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CHANGES IN THE FOOD HABITS OF VARIOUS GAME FISHES AFTER STOCKING RAINBOW TROUT IN THE CORDELL HULL SECTION OF THE CUMBERLAND RIVER[1]

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ABSTRACT

A study of the food habits of seven species of warmwater game fishes in the Cordell Hull Section of the Cumberland River, prior to the impoundment of Cordell Hull Reservoir, revealed predation on rainbow trout by four of these species. Largemouth bass, spotted bass, smallmouth bass, and walleye consumed rainbow trout when large numbers of small trout were stocked in the Cumberland. Black crappie, white crappie and channel catfish were not found to consume trout. Stocked trout were most vulnerable to predation for a period of three to four weeks after stocking. Trout up to 210 mm TL (8.3 inches) were found in stomachs and as many as 12 trout were found in a single stomach.

INTRODUCTION

Discharges from Wolf Creek Dam on the Cumberland River, in Kentucky, and Dale Hollow Dam on the Obey River, in Tennessee maintained a coldwater habitat throughout the year in the Cordell Hull Section of the Cumberland River. Presence of migrant trout from tailwater stockings below each of these dams had indicated that trout could survive and grow in this area of the Cumberland River. The Tennessee Game and Fish Commission and the United States Bureau of Sport Fisheries and Wildlife (Dingell-Johnson Act, Project F-42-R) therefore established a program of stocking rainbow trout, *Salmo gairdneri,* in this part of the Cumberland to create a coldwater fishery upon impoundment of Cordell Hull Reservoir. Approximately 525,000 rainbow trout from 4 to 15 inches were stocked at various places throughout this section of the river.

We postulated that important changes in the food habits of warmwater game fishes would occur when large numbers of small rainbow trout were stocked in the Cumberland and that these changes would be indicated by a study of the food habits of several species of warmwater game fishes before and after stocking trout. Predation on trout by several species of warmwater game fishes has been reported (Keith and Barkley, 1970; Kirkland and Bowling, 1966; Libbey, 1969; McAffee, 1966). Similar predation by warmwater and coldwater fishes on stocked salmon has been reported (Warner, 1972; Warner, *et al.,* 1968). Several authors have discussed advantages and disadvantages of various sizes at which trout are stocked (Jenkins, 1970; Wilkins, Kirkland and Hulsey, 1967).

This study was conducted to: determine the food habits of warmwater game fishes present in the Cordell Hull Section of the Cumberland River prior to the stocking of large numbers of small trout; determine the species of warmwater game fishes which feed on rainbow trout in this study area; determine the maximum size of trout eaten by the warmwater game fishes; and determine the length of time, after stocking, during which rainbow trout were most vulnerable to predation by the predator species.

The warmwater fishes considered in this investigation were largemouth bass, *Micropterus salmoides;* spotted bass, *Micropterus punctulatus;* smallmouth bass, *Micropterus dolomieui;* and walleye, *Stizostedion vitreum vitreum.* Also studied were white crappie, *Pomoxis annularis;* black crappie, *Pomoxis nigromaculatus;* and channel catfish, *Ictalurus punctatus,* although none of the latter species were found to have consumed trout.

DESCRIPTION OF STUDY AREA

The 71 mile section of the Cumberland River impounded to form Cordell Hull Reservoir was the largest remaining free-flowing section of the river. The river bottom in the upper part of the study area was primarily limestone with gravel shoals, the bottom in the middle part was primarily gravel, and the bottom in the lower part was a mixture of gravel and silt. Limestone bluffs and floodplains dominated the shore along the river. There were approximately 36 small tributary streams flowing into the study area along with two major coldwater tributaries and one large warmwater tributary. In general, these had gravel bottoms and drained agricultural and forested land. The total drainage, including that controlled by upstream reservoirs, was 14,820 square miles (Moss, 1967). The minimum temperature in this section of the river for a period from April, 1972 through March, 1973 was 40 F during February, 1973 and the maximum temperature was 64 F during July, 1972.

MATERIALS AND METHODS

The majority of fishes used in this study were captured by electrofishing (Stubbs, 1965). On several occasions fish were taken using gill nets and trammel nets of various sizes and meshes.

Each fish was weighed and measured in the field. The stomach was removed from fish greater than 5 inches in total length and preserved in 10% formalin. Smaller fish were preserved intact. Stomachs were first deformalized (Korschgen, 1971) then opened by making a longitudinal incision from the esophagus to the pylorus. The contents were emptied into a petri dish and the stomach flushed with water to remove all food organisms. These were identified, sorted and counted. For each item, the volume was determined by water displacement. Organisms displacing less than 0.05 ml were recorded as trace. Frequency of occurrence was calculated for the entire sample, including empty stomachs.

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RESULTS AND DISCUSSION

Largemouth bass. Ingestion of rainbow trout by largemouth bass increased from 24.2% of the total volume before stocking trout in the Cumberland River to 45.0% of the total volume after stocking trout (Table 1). Rainbow trout also increased from 3.4% of the total number of articles found before stocking to 9.8% of the total number found in largemouth stomachs after stocking trout. Changes in the intake of other organisms may also have been influenced by the presence of newly stocked trout.

TABLE 1:

Percent of total volume and number of items present in the stomachs of largemouth bass before and after the stocking of rainbow trout in the Cordell Hull Section of the Cumberland River, 1972-73. The number of stomachs examined is indicated in parenthesis

Stomach Contents	Before (29) % Vol	% No	After (59) % Vol	% No
Salmo gairdneri	24.2	3.4	45.0	9.8
Pomoxis spp.	—	—	5.5	1.4
Lepomis sp.	—	—	16.8	0.7
Centrarchidae	—	—	2.1	0.7
Etheostoma spp.	1.2	3.4	—	—
Dorosoma cepedianum	63.3	3.4	2.5	0.7
Dorosoma petenense	—	—	6.0	18.2
Notropis sp.	—	—	1.1	0.7
Unidentified Fish	1.8	20.3	12.6	16.8
Orconectes spp.	7.3	6.7	1.3	0.7
Cambarus spp.	1.8	3.4	—	—
Cladocera	—	—	—	7.0
Coleoptera	—	1.7	—	1.4
Diptera	—	3.4	—	—
Ephemeroptera	—	8.5	—	1.4
Hemiptera	—	—	—	13.4
Hymenoptera	—	—	—	1.4
Orthoptera	—	—	—	2.7
Plecoptera	0.2	15.3	—	1.4
Trichoptera	—	—	—	2.7
Unidentified Insect	0.1	3.4	—	14.7
Annelida	—	1.7	—	—
Nematoda	—	—	—	0.7
Trematoda	0.1	16.9	—	0.7
Anura	—	—	7.1	1.4
Plant Material	—	8.5	—	1.4

McAffee (1966) stated that black bass undoubtedly eat rainbow trout in some bodies of water including some waters heavily stocked with small trout. Trout were important in the diet of largemouth bass throughout this entire study, although their importance increased immediately after stocking large numbers of small trout and continued to be important for a period of three to four weeks after the Cumberland was stocked with trout.

Introducing selected fish species in newly constructed and filled lakes and reservoirs is one of the limited uses of stocking that has proven to be of value in fisheries management (Bennett, 1971). Stocking trout fingerlings less than 100 mm has been successful in new reservoirs when the resident fish population has been eliminated (Jenkins, 1970). Once warmwater fishes are firmly established, however, fingerling trout are usually unable to compete (Jenkins, 1970). Fingerling trout do survive well in cold water lakes that warmwater fishes have invaded (Wilkins, Kirkland and Hulsey, 1967). Plants of trout from 9 to 12 inches in length appear to yield optimum survival. Keith and Barkley (1970) found that when trout averaging 9 inches were stocked, 48.6% of the bass 16 inches and over and 90.0% of the bass 18 inches and over consumed trout. They reported that two or more trout were common in the stomachs of largemouth with a maximum number of five trout in a single stomach.

In the present study, 15 largemouth stomachs each contained one trout and one bass contained two trout. Many of these fish also had remains of other fish thought to be trout but not positively identified. One 14 inch largemouth bass consumed an 8 inch trout.

Since largemouth bass became relatively inactive below 55 F, Kirkland and Bowling (1966) stocked trout when the water surface temperature was below 55 F. The water temperatures of the Cumberland River remained below 55 F much of the year due to discharges from Dale Hollow Dam and Wolf Creek Dam. In certain sections of the Cumberland River below Wolf Creek Dam, a put-and-take trout fishery has been maintained for a number of years although Pfitzer (1967) questions whether this operation will ever equal the warmwater fishery present before these reservoirs were created. Eschmeyer and Scott (1943) noted large numbers of warmwater fishes below Norris Dam, also a coldwater discharge. Presence of eggs from the previous season, however, indicated that many of these had

TABLE 2:

Percent of total volume and number of items present in the stomachs of spotted bass before and after the stocking of rainbow trout in the Cordell Hull Section of the Cumberland River, 1972-73. The number of stomachs examined is indicated in parenthesis

Stomach Contents	Before (99) % Vol	% No	After (10) % Vol	% Vol
Salmo gairdneri	5.7	0.8	49.1	5.6
Lepomis macrochirus	11.7	1.7	—	—
Etheostoma spp.	2.6	1.7	—	—
Dorosoma cepedianum	2.1	0.8	—	—
Pimephales spp.	2.8	2.5	—	—
Notropis spp.	2.3	6.6	—	—
Campostoma anomalum	2.7	0.8	—	—
Unidentified Fish	17.9	27.3	4.4	5.6
Orconectes spp.	27.4	7.4	38.6	11.1
Cambarus spp.	17.4	1.7	—	—
Crayfish Remains	0.9	0.8	—	—
Copepoda	—	0.8	—	—
Diptera	—	3.3	—	—
Ephemeroptera	—	4.1	—	—
Hemiptera	0.3	11.6	—	16.6
Hymenoptera	—	2.5	—	—
Orthoptera	2.5	0.8	—	—
Unidentified Insect	—	12.4	—	—
Arachnida	0.5	0.8	—	—
Annelida	—	0.8	7.9	58.3
Nematoda	—	1.7	—	—
Trematoda	—	5.8	—	—
Hirudinea	—	0.8	—	—
Anura	3.2	0.8	—	—
Plant Material	—	1.7	—	2.8

failed to spawn, apparently due to low water temperatures. This could also happen in the Cumberland River.

Spotted bass. Volume of rainbow trout in spotted bass stomach samples increased from 5.7% to 49.1% of the total volume found in spotted bass stomachs after stocking trout in the Cordell Hull Section of the Cumberland River (Table 2). Rainbow trout also increased from 0.8% of the total number of articles found before stocking to 5.6% of the total number of articles found after stocking. Other changes in the intake of food organisms may have been influenced by the presence of newly stocked trout although the increased consumption of annelids could be attributed to the rising water level.

One rainbow trout was found in the stomach of each of three spotted bass. The majorty of spotted bass collected, however, were separated from areas in which trout were stocked by a barricade placed across Roaring River during the construction of a highway bridge. This barricade has since been removed, enabling fish to migrate freely into and out of this area. Since the food habits of spotted bass are similar to those of largemouth bass, more trout may have been eaten by spotted bass if there had been more of these bass in the areas where trout were stocked.

Smallmouth bass. Ingestion of rainbow trout by smallmouth bass increased from 0.0% to 34.0% of the total volume after stocking trout (Table 3). Rainbow trout also increased from 0.0% found before stocking to 7.1% of the total number of articles found in smallmouth stomachs after stocking trout. Although other changes in the intake of food organisms may have been influenced by the presence of newly stocked trout, it sems unlikely since trout and smallmouth were usually not found in the same samples. Most of the smallmouth captured during this investigation were in areas where there were no stocked trout. There was no apparent reason for this separation of smallmouth and trout. Perhaps smallmouth and trout inhabit separate areas of the Cumberland River and its tributary streams throughout most of the year and only come into contact for short periods of time. Unlike the other basses and the walleye, smallmouth bass were not congregated in areas in which trout were stocked.

TABLE 3:

Percent of total volume and number of items present in the stomachs of smallmouth bass before and after the stocking of rainbow trout in the Cordell Hull Section of the Cumberland River, 1972-73. The number of stomachs examined is indicated in parenthesis

Stomach Contents	Before (36) % Vol	% No	After (6) % Vol	% No
Salmo gairdneri	—	—	34.0	7.1
Centrarchidae	—	1.1	—	—
Etheostoma flabellare	1.1	1.1	—	—
Etheostoma caeruleum	6.4	1.1	—	—
Etheostoma spp.	12.4	4.7	17.0	14.4
Pimephales notatus	1.7	1.1	—	—
Notropis spp.	0.1	1.1	11.9	7.1
Unidentified Fish	29.4	18.5	30.3	43.0
Orconectes spp.	13.7	3.4	6.8	7.1
Cambarus spp.	32.0	4.7	—	—
Cladocera	—	—	—	7.1
Copepoda	—	1.1	—	—
Rotifera	—	1.1	—	—
Coleoptera	—	2.3	—	—
Diptera	0.2	31.1	—	—
Hemiptera	—	2.3	—	—
Plecoptera	0.9	16.1	—	—
Unidentified Insect	—	7.0	—	7.1
Annelida	—	1.1	—	—
Plant Material	—	—	—	7.1
Gravel	2.1	1.1	—	—

Walleye. Ingestion of rainbow trout by walleye increased from 0.0% to 80.3% of the total volume after stocking trout (Table 4). Rainbow trout also increased from 0.0% of the total number of articles found in walleye stomachs before stocking trout to 71.4% of the total number of articles found in stomachs of walleye after stocking. Other changes in the intake of food organisms may have been influenced by the presence of newly stocked trout.

TABLE 4:

Percent of total volume and number of items present in the stomachs of walleye before and after the stocking of rainbow trout in the Cordell Hull Section of the Cumberland River, 1972-73. The number of stomachs examined is indicated in parenthesis

Stomach Contents	Before(5) % Vol	% No	After (11) % Vol	% No
Salmo gairdneri	—	—	80.3	71.4
Etheostoma sp.	97.8	20.0	—	—
Dorosoma cepedianum	—	—	16.9	14.3
Unidentified Fish	2.2	40.0	2.8	10.7
Coleoptera	—	20.0	—	—
Plant Material	—	20.0	—	3.6

A possible method for reduction of predation on trout. Rainbow trout were often used as food by several species of warmwater game fishes when these species simultaneously inhabited an area. During winter months (December, January and February) warmwater game fishes could not be found in many of the small tributary streams of the study area. On several occasions attempts were made to collect predator species concerned in this investigation; none were taken. Minnows, darters and small trout, however, were taken in these small streams by electrofishing. This suggests that trout predation could be reduced by stocking in these small streams, upstream from their confluence with the reservoir, during the winter months. Near the end of this investigation, coho salmon were stocked in some of these streams during the winter months. Although several warmwater game fishes were subsequently collected from the mouth of these streams, none were found to have eaten coho salmon.

SUMMARY

The most important foods eaten by each of the five species in this investigation, by volume, were fishes. Fish were also the most important foods taken, by frequency of occurrence, by largemouth bass, spotted bass and walleye. Insects were the most important foods taken by frequency of occurrence, by smallmouth bass. The congregation of largemouth bass, spotted bass and walleye in areas in which trout were found seemed to indicate a preference for trout in the diet of these species. Unlike the other trout predators, smallmouth bass did not congregate in areas where small trout were present. Trout were important in the diet of largemouth bass, spotted bass, and smallmouth bass for a short period after large numbers of small trout were released in an area. The walleye was the only species of fish which continued to feed on trout after the three to four week period immediately following the release of trout. Since the warmwater game fishes did not inhabit the small tributary streams during the winter months, it may be possible to minimize predation on newly stocked trout by stocking trout in these streams at this time of the year.

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