buffalo had nothing but plant material (algae) in the stomach.

GENERAL DISCUSSION

Distribution

As the water temperature increases, warmwater fish activity and therefore numbers of warmwater fish caught should also increase. This was found to be true by the data from Figures 2 through 12 excluding Figure 11. These data represent typically warmwater species. These species were taken in maximum numbers generally during the warmer months. The one typically cold water species, walleye (Figure 11), was taken in greatest numbers during the cooler months of October and November.

Tuttle Creek Reservoir was subjected to windy conditions throughout the time of this study, and therefore did not thermally stratify. The mixing of the lake due to wind kept temperature and dissolved oxygen concentrations nearly constant from top to bottom of the water column and throughout the reservoir (Dufford, 1970). These factors then were assumed not to affect fish distribution.

Factors which probably did affect the distribution of fishes in Tuttle Creek Reservoir were depth of water (as indicated by the low catch at the deep-water station), relationship of area to surrounding topography, and ratio of shoreline to open water. Generally the shallower the water and the greater the ratio of shoreline to open water found in the area, the more fish found in the area. Generally the smaller fish were found in this type of area, while the larger fish were found in the deeper open water area. The lower the slope of the nearest shoreline, the more fish tended to congregate in the area, as shown in the coves and Station IV. Perhaps the reason for this was the smaller the slope, the larger the area of mud-water interface providing a greater area for food production. Also, a small increase in

depth of the reservoir would cover a proportionally larger area of beach in this area, exposing more feeding area for the foraging fish.

Food Habits

The diets of the carp, river carpsucker, and the smallmouth buffalo, determined from this study, were very similar. These fishes depended upon detritus material of plant origin, that is, detritus, algae, leaves, seeds, etc. and microcrustacea for the bulk of their food. A greater volume of microcrustacea than plant material was taken by these fishes only during the month of June. After June, predation upon zooplankton by gizzard shad may have decreased the population (Cramer and Marzolf, 1970) so that they were not available in large numbers for other species of fishes.

Preferred food of the river carpsucker and smallmouth buffalo throughout the sampling period seemed to be microcrustacea and aquatic insects, however, when these were not available in sufficient quantities, plant material was taken at increased rates. Further study may show that the plant material is taken accidentally while these fishes are browsing the periphyton for aquatic insect larvae.

The carp seemed to show a preference for plant material, taking microcrustacea, aquatic and terrestrial insects when available, but the bulk of the volume of the stomach contents throughout the sampling period was plant material.

The channel catfish was an omnivorous feeder. Some of the miscellaneous food items found in stomachs of the channel catfish during this study were elm seeds, a nematomarpha, acorns, crayfish, and a bait of nightcrawlers presumably taken from a fisherman.

The bulk of food taken by the channel catfish during this study was about equally divided among the aquatic insects, terrestrial insects and the

fish food groups, however, the rate of utilization of each food group changed during this time. During the windy days of early summer, terrestrial insects were utilized extensively (Table 18). Aquatic insects were taken during July and fish (mostly gizzard shad) were taken at a higher rate than insects the rest of the sampling period.

The data collected from this study indicated that white bass and walleye in Tuttle Creek Reservoir feed strictly on fish. This is probably true when the young-of-the-year gizzard shad are abundant, as they were during the period when these white bass were taken. These fishes taken in the spring or late fall would probably be found to be feeding on other food items.

The white crappie were piscivorous. Young-of-the-year gizzard shad, when available, made up more than 90 percent of the volume of stomach contents. When the young shad were not available, June in this study, aquatic insects were used for the bulk of the diet. Some terrestrials and microcrustacea were also taken during June.

The food habits of the freshwater drum were similar to those of the white crappie with a greater dependence on aquatic insects throughout the period of this study. Fish (mostly small gizzard shad) made up the bulk of the diet during all months except June when aquatic insects were the most abundant organisms found in the stomachs.

The food items taken by fishes in Tuttle Creek Reservoir in order of volumetric importance as a food source were fish (gizzard shad), plant material (mostly filamentous algae), aquatic insects (Chironomids and Hexagenia spp. most abundant), microcrustacea (clopods and cladocerans), and terrestrial insects (leaf hoppers most abundant).

SUGGESTIONS FOR FURTHER STUDY

Research of the literature and this study indicated that the young of many species of fishes utilize microcrustacea as a major food source. Young gizzard shad apparently feed on microcrustacea in Tuttle Creek Reservoir (Cramer and Marzolf, 1970), and a study needs to be initiated to determine the dependence of young of other fishes in the reservoir on this food source. The present study indicates the value of the gizzard shad as a forage fish, but perhaps the detrimental effect of the young gizzard shad decreasing survival of the young of more desirable species outweighs this value. Perhaps competition between young gizzard shad and young "rough fish" decreases the survival of the young "rough fish", which would be beneficial.

Few young-of-the-year carp, river carpsucker and smallmouth buffalo were taken from the reservoir by any means during the period of this study. If this is a phenomenon of poor year class formation, knowledge of factors affecting year class formation would be valuable.

Schwartz (1970), indicates that the bottom fauna population in the open water areas of Tuttle Creek Reservoir is low, but nearly all species of fish in the reservoir take at least a few bottom organisms. What feeding adaptations a fish species has which enables it to locate and ingest bottom organisms needs to be determined. The population of bottom fauna in Tuttle Creek Reservoir in very shallow shoreline area and on submerged trees and other material needs to be determined.

Conversation with fishermen who fish the lower end of the reservoir indicates that the population of longnose gar was much greater during the period of this study than in previous years. The interspecific competition between the gar and the game fishes for forage fish (gizzard shad), needs to be investigated.

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THE DISTRIBUTION AND FOOD HABITS
OF BOTTOM FISHES IN TUTTLE CREEK RESERVOIR

by

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ABSTRACT

This is an investigation of the distribution of bottom fishes in Tuttle Creek Reservoir, Kansas and their relationship to their food resources.

Six stations were sampled, two in coves and four in the open water area. Sampling gear used were six bottom fishing experimental gill nets, and a semi-balloon bottom trawl. Sampling was done with the gill nets, two to a station, 48 hours each month from May through November for three stations. The other three stations were sampled 48 hours a month with two gill nets each month from June through October. Trawling was done for a total of either 15 or 20 minutes in the two cove sites once a month during the period of July to November.

Sixteen species of fishes were taken in the gill nets. These species were: longnose gar, gizzard shad, northern pike, carp, river carpsucker, smallmouth buffalo, bigmouth buffalo, black buffalo, northern redhorse, channel catfish, flathead catfish, white bass, white crappie, black crappie, walleye, and freshwater drum. The bottom trawl caught these same species except longnose gar, northern pike, bigmouth and black buffalo, northern redhorse, flathead catfish and black crappie. A sunfish was also taken with the trawl.

Distribution of these fishes as sampled in this study is reservoir wide. The shallower the water and the greater the ratio of shoreline to open water, the greater the number of fish taken in the area. The two coves produced the largest numbers of fishes, but these fishes tended to be smaller than those caught in the open portion of the reservoir. The one deep water station produced very few fish.

Most species of fishes were taken in greatest numbers in the late

summer. The walleye, a cold water fish, was taken in greatest numbers in the cool fall months, October and November.

Gizzard shad was the most important single food item utilized by the fishes in Tuttle Creek Reservoir. This was the major food item taken by the channel catfish, white bass, walleye, white crappie, and freshwater drum. Immature aquatic insects were also taken by channel catfish, white crappie and freshwater drum. The major food item found in the stomach of carp was plant material. Microcrustacea and immature aquatic insects were also of some importance in the diet of carp. The buffalo fishes and river carpsucker depended on microcrustacea and plant material for the bulk of their diet, with microcrustacea taking a more important role than in the diet of the carp.