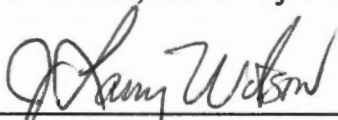


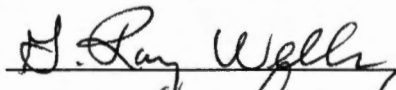
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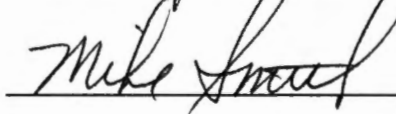
I am submitting herewith a thesis written by Denny W. Smith, Jr. entitled "Summer Pool Food Habits of Flathead Catfish in Norris Reservoir, Tennessee." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Wildlife and Fisheries Science.



J. Larry Wilson, Major Professor

We have read this thesis
and recommend its acceptance:





Accepted for the Council:



Associate Vice Chancellor and
Dean of The Graduate School

**SUMMER POOL FOOD HABITS OF FLATHEAD CATFISH
IN NORRIS RESERVOIR, TENNESSEE**

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee, Knoxville

Denny W. Smith, Jr.

May 1997

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ABSTRACT

iii

Of the 172 flathead catfish *Pylodictis olivaris* collected from Norris Reservoir, Tennessee, from 1 June through 31 October 1996, 106 (61%) contained food items in the stomach. Examination of stomach contents showed that fish were the most important food item by frequency of occurrence; 56 of the 106 stomachs examined contained fish. Crayfish were the second most important food item by number with 54 of the 106 stomachs containing crayfish. For flatheads greater than 44 cm in total length, fish were the only food item consumed. For the flathead smaller than 44 cm in length, crayfish were the most important food item consumed.

Centrarchids were the most frequent fishes consumed (N=39, 36.7%) followed by clupeids (N=13, 12.3%). Of the centrarchids, all were bluegill (*Lepomis macrochirus*) with the exception of 6 fish, 2 of which were smallmouth bass (*Micropterus dolomieu*) and 4 were largemouth bass *M. salmoides*. The clupeids were threadfin shad *Dorosoma petenense* and gizzard shad *D. cepedianum*. Ictalurids were also found in the stomachs and were represented by a single species, the flathead catfish; only 4 were found in adult flathead stomachs. Aquatic insect larvae including mayflies, stoneflies, and a dragonfly were also consumed but in insignificant amounts.

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CHAPTER 1

INTRODUCTION

Pylodictis olivaris, the flathead catfish, is easily recognized by its broad, flat head and its distinctive lower jaw which protrudes well beyond the upper jaw. In addition to extending across the front of the mouth as in other catfish, the band of teeth in the upper jaw extends posteriorly on either side. The combination of a small anal fin and an unusually large adipose fin differentiates the flathead from other squaretailed catfish. The adipose fin is about equal to the length of the anal fin base. There are between 15 and 17 rays in the anal fin. The elongated body is flattened anteriorly, almost cylindrical in the middle, and compressed toward the tail (Koster 1957). The color is dark to olive - brown, with dark brownish mottlings especially evident on the sides of the younger fish. The young fingerlings are black (Koster 1957). An important characteristic of flatheads is their large size as adults, which makes the species very popular with anglers (Mayhew 1969). Specimens up to 27 kg have been exhibited at the Iowa State Fair, and commercial fishermen have reported individuals weighing over 46 kg (Harlan and Speaker 1956).

The natural range of flathead catfish extends from South Dakota to Pennsylvania, south to the Mississippi Valley, and to the Gulf Coastal Plain and in the Rio Grande to Mexico (Blair et al. 1968). Glodek (1980) reported that the native distribution of the flathead catfish includes the large rivers of the Mississippi, Missouri, and Ohio River basins from the Great Lakes south into Mexico. It has been introduced into Colorado (Beckman 1953) and Arizona, from where it has entered southern California (Bottroff et al. 1969).

Flathead catfish are most abundant in the lower courses of large streams and in the bayous and overflow ponds of the lower Mississippi Valley (Forbes and Richardson 1920). They are a big water species found in reservoirs as well as in rivers (Harlan and Speaker 1956). Large individuals are almost always found near massive logs and drift, usually in or near deep holes in the streambed (Minckley and Deacon 1959). In the evening, flatheads move into shallow water to feed (Harlan and Speaker 1956).

Flathead catfish become sexually mature between the third and fifth year of life (Harlan and Speaker 1956, Turner and Summerfelt 1970). They build their nests in places such as rock outcroppings, hollow logs, and holes in the bank (Harlan and Speaker 1956, Koster 1957, Deacon 1961). According to Turner and Summerfelt (1970), the spawning site is 2 to 5 meters in depth. Henderson (1965) reported the spawning temperature as 22 to 25 C, while Turner and Summerfelt (1970) documented a spawning range of 24 to 29 C. The male guards the nest until the yolk sac of the fry has been absorbed (Deacon 1961, Turner and Summerfelt 1970).

Many anglers who fish Norris Reservoir have complained for some time about the declining quality of fishing. Some suggest that predatory fish are having an impact on the game fish populations. These complaints were a motivating factor to initiate the current research project. Therefore, a food habit study of flathead catfish on Norris Reservoir was conducted to determine if these complaints were justifiable, i.e., to see if flatheads are consuming game fish.

Forbes and Richardson (1920), Brown and Dendy (1961), Deacon (1961), Hackney (1965), Swingle (1967), Holz (1969), Layher and Boles (1980), and Ashley and

Buff (1987) described the flathead catfish as being piscivorous. Harlan and Speaker (1956) reported that flathead catfish feed largely upon immature aquatic insects, crayfish, mollusks, and fish. Langemeier (1965), however, suggested that actual abundance of forage fishes, or the relative abundance of forage fishes and invertebrates (Minckley and Deacon 1959, Turner and Summerfelt 1970, and Quinn 1987), influences the food selected by flathead catfish.

Several studies have been conducted on the feeding habits of flathead catfish. A variety of methods have been used to capture flatheads. Low frequency electrofishing units have been reported to be effective techniques for collecting flatheads (Quinn 1986). Brown and Dendy (1961), Morris and Novak (1968), Guier et al.(1981), and Ashley and Buff (1987) employed a catfish capture technique using a hand-cranked telephone magneto as an electrofishing device, and reported that flathead catfish were particularly susceptible using this device. Using a variable voltage pulsator (v.v.p.), telephone magneto, and pacemaker electrofishing gear in Oklahoma lakes and rivers, Gilliland (1987) found the v.v.p. the most successful capture method. Quinn (1986) found that a Model-3A catfish shocking apparatus was species selective toward flathead catfish. When electrofishing for flatheads, low amps (2-3) are recommended for best results by Morris and Novak (1968) and Quinn (1989). Quinn (1987), however, observed electrofishing efficiency was greatly reduced when water temperatures were below 20 C.

Stationary and mobile electrofishing techniques have produced different results. Quinn (1986) in the Flint River, Georgia, and Pugibet and Jackson (1989) in small streams in Mississippi, used the mobile technique for collecting flathead catfish which involved

fishing downstream in a figure-S pattern. However, in Oklahoma reservoirs, Cunningham (1995) found that mobile electrofishing over log piles and other non-riprap habitat was not as effective as stationary electrofishing for sampling flathead catfish 510 mm in length or greater. This method was effective, however, for sampling flatheads less than 200 mm in length. In Oklahoma lakes and rivers, Gilliland (1987) was most successful using the stationary method at timed intervals.

Jackson and Jackson (1989) used large diameter hoop nets in Mississippi streams, and Mayhew (1969) used baited hoop nets in the Des Moines River, Iowa, to successfully capture flathead catfish. In the Neuse River, North Carolina, Nelson and Little (1968) used three different techniques (electrofishing, hoop nets, and trotlines) and reported the hoop nets to be the most effective. Pugibet and Jackson (1989) used hoop nets and electrofishing in small Mississippi streams. They found hoop nets had a better success rate for capturing flatheads than electrofishing. Layher and Boles (1980) used rod and reel, trotlines, and trammel and gill nets as methods of capture for flatheads in a study in a large Kansas reservoir. In the Cape Fear River, North Carolina, Guier et al. (1981) successfully used fyke and gill nets in collecting flathead catfish. Turner and Summerfelt (1970) found that in Oklahoma reservoirs, gill and trammel nets were successful collection methods.

Harlan and Speaker (1956) observed individual flatheads 203-254 mm in length feeding on schools of young minnows in shallow water along the banks of the Mississippi River. Swingle (1967) noted that, in ponds, flatheads as small as 51 mm in length have been known to eat fish while Hackney (1965) stated that flatheads in ponds preferred large prey items which were often over 127 mm in length. Swingle (1967) reported that large

flatheads may compete with anglers for harvestable size fish.

Guier et al. (1981) in the Cape Fear River, North Carolina, found that fish were the dominant food item found in the flathead stomachs. Fish accounted for the majority of total numbers and almost the entire total weight of stomach contents. Bluegill (*Lepomis macrochirus*), black crappie (*Pomoxis nigromaculatus*), and blue catfish (*Ictalurus furcatus*) were the dominant fish species identified in the stomachs, with *Ictalurus* species most abundant.

Crayfish serve as a major food item throughout much of the flathead's native range (Morris et al. 1968, Edmundson 1974). However, in the Cape Fear River, they represented less than 4% of total numbers of all food items. This figure could indicate that crayfish are not present in significant numbers. Aquatic insects were almost non-existent in the stomach contents of the Cape Fear River study.

In Alabama rivers, Brown and Dendy (1961) indicated that invertebrates were found in small flathead stomachs, but not in individuals greater than 28 cm in total length. In fish greater than 28 cm in length, fish was the major food item found. In the same study, however, it was observed that blue catfish made the transition from invertebrates to fish through the 20-33 cm classes.

Ashley and Buff (1986) in the Cape Fear River, North Carolina, found that clupeids were the dominant food group in the diet of flatheads. Ictalurids, primarily white catfish *I. catus*, blue catfish, channel catfish *I. punctatus*, and flathead catfish, were the second most abundant food items consumed by flathead catfish. Centrarchids did occur, but were a relatively small component of the diet.

In Oklahoma reservoirs, Turner and Summerfelt (1970) found flathead catfish greater than 500 mm fed exclusively on gizzard shad *Dorosoma cepedianum* and freshwater drum *Aplodinotus grunniens*. Layher and Boles (1980) observed that stomachs of flathead catfish under 102 mm in length from the Big Blue River in Kansas contained mostly larvae of Ephemeroptera, Tricoptera, and Diptera. Crayfish and fish were most abundant in flatheads between 104 and 254 mm in length. In the Neosho River, Minckley and Deacon (1959) found that flathead catfish from 104 to 254 mm relied almost exclusively on Ephemeroptera nymphs for food. Quinn (1987) found stomach contents of flatheads less than 300 mm in length in the Flint River, Georgia, were dominated by invertebrates of which crayfish (Decapoda) were the dominant prey item. Crayfish were also the most numerous food item found in flathead catfish from 301 to 600 mm in length. Of the stomach contents identified, channel catfish, centrarchids, and flathead catfish, respectively, were most frequently found. Minckley and Deacon (1959), Turner and Summerfelt (1970), and Quinn (1987) suggested flathead catfish feed on whatever is most abundant.

Carroll and Hall (1964) reported in the early years of impoundment of Norris Reservoir that flathead catfish growth was slightly faster than comparable growth data for flatheads studied in the Salt River, Missouri (Purkett 1958). Growth rates for flathead catfish for years 1-5 were faster than any other time of the flathead's life (Jenkins 1954 and Carroll and Hall 1964). Mayhew (1969) reported faster growth to be in the first three years. Jenkins (1954) found that, in an Oklahoma lake, growth rates for flathead catfish were different depending upon habitat. The faster growth occurred in the areas of shallow mud

flats and relatively turbid water, as opposed to the deep coves with steep shore lines, rocky substrate, and clear water.

The literature researched indicates flathead catfish are piscivorous, and are aggressive predators. The collection of flatheads for this study occurred from 1 June through 31 October 1996. At this time, the reservoir was at full pool. October is the onset of the winter drawdown, which reduces the reservoir to winter pool. Collecting was conducted during full pool because it was the most successful period to capture flathead catfish. During the winter, flatheads are much more difficult to capture (M. Smollen, pers.commun.). The primary objectives of this project were: (1) to evaluate food habits of flathead catfish, and (2) to determine if flatheads are, in fact, impacting game fish populations.

CHAPTER 2

STUDY AREA

The construction of Norris Dam was completed in 1936, making Norris Reservoir the oldest in the Tennessee Valley Authority (TVA) system. It is a multipurpose reservoir, with primary uses for flood control, power generation, and recreation. Norris is a deep, clear, cool water reservoir. The reservoir is located approximately 40 km north of Knoxville, Tennessee (Figure 1). The reservoir has two major tributaries, the Clinch and Powell Rivers (Figure 2), and extends 116 km up the Clinch River and 90 km up the Powell River. At normal pool, it will maintain an elevation of 310.9 m and will have a surface area of 13,840 ha and a shoreline distance of 1,286 km. Total drainage of the area at the dam is 7,542 km² (Moss 1967). Throughout the year the water level of Norris Reservoir fluctuates, with an average yearly change of 9.2 m. The reservoir is reduced to winter pool by approximately January 1 and usually returns to maximum pool by the end of May, at which time it will maintain an elevation of 306 m (TVA 1991).

The areas to be sampled for this study were left to the discretion of the researcher. This was determined by contacting Tennessee Wildlife Resources Agency (TWRA) biologists, creel clerks, and anglers. TWRA biologist provided information about specific areas on the reservoir and type of structure where they had collected flatheads previously. Creel clerks and anglers also provided useful information about where flatheads were being caught and type of bait used to catch them. Names of sampling areas used in this study are consistent with those used on maps of Norris Reservoir (Figure 3).

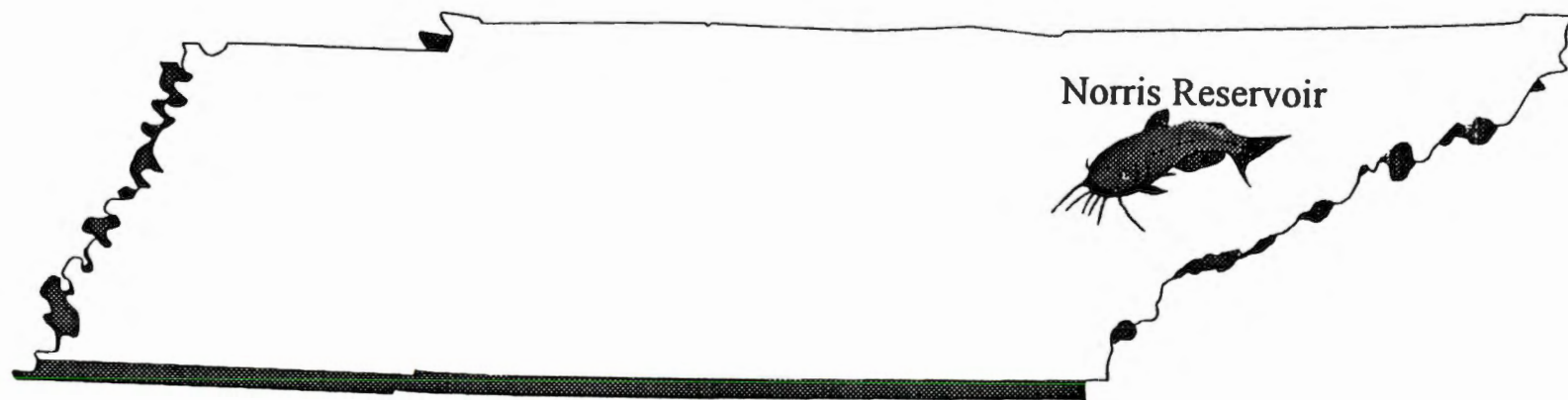


Figure 1. Map of Tennessee showing location of Norris Reservoir.

Norris Reservoir

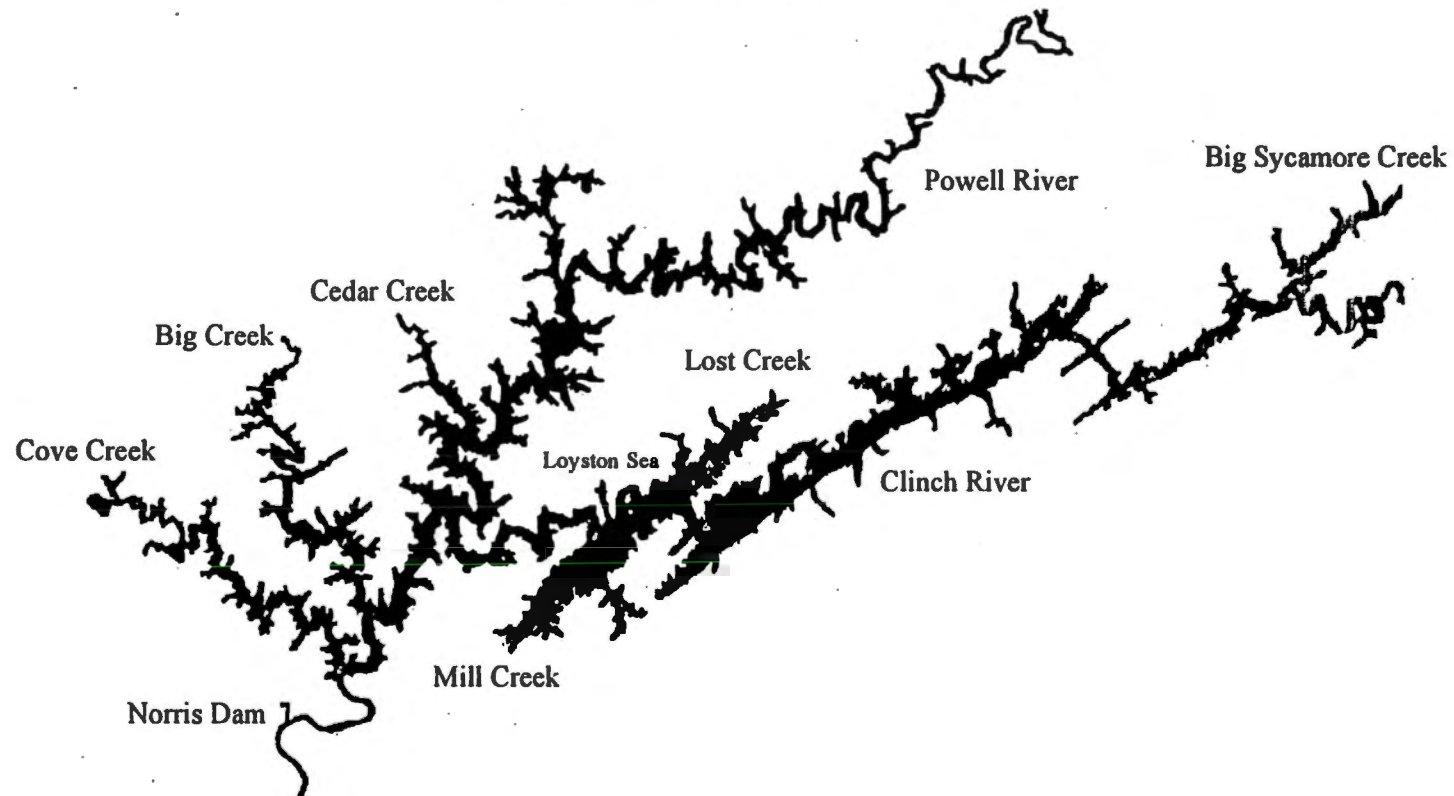


Figure 2. Map of Norris Reservoir showing major tributaries.

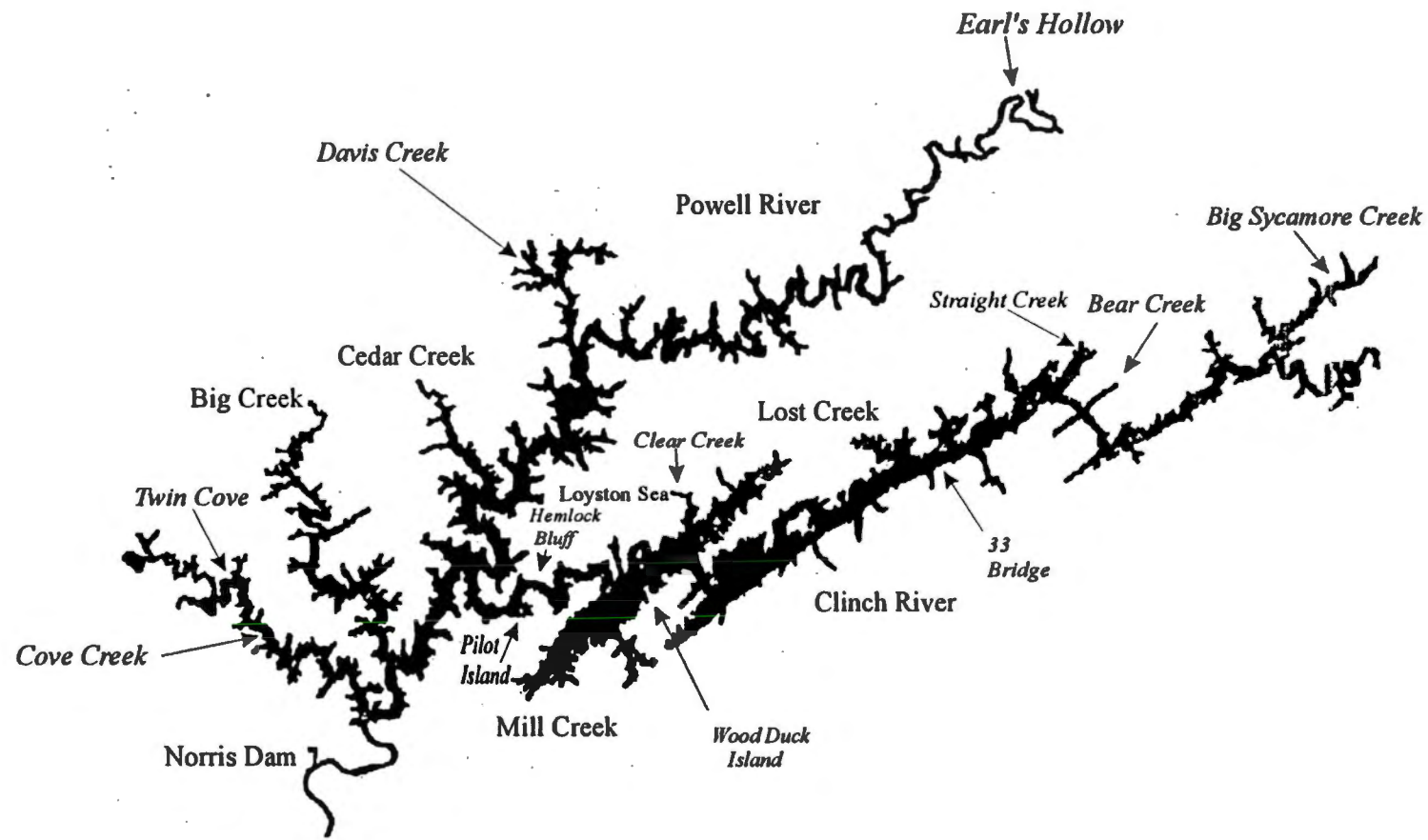


Figure 3. Map of Norris Reservoir showing sample sites in italics.

CHAPTER 3

METHODS

Flathead catfish were sampled for this project from 1 July through 31 October 1996. Twelve selected areas of Norris Reservoir and its major tributaries comprised the study sites: Hemlock Bluff, 33 Bridge, Loyston Sea, Bear Creek, Pilot Island, Wood duck Island, Clear Creek, Earl's Hollow, Davis Creek, Cove Creek, Twin Cove, and Big Sycamore Creek.

Gill Netting

Gill nets were used in the capture of flathead catfish throughout the sampling period. Due to the nocturnal feeding habits of flathead catfish (Trautman 1957), gill nets were set as near to sunset as possible and fished overnight. Four various size nets were used. Two nets were 29.4 m in length x 2.4 m in depth; one had 7.5- cm bar mesh and the other 8.0- cm bar mesh. Another net had measurements of 45.6 m in length x 2.2 m in depth, with a 7.5- cm bar mesh. The fourth net measured 22.1 m in length x 1.8 m in depth, with a bar mesh of 5 cm. The nets were made of monofilament, with exposed floats and a core lead line.

The gill nets were set 1 to 2 nights per week for a total of 22 nights for the period 1 June through 31 October 1996. Gill nets per night and location varied from 1 to 4 sets depending on available time, and experience of fellow students who assisted with the project. The nets were set perpendicular to the shore with one end tied to a permanent

structure on the shore, and the other end was held in place by a weight with a float to mark the offshore end. As the nets were checked, the fish were removed and total lengths (cm) and weights (kg) were recorded. After measuring and weighing the fish, the stomach contents were removed. After removal, contents were placed in a plastic zip-lock bag identified by the length and weight of the fish from which the contents were removed. All zip-lock bags containing stomach contents were placed in an ice filled container; following the sample period, all samples were returned to the lab for identification.

Electrofishing

Electrofishing was conducted from a 5.2- m Schaeffer aluminum flat bottom boat equipped with a Smith-Root Model 6 A shocker, powered by a 5,000 watt a.c. Honda generator. The boat was fitted with two booms that supported a total of five cables. During shocking, the amperes were maintained between 7.0 and 8.0.

The electrofishing was conducted in approximately 0.4 to 0.8 km sections. There was an average of 3 shocking runs per electrofishing area. Shocking runs were continuous with the shore and did not overlap. When each of the 1800-second (30 minute) shocking runs was completed, the next run was started where the previous run ended. The boat was positioned parallel with the shore approximately 1 - 3 m from the shore. The generator was started after the boom poles were extended and cables placed in the water. The boat was driven as slow as possible by putting the motor in the forward gear and then returning to neutral, repeatedly, paralleling the shore. Shocking was conducted at night; therefore, lights were mounted to the rails of the boat and powered by the generator.

Stunned flathead catfish were dipped from the water and placed in a holding tank with water. After each run was completed, total lengths (cm) and weights (kg) were recorded and the stomachs of the fish were removed, and handled as previously described.

Jug Fishing

Jug fishing consisted of taking 3.8 l bleach jugs, painted fluorescent orange, and labeled with the name and address of the user. There were two lines attached to each jug, one tied to where the lid screws on, and the other around the handle. The line attached to the handle was equipped with a clothespin at the opposite end. The other line was attached to the lid portion. It was 1-1.5 m in length and contained a two-point swivel tied to the opposite end. Above the swivel was a 57 g lead sinker. Attached to the other end of the swivel was a nylon line approximately 30 cm in length with a No. 9.0 hook tied to the end. The line with the clothespin was attached to vegetation overhanging the water or a river cane pole that was either placed directly into the bank, or into a rock crevice. This was done to hold the jug in place in the water.

The jugs were set during the last hour prior to sunset, and were fished overnight. They were recovered as soon as possible the following morning. Fish were removed from the jugs, total lengths (cm) and weights (kg) were recorded, and stomach contents were removed. After removal the stomach contents were placed in a plastic zip-lock bag identified by the length and weight of the fish from which the contents were removed. All zip-lock bags were placed in an ice-filled container and brought to the lab for identification.

Bluegill (*Lepomis macrochirus*) was the bait of choice. They were collected from Fort Loudon Reservoir at I.C. King Park boat ramp by electrofishing. Stunned bluegill were dipped from the water with a dip net, and were immediately placed in a holding tank and transported to Norris Reservoir. When fished the bluegill was hooked through the back immediately behind the dorsal fin just beneath the spine.

Stomach Content Analysis

Stomach contents were determined by removing the stomach of each fish and identifying the remains. This procedure was conducted by making a ventral incision from the pelvic fins to the anus. The abdominal cavity was exposed, and the stomach was then identified and removed. The stomach was cut longitudinally and all contents removed. Contents were then identified using identification keys by Page and Burr (1991) and Etnier and Starnes (1993) for fish, and Brigham and Gnillka (1982) for aquatic insects. Lengths of all fish found in stomachs were measured in mm and recorded. All other contents non-fish contents (crayfish and aquatic insect larvae) were also recorded as to numbers present.

CHAPTER 4

RESULTS AND DISCUSSION

During the course of this research project three collection methods were used (gill nets, electrofishing, jug fishing). These methods used were variously fished for a total of 3,435 hours over the period 1 June through 31 October 1996. The methods used for collection were not fished equally at all sampling areas.

In the collection process, two distinctly different habitat types were sampled throughout the sampling period. Habitat A was characterized by having approximately a 1:1 slope or 45° angle banking, with gravel to rubble substrate. The gravel to rubble particle size ranged from approximately 10 to 30 cm in diameter (Figure 4). Habitat B was characterized by having approximately a 60° angle banking and deep water in excess of 6 m with big boulders greater than 1 m in diameter (Figure 5).

Catch Per Unit Effort

Catch per unit effort (CPUE) is the number of fish collected divided by hours spent collecting. Catch per unit effort was not equally distributed among the collecting methods (Table 1). Electrofishing was conducted for 17 hours and produced 147 flatheads with a CPUE of 8.6 fish/hour. Jug fishing was conducted for 3047 hours and produced 18 flatheads with a CPUE of .01 fish/hour. There were 14 to 30 jugs set per jug fishing night. Gill netting which was conducted for 371 hours and produced 7 flatheads with a CPUE of .02 fish/hour. When comparing the three methods of



Figure 4. Habitat A showing angle of slope and 10-30 cm substrate.

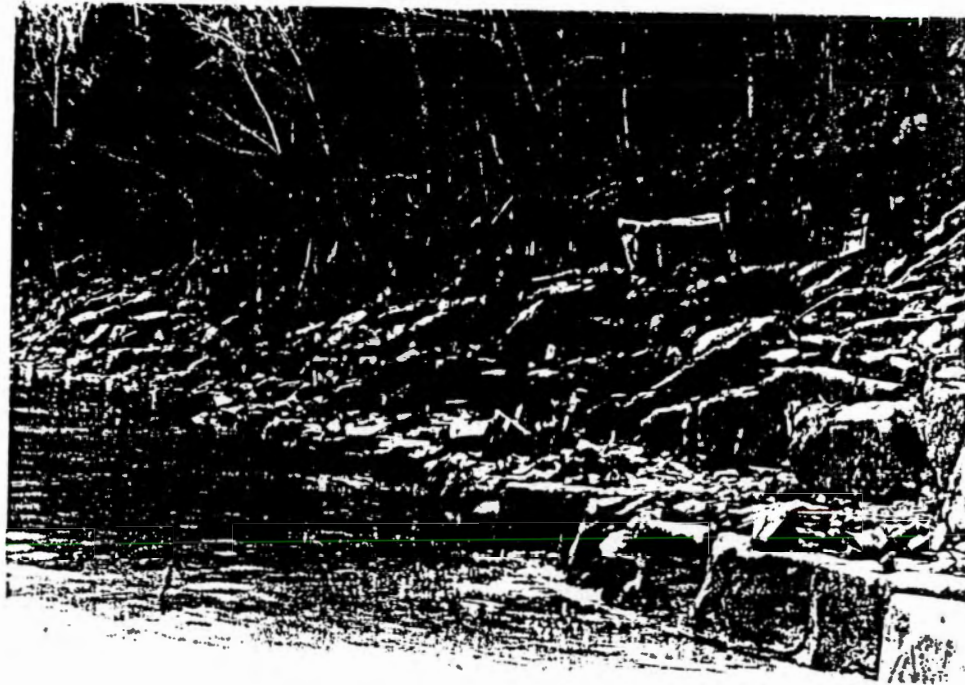


Figure 5. Habitat B showing drop off area and large boulder substrate.

Table 1. Catch per unit effort (CPUE) using three collecting methods in two different habitats on Norris Reservoir, Tennessee, 1 June through 31 October 1996.

	Methods			
	Electrofishing	Jug fishing	Gill netting	Total
Hours fished				
Habitat A	13	420	139	572
Habitat B	<u>4</u>	<u>2627</u>	<u>232</u>	<u>2863</u>
Total	17	3047	371	3435
Fish Caught				
Habitat A	137	2	2	141
Habitat B	<u>10</u>	<u>16</u>	<u>5</u>	<u>31</u>
Total	147	18	7	172
CPUE				
Habitat A	10.54	0.01	0.01	0.25
Habitat B	2.50	0.01	0.02	0.01
Overall	8.6	0.01	0.02	0.05

collection, it was obvious that electrofishing was the most successful method used. There was also a significant difference in the CPUE in the two different habitats (Table 1).

Habitat A was a more successful collecting area than was Habitat B (Table 2). This was due to Habitat A being a more suitable collecting area using the electrofishing method, because of the 45° slope and size of the substrate where the collecting was conducted. Jug fishing was next in the order of success by number of flatheads collected, but not by CPUE. Gill netting was the least successful method by number, but the CPUE was slightly better than jug fishing (Table 1).

As mentioned earlier, electrofishing was the most successful method of collecting flathead catfish during this research project. Of the total of 172 flatheads which were collected, 147 (85.41%) were collected using the electrofishing method (Table 3). Of the 147 flatheads collected by electrofishing, 65 (44.21%) were in the length group 30 to 40 cm. This figure represents the greatest number collected electrofishing. There were 49 (33.33%) flatheads in the length group less than 30 cm, and the remaining 33 (22.44%) were of lengths greater than 40 cm (Table 3).

Jug fishing accounted for 18 (10.46%) of the flatheads collected. Only 1 (0.55%) occurred in the 30 to 40 cm length group, and 17 (94.44%) flatheads were in the greater than 40 cm length group. This could be explained by the habitat selected for jug fishing. Jug fishing was utilized in Habitat B exclusively. This habitat type is preferred by larger flathead catfish as reported by Layher and Boles (1980). There were no flatheads collected less than 30 cm using this collecting method. Jug fishing for flatheads in Habitat type B areas tended to be size selective for flatheads 40 cm and larger in Norris

Table 2. Number of flatheads collected (N=172) using three collecting methods in two different habitats. The first number represents fish, and the second number equals number of fish with food in stomachs. The number in parenthesis indicates % of fish with food in stomachs.

METHOD	HABITAT A	HABITAT B
Electrofishing	137/89 (65)	10/5 (50)
Jug fishing	2/1 (50)	16/5 (31)
Gill netting	2/0 (0)	5/0 (0)

Table 3. Numbers and lengths of flathead catfish collected with three methods from Norris Reservoir, Tennessee, for the period 1 June through 31 October 1996. Percentages are presented in parenthesis.

Number of fish by method			
Size (cm)	Electrofishing	Jug fishing	Gill netting
< 30	49 (33.33)	0 (0)	0 (0)
30-40	65 (44.21)	1 (0.55)	1 (0.58)
> 40	33 (22.44)	17 (94.44)	6 (3.84)
Totals	147 (85.41)	18 (10.46)	7 (4.06)

Reservoir.

The remaining 7 (4.06%) flatheads were collected using gill nets. Again, only 1 (0.58%) flathead was collected in the 30 to 40 cm length group, and the other 6 (3.47%) were 40 cm or greater (Table 3). The size selectiveness of this method can be attributed to the large size of the bar mesh of the gill nets. It also could be due to the habitat selected for setting the gill nets. Habitat B was chosen more frequently than Habitat A for this collecting method, in expectation of collecting larger flatheads.

Food Habits

Stomachs of 172 flathead catfish were examined. Food items were found in 106 of the stomachs, and 66 stomachs were empty. Fish and crayfish were most frequently consumed food items by number and frequency occurrence in Norris Reservoir flathead catfish. Of the 106 stomachs containing food items, 56 (52.8%) stomachs contained fish and 54 (50.9%) contained crayfish (Table 4). Every stomach that contained food included either fish, crayfish, aquatic insect larvae, or a combination of these food items. In flatheads containing fish in the stomach, the only other food item observed in combination with fish was crayfish. This combination was observed nine times. In one other observation, there was a combination of crayfish and aquatic insect larvae.

Of the stomachs containing insect larvae, two stomachs contained mayfly larvae of the genus *Stenonema*. Three other stomachs contained mayfly larvae of the genus *Hexagenia*. One stomach contained a beetle larvae of the family Elmidae. Another stomach contained a stonefly larvae of the genus *Acroneuria*, and one other stomach

Table 4. Frequency of food items in stomachs of flathead catfish (N=106) from Norris Reservoir, Tennessee, for the period of 1 June through 31 October 1996. The 106 stomachs represent 61% of the total number of flatheads collected.

	Fish				Invertebrates				
	¹ Centrarchidae	² Clupeidae	³ Ictaluridae	All fish combined	⁴ Decapoda	⁵ Ephemeroptera	⁶ Coleoptera	⁷ Plecoptera	⁸ Odonata
Number of Items in Flathead Stomachs	39	13	4	56	54	6	1	1	1
Frequency (%)	36.7	12.3	3.8	52.8	50.9	5.7	0.95	0.95	0.95

¹Centrarchidae = bluegill, sunfish, largemouth and smallmouth bass

²Clupeidae = gizzard and threadfin shad

³Ictaluridae = flathead catfish only

⁴Decapoda = probably *Orconectes rusticus* (see page 25)

⁵Ephemeroptera = mayfly larvae, *Stenonema* and *Hexagenia*

⁶Coleoptera = beetle larvae, Elmidae

⁷Plecoptera = stonefly larvae, *Acroneuria*

⁸Odonata = dragonfly larvae, *Boyeria*

contained a dragonfly larvae of the genus *Boyeria*. Of the 106 stomachs containing food items only 9(8.5%) stomachs contained aquatic insect larvae. Fortunately, all stomach contents were easily identified. The identification process was made easier due to the lack of digestion. As a result, frequencies in Table 4 indicate stomachs containing a total of 54 crayfish (50.94%) were most common, followed by 45 centrarchids (42.50%), 13 clupeids (12.30%), and the remaining (12.30%) of the stomach contents were ictalurids and aquatic insect larvae.

Crayfish were not identified to species. However, they were most likely *Orconectes rusticus*; in two other studies from Norris Reservoir this was the only species of crayfish found in stomachs of juvenile black bass(Bennett 1995), and in young-of-year striped bass (Tarbert 1996).

Although crayfish were the most numerous food item found by number in flathead stomachs (54 crayfish, 50.9%), they did not occur in as many stomachs as did fish which were the most frequent item (56 fish, 52.83%) (Table 4). When the flatheads were sorted into 10-cm length increments, it was obvious that the 25 to 35 cm length group was responsible for the majority of crayfish consumed (Figure 6). The size of bluegill consumed ranged from 21 to 139 mm.

Of fish consumed by flatheads, centrarchids were the most frequently found item in the stomachs (45 bluegill, 42.50%). Bluegill were the most numerous of the centrarchids consumed (N=39). Bluegills were consumed by flatheads of a variety of sizes, ranging from 22 to 88 cm in length (Figure 7). Other centrarchids consumed were four largemouth bass and two smallmouth bass. These fish made up less than 5% of the

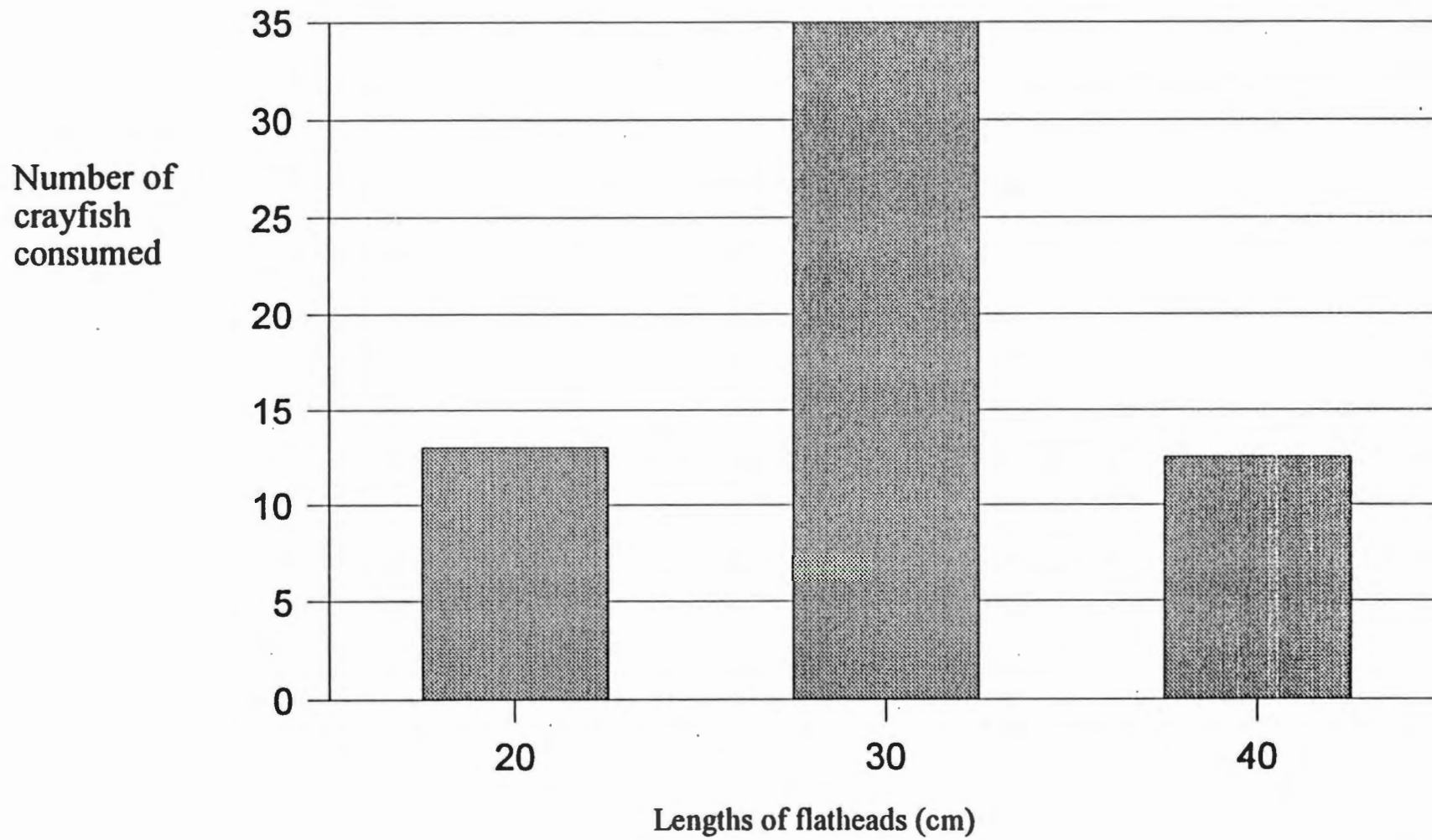


Figure 6. Crayfish consumed by flathead catfish in Norris Reservoir, Tennessee, 1 June through 31 October 1996.

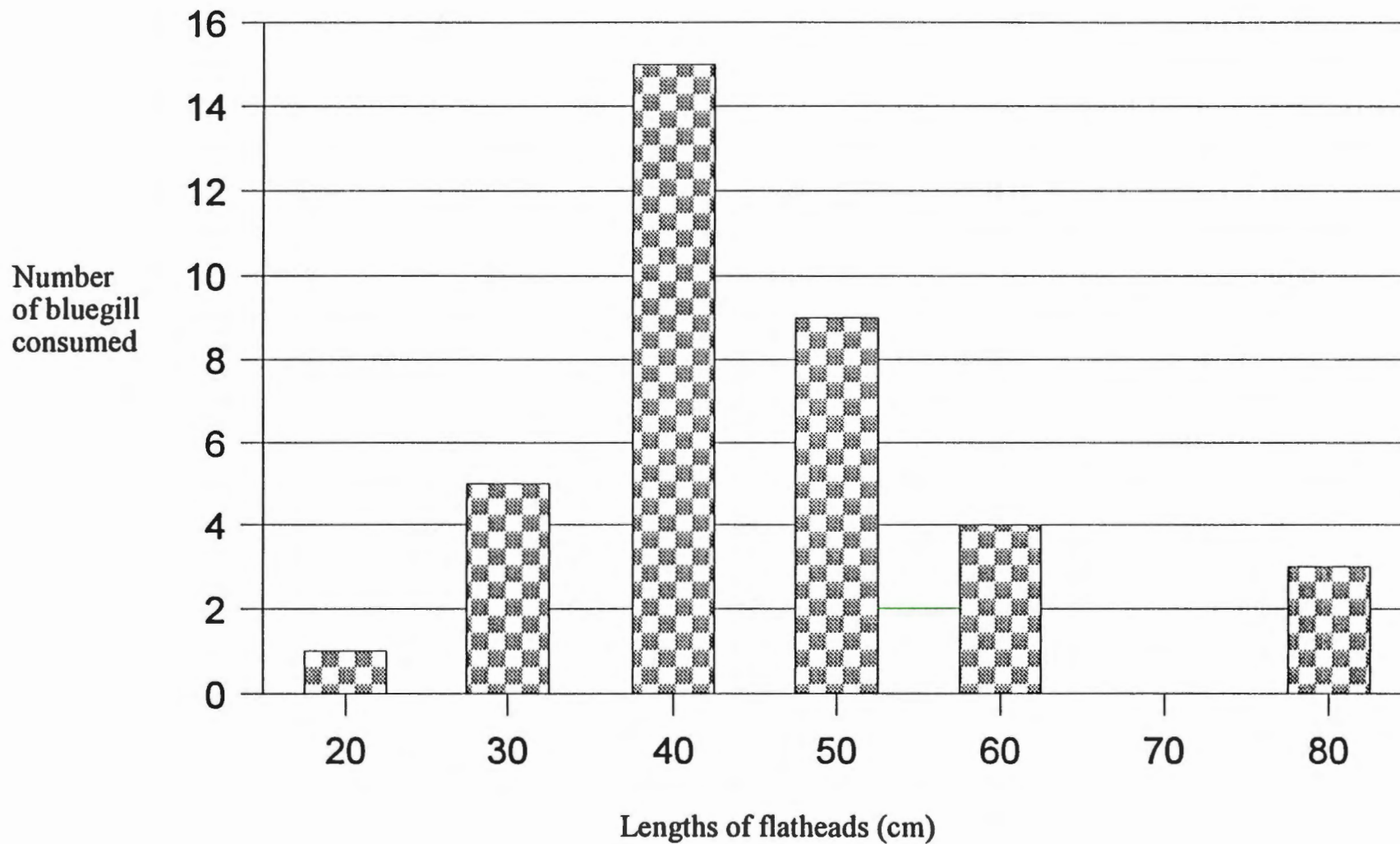


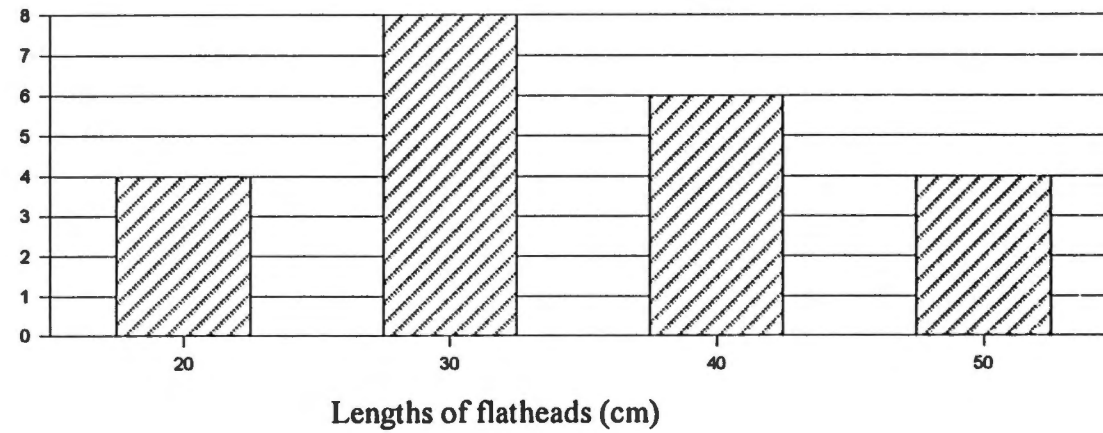
Figure 7. Bluegill consumed by flathead catfish in Norris Reservoir, Tennessee, 1 June through 31 October 1996.

centrarchids found in the flathead catfish diet in Norris Reservoir. Ictalurids were represented by only one species, the flathead catfish, and accounted for less than 4% of the diet. An occurrence worth noting was that a flathead 37 cm in length had consumed a smallmouth bass 16 cm in length.

Clupeids were the only other fish species consumed by flatheads in this study. Of the clupeids represented, gizzard and threadfin shad were the only species found in the stomachs of flatheads. Gizzard shad were consumed more frequently and over a broader length range than were the threadfin shad (Figure 8). A complete list of food items consumed is presented in Table 5.

The predominance of fish in the diet of flathead catfish is generally accepted (Turner and Summerfelt 1970, Edmundson 1974, Guier et al. 1981, Quinn 1987). The piscivorous nature of flatheads is apparent when they are only 51 mm in length (Swingle 1967). However, most small flatheads feed primarily on invertebrates. Flathead catfish 110 mm in length have been found to feed on Diptera (Turner 1966), and on Ephemeroptera and Tricoptera (Minckley and Deacon 1959). In Kansas, flatheads between 110 and 250 mm in length fed primarily on crayfish (Minckley and Deacon 1959). In Oklahoma lakes, stomachs of flatheads between 170 and 400 mm in length contained 83% crayfish by volume (Turner 1966). Crayfish were most abundant in flatheads between 104 and 254 mm in length in the Big Blue River, Kansas (Layher and Boles 1980). Quinn (1987) found stomach contents of flatheads less than 300 mm in length in the Flint River, Georgia, were dominated by crayfish. At a length of about 250 mm, there is a change in diet from predominantly invertebrates to predominantly fish (Brown and

Number of gizzard
shad consumed



Number of
threadfin shad
consumed

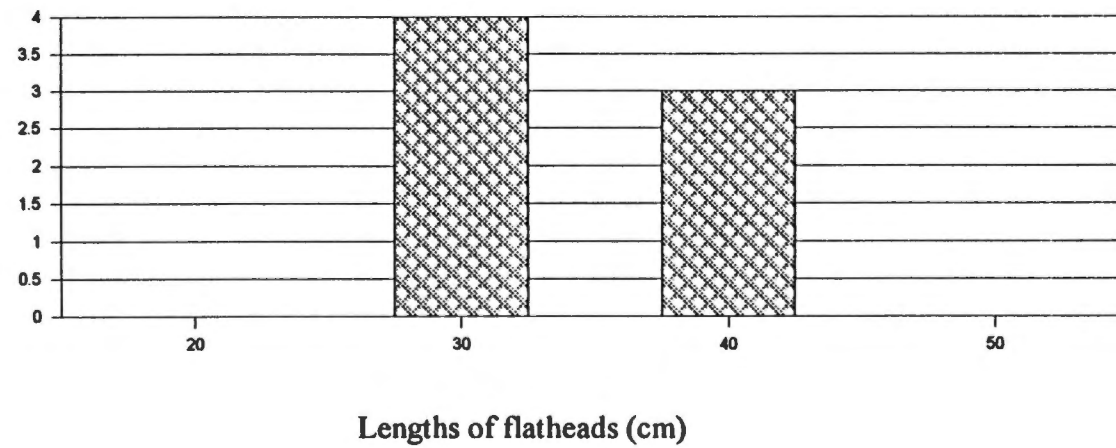


Figure 8. Shad consumed by flathead catfish in Norris Reservoir, Tennessee, 1 June through 31 October 1996.

Table 5. Species list of food items consumed by flathead catfish on Norris Reservoir, Tennessee 1 June through 31 October 1996.

Common Name	Genus/species
Bluegill	<i>Lepomis macrochirus</i>
Gizzard shad	<i>Dorosoma cepedianum</i>
Threadfin shad	<i>Dorosoma petenense</i>
Largemouth bass	<i>Micropterus salmoides</i>
Smallmouth bass	<i>Micropterus dolomieu</i>
Flathead catfish	<i>Pylodictis olivaris</i>
Crayfish	<i>Orconectes rusticus</i>
Mayfly (larvae)	<i>Stenonema terminatum</i>
Mayfly (larvae)	<i>Hexagenia</i> sp.
Stonefly (larvae)	<i>Acroneuria carolinensis</i>
Dragonfly (larvae)	<i>Boyeria vinosa</i>
Beetle (larvae)	Elmidae

Dendy 1961, Swingle 1967). In Milford Reservoir, Kansas crayfish were found in flathead stomachs 500 to 600 mm in length, but none were found in flatheads of larger sizes (Layher and Boles 1980). In Bluestone Reservoir, a change from crayfish to fish occurred at a length of about 500 mm (Edmundson 1974). In the present study in Norris Reservoir, the dietary change from invertebrates, predominantly crayfish, to fish occurred at a length of approximately 440 mm (Figure 9).

In Kansas Rivers, flatheads apparently fed on organisms most available to them at the time of feeding (Minckley and Deacon 1959). In Oklahoma, predation by flatheads in reservoirs was probably determined by the availability of forage species (Turner and Summerfelt 1970). In the Bluestone Reservoir, sunfish and crayfish appeared to be the main food item for flatheads (Edmundson 1974). The same feeding pattern was seen in Norris Reservoir, with bluegill and crayfish appearing to be the main food items consumed by flatheads (Table 5). With an abundance of crayfish in the reservoir, as observed in a black bass study by Bennett (1995), it is logical that flatheads would continue to feed on them until they reached a larger size. In the Big Blue River of Kansas, where crayfish were not as abundant as in the Neosho River (Minckley and Deacon 1959), flatheads restricted their feeding on crayfish in favor of fish as they became larger. With greater availability of crayfish, the dietary change was not as apparent as it was in the Neosho River flatheads.

In the Cape Fear River, North Carolina, clupeids were the dominant food item found (Ashely and Buff 1987). Ictalurids were the second most abundant forage item consumed, followed by centrarchids, which were a relatively small component of the diet

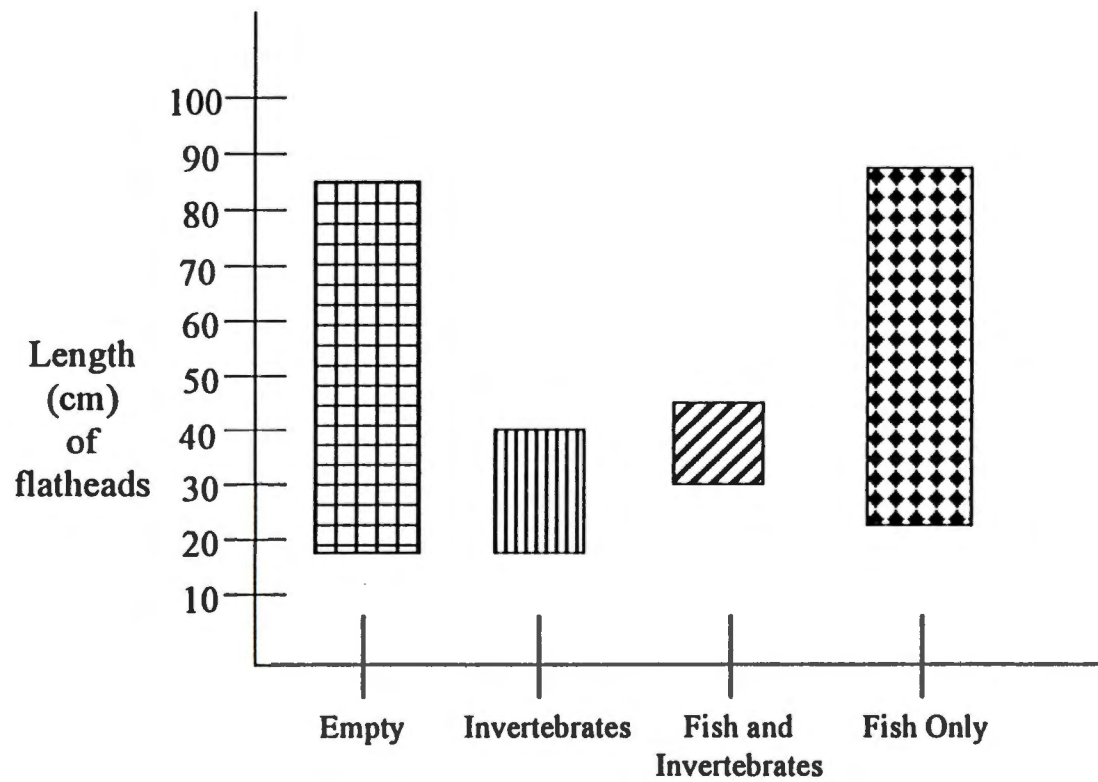


Fig. 9 Relationship of flathead lengths and stomach contents from Norris Reservoir, Tennessee, 1 June through 31 October, 1996.

(Ashely and Buff 1987). However, these findings could have been influenced by the sampling period as it corresponded with the shad run. In Oklahoma reservoirs, the main forage fish were gizzard shad, freshwater drum, and carp. Bluegills were possibly utilized more in Oklahoma than these results indicated because netting for flatheads was restricted in most lakes to deeper water (Turner 1966, Turner and Summerfelt 1970).

In Norris Reservoir the prevalence of bluegill as a food item may be related to a limited forage fish base. Food preference studies in plastic lined tanks indicated largemouth bass were preferred by flatheads followed by white catfish, green sunfish, and goldfish, respectively (Hackney 1965). This seems to indicate a preference for centrarchids over cyprinids, as was the case for Norris Reservoir flatheads. In earthen ponds, Hackney (1965) found that white catfish were preferred over largemouth bass. In contrast, centrarchids were found more often in stomachs than ictalurids in Norris Reservoir flatheads (Table 5). Other studies have indicated that flatheads may be useful in controlling bluegill populations (Hackney 1965, Swingle 1967). These results also indicated that centrarchids can be a primary food source of flathead catfish.

Flathead catfish are opportunistic predators, and once they reach the adult stage of their life, any fish that can fit in their mouth is a potential prey item. During the collection period it was observed that the smaller flatheads 35 cm and less were easily collected in areas with a moderately sloping bank of approximately a 45° angle with gravel to rubble substrate. It was also observed that at these collecting sites the stomachs of flatheads rarely contained anything but crayfish. When sampling in areas of brush piles retrieval of flatheads was very difficult. When shocking these areas, flatheads would

become lodged in the brush and were unable to be collected. While jug fishing these areas, flatheads would entangle themselves in the brush pile, this enabling them to free themselves from the hook. Other cover areas, such as rock outcroppings, rock shelves, and submerged logs, were not as difficult to collect flatheads due to lack of debris.

Collection sites and cover most likely had an impact on the CPUE due to difficulties in retrieval of the flatheads. If this project were to be undertaken again, one should examine the reservoir during the winter pool to select favorable collection sites. This would give one a better understanding of the structure and habitat that will be later covered with water during full pool sampling.

CHAPTER 5

SUMMARY

1. Norris Reservoir is a deep, cool, well oxygenated reservoir. A food habit study of flathead catfish was conducted on the reservoir from 1 June through 31 October 1996.
2. Fish accounted for 52% by frequency of occurrence of the stomach contents of flathead catfish collected while crayfish accounted for 50%.
3. Of the stomachs containing fish, centrarchids (39) were most common, followed by clupeids (13), and ictalurids (4).
4. In flathead catfish greater than 44 cm in length, fish were the only prey item found.
5. In flathead catfish 44 cm and less, invertebrates (crayfish and aquatic insect larvae) were the primary food items found.
6. Aquatic insects appeared as food items in flatheads smaller than 39 cm but in insignificant numbers.
7. It does not appear that flathead catfish are impacting the gamefish populations in Norris Reservoir by means of predation. However, there may be some overlap with some gamefish species (i.e., black bass) for food.
8. The 1:1 slope or 45° angle banks with gravel-rubble substrate were most productive sites for collecting flathead catfish using the electrofishing method. However, 65.5% of the flatheads collected using this method in this habitat type were 40 cm or less in length.

9. Jug fishing in the deep water areas with big boulders produced the larger flatheads. However, this habitat type did not produce significant numbers of flatheads when electrofished.
10. Gill netting also produced larger flatheads, but due to the large bar mesh of the nets, this method was size selective.

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