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

by 4589

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TABLE OF CONTENTS

THIS BOOK CONTAINS NUMEROUS PAGES WITH DIAGRAMS THAT ARE CROOKED COMPARED TO THE REST OF THE INFORMATION ON THE PAGE.

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Table of Contents Continued

INDEX TO TABLES

Index to Tables Continued

INDEX TO FIGURES

Index to Figures Continued

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 hydroelectric 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

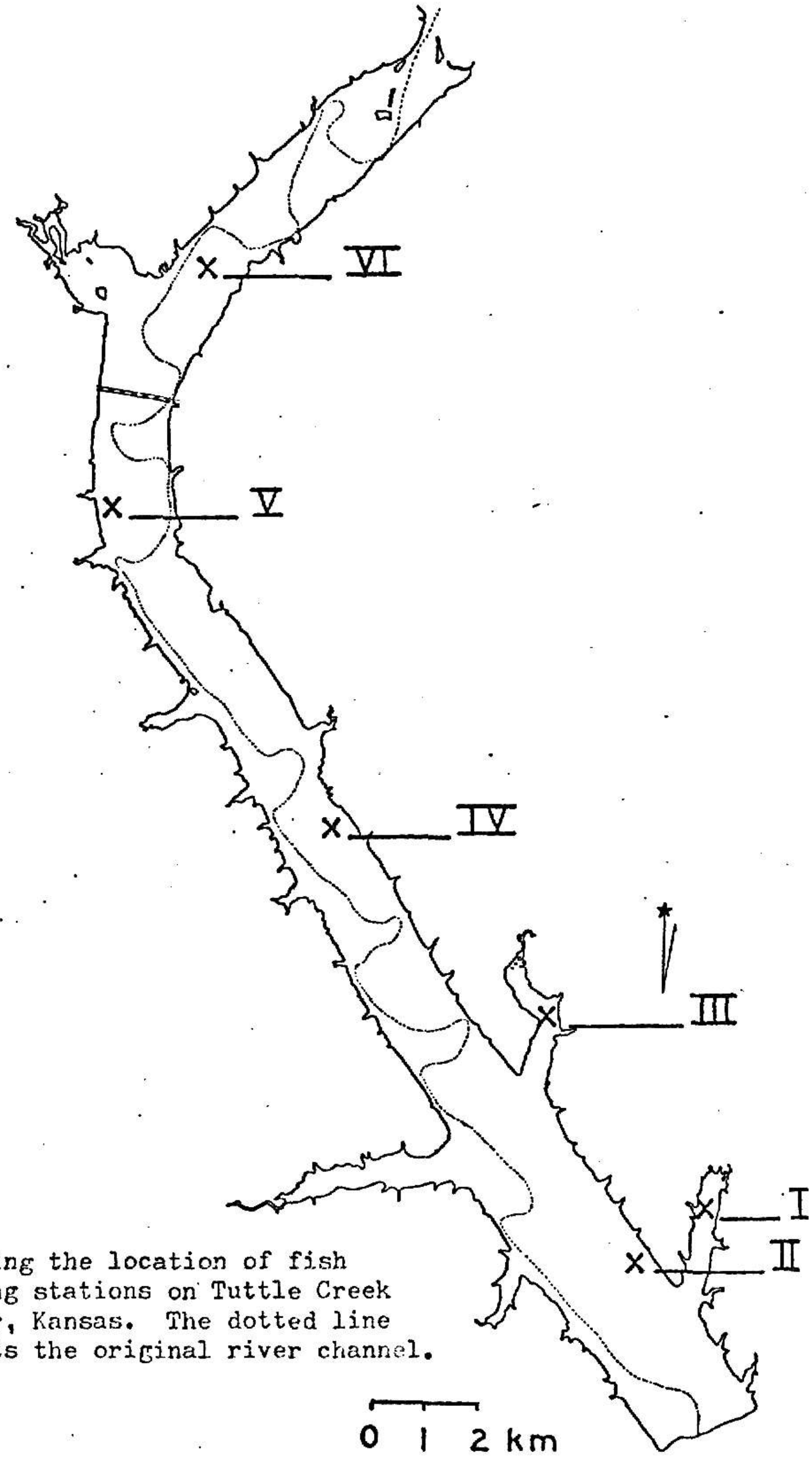

Figure 1 Map showing the location of fish collecting stations on Tuttle Creek Reservoir, Kansas. The dotted line represents the original river channel.

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 oat 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 formlin 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 magnificatio to identify macroscopic organisms. To identify microscopic material, the scope was adjusted to 45x magnification. After the identification of all foo 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.

Sampling Period	Water Temperature
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