LIFE HISTORY STUDY OF THE RIVER REDHORSE, *MOXOSTOMA CARINATUM* (COPE), IN THE CAHABA RIVER, ALABAMA, WITH NOTES ON THE MANAGEMENT OF THE SPECIES AS A SPORT FISH

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ABSTRACT

Severe reduction in number of river redhorse, *Moxostoma carinatum* (Cope), has occurred in Alabama and the southeast during recent years. The Cahaba River is one of the last strongholds for this species in Alabama. Electrical shocking equipment was utilized during this study. Two hundred eighty-six adult river redhorse were captured, tagged, and returned to the Cahaba River.

Redhorse were observed spawning on gravel shoals during April, 1966 and April, 1967 with water temperatures ranging from 71°F. to 76° F. Egg counts made on river redhorse ranging in size from 17.9 inches to 22.1 inches total length revealed a range from 6,078 to 23,085 eggs per individual, respectively. Pond-reared river redhorse exhibited slower growth than those in natural habitats. River redhorse fed heavily on the Asiatic clam, *Corbicula spp.* Present utilization of the river redhorse as a sport fish is light.

INTRODUCTION

From a review of the literature it is apparent that relatively little is known about the river redhorse, *Moxostoma carinatum* (Cope). Most of the work conducted with this species is concerned with its identification and occurrence.

Severe reduction in number or extirpation of the river redhorse from areas of former abundance has been noted by several authors (Harlan and Speaker, 1951; Hubbs and Lagler, 1957; Trautman, 1957). This trend is also occurring in Alabama. The species has constituted as high as 24.3 percent of the total weight of fish collected in rotenone samples of Alabama streams.[1] They have not been recorded in similar studies of these same areas following impoundment and inundation of the river habitat.[2,3] Although reliable records of earlier abundance are generally lacking for many areas of Alabama, it is apparent that the river redhorse has suffered severe reduction in number and possible extirpation over much of its former range within the state. One exception is the Cahaba River where the species is still found in abundance.

The river redhorse has fine potential as a sport fish because of its relatively large size, palatability, and stamina. It was felt that there was need for more knowledge of this disappearing redhorse before initiating any greatly increased exploitation. The Cahaba River offered an excellent opportunity for study of this fish.

DESCRIPTION OF STUDY AREA

The study area for this project was the Cahaba River in the central portion of Alabama. The headwaters of the Cahaba River are located in the northeastern portion of Jefferson County near Birmingham, Alabama. The river flows in a southwesterly direction and joins the Alabama River near Selma, Alabama (Figure 1). The Cahaba River Basin com-

[1] Alabama Department of Conservation, Report for Fiscal Year October 1, 1957-September 30, 1958. p. 134.
[2] Ibid. October 1, 1962-September 30, 1963. pp. 110-111.
[3] Ibid. October 1, 1963-September 30, 1964. pp. 119-120.

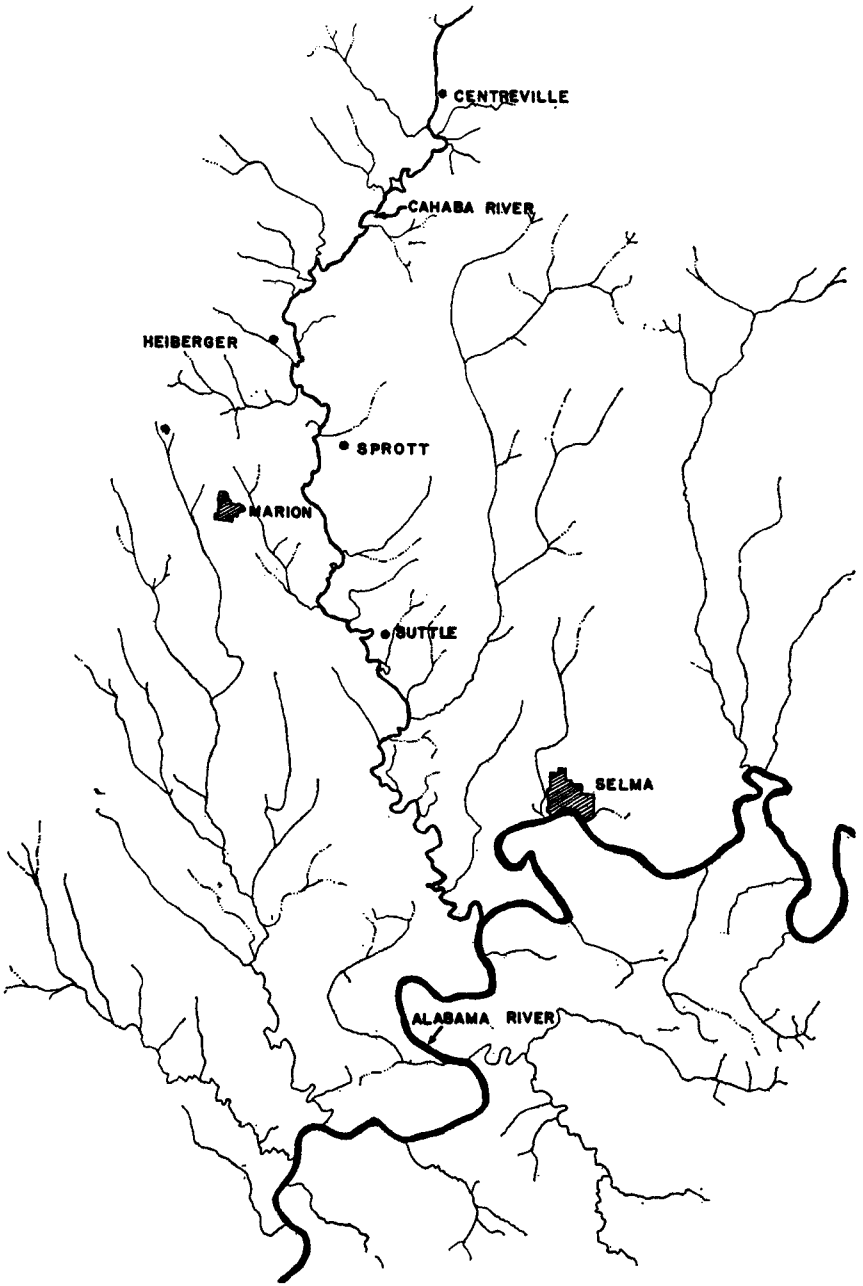

Figure 1 — Map of the Cahaba River study area.

prises approximately 1,870 square miles. The 27-year average flow at Sprott, Alabama is 2,053 cubic feet per second with a maxmium recorded flow of 95,000 cubic feet per second. A minimum flow of 188 cubic feet per second was recorded on October 25 and 26, 1954.

The river exhibits considerable gradient with long pools broken by rapids or shoals. The shoals above Suttle, Alabama are composed of rocks and gravel. Below Suttle, shoals are less numerous and consist mainly of gravel and sand. Submersed aquatic vegetation is absent and marginal aquatics are scarce.

Except for 1,000-acre water supply reservoir located in the extreme headwaters and a very small amount of pollution, the river has been relatively unaffected by man's activity.

METHODS

Collecting River Redhorse

River redhorse were captured with a boat mounted electric shocker. Electric current was provided by a 110-220 volt Sears, Roebuck and Company alternator with a rated capacity of 2,650 watts. Output was controlled with a Model II-C, Variable Voltage Pulsator manufactured by Coffelt Electronics Company, Denver, Colorado.

The electric shocking equipment was mounted on a flat-bottom 16-foot Monarc boat. Two weighted flexible electrodes were mounted 14 feet in front of the boat and approximately 10 feet apart.

A voltage range from 150 to 300 volts A.C. at 3 to 4 amperes was effective for capturing this species. Fish were picked up with large hoop dip nets fitted with 8-foot aluminum reinforced fiberglass handles. Immediately upon capture, fish were placed into the boat live well and aeration was provided by a compressed oxygen cylinder and regulator. After the live well capacity was reached, the fish were weighed to the nearest 0.01 pound, measured to the nearest 0.1 inch, sexed, tagged and scale samples collected. The fish were then returned to the river and the location of release recorded. Sex was determined by the presence of spawning tubercles on the males during the spawning season. On mature fish, the males could be distinguished during all seasons by the presence of tubercle scars left from previous spawning periods. Fish which died during capture were dissected to determine condition of gonads and food habits.

Tagging Fish

River redhorse were tagged with a number FT-6A Floy fish tag (Figure 2). This tag consisted of a double barbed nylon dart on a 1-inch

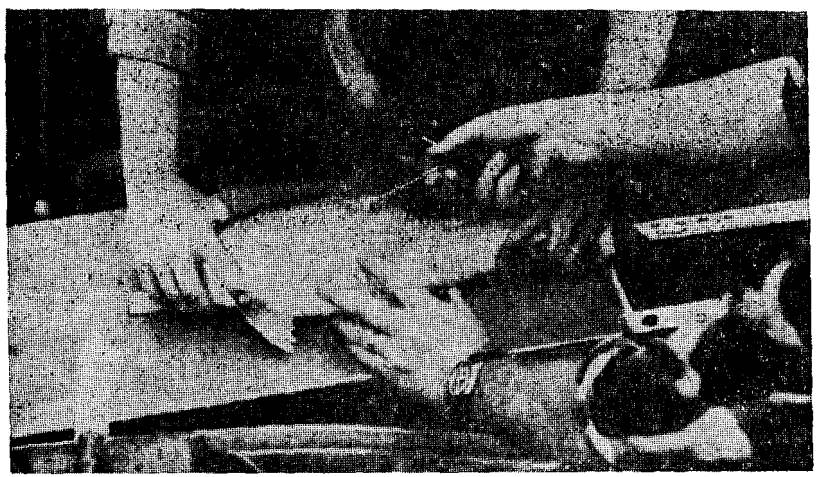

Figure 2 — Tagging river redhorse.

nylon shaft and a 3½-inch vinyl tube. The tag number and return address were printed on the vinyl tube. The tags were inserted beside the mid-portion of the dorsal fin in the second or third scale row down from the fin. Two scales were removed and the tag was inserted past the barb point into the posterior scale pocket by using the stainless steel applicator. The applicator was then removed and the tag forced deeper with the forefinger and thumb.

RESULTS AND DISCUSSION

Spawning Notes

During the spring of 1966 river redhorse reportedly began shoaling on April 17. Spawning activities were confirmed by the authors on April 21, at which time the water temperature was 71°F. Heavy rains set in on April 22, and because of high, muddy water, no spawning observations were made. The water remained high and muddy until May 7 at which time the redhorse were off the shoals. Because of the high water during this period, many of the shoals on which redhorse had been observed earlier had been completely washed away. Unsuccessful attempts were made throughout the spring and summer of 1966 to capture young-of-the-year river redhorse by seining and with electricity. It is hypothesized by the authors that severe decimation of the incubating eggs occurred during the spring of 1966 as a result of the flooding river conditions. Similar decimation has been reported under flooding conditions to the eggs of other redd utilizing fish species (Allen, 1951; Hatch, 1957).

During the spring of 1967, river redhorse were first observed shoaling on April 10. The fish remained on the shoals until April 17. The water temperature during this period ranged from 72°F. on April 10 to 76°F. on April 17. Because of an unseasonal drought, the Cahaba River remained low and clear throughout the entire redhorse spawning period. The low, clear water facilitated observations of the entire spawning process. A seven-foot step ladder was set in the middle of the shoals giving the observer a good vantage point. During the height of spawning activities redhorse were observed spawning only inches from the ladder.

River redhorse in the Cahaba River spawn on gravel shoals. The males precede the females onto the shoals. They were found to have free running milt 10 days prior to the females reaching spawning readiness. The redds were excavated by using the caudal fin in a sweeping motion, the mouth in a sucking motion, and the head in a pushing motion. Redds were observed in water from 6 inches to 3.5 feet deep. The size of the redds varied from 4 to 8 feet across and were excavated to a depth of 8 to 12 inches into the gravel. Frequently there were overlaps from one redd to another. A minimum of eight redds were found on all spawning sites. After the redds were constructed the male took a position on the redd facing upstream. This practically motionless position was maintained until a female neared the redd. At this point the male darted back and forth across the redd in somewhat of a nuptial dance. In all spawning instances observed a second male came onto the redd, and in perfect harmonic motions, joined the first male in the nuptial dance. After the two males remained for a few seconds in this rhythmic movement the female took a position between the two males. Reignard (1920) reported similar spawning position in his study of the golden redhorse, *Moxostoma erythrurum*. The two males then pressed tightly against the female and all three began a series of tetanic vibrations. During these vibrations the eggs were released, fertilized and buried in the gavel. On several occasions one of the males left the formation after the tetanic vibrations had started, subsequently leaving one male and one female in the spawning act. In no instances did a female come onto a redd to spawn when only one male was present.

Egg Development and Fecundity

Egg development in the river redhorse was not evident on September 31, 1966. Early egg development was observed on January 7, 1967. Since no sampling was conducted during the intervening period it was surmised that egg development began during the latter part of this period. During January, 1967, volumetric determinations indicated 220 eggs

per milliliter. On March 20, 1967, the eggs had advanced to 121 eggs per milliliter and on March 31 were further advanced to 54 eggs per milliliter. Since spawning occurred 10 days following the last determination, it is assumed that further development occurred.

Egg counts made on river redhorse ranging in size from 17.9 inches to 22.1 inches total length indicated a range from 6,078 to 23,085 eggs per individual, respectively. Determinations were accomplished by volumetrics with the actual counts coming from 10% aliquots. The average size of the fish on which the egg counts were made was 20.6 inches total length and the average number of eggs from the sampled fish was 14,626.

Juvenile River Redhorse

Despite intensive sampling efforts by seining, electro-fishing and trawling, no juvenile river redhorse were collected in the Cahaba River during the two-year study period. However, the collection of juvenile river redhorse has seldom been recorded anywhere. Although young river redhorse were collected as sac fry from redds, the next smallest specimen taken was a 12.3-inch fish weighing 0.68 pounds. Large numbers of juvenile black redhorse, *M. duquesnei,* and blacktail redhorse, *M. poecilurum,* were taken during attempts to collect juvenile river redhorse. Juvenile golden redhorse were also collected.

Eggs of the river redhorse were relatively large, ranging from 3 to 4 mm in diameter. Consequently, newly hatched sac fry were relatively large and were characterized by a three-lobed yolk sac extending nearly the length of the thread-like body. Within a week after hatching the sac fry averaged in excess of 13 mm in length with the remaining yolk having lost its three-lobed appearance.

On April 11, 1967, eggs were stripped and fertilized from ripe river redhorse collected in the Cahaba River. It was noted that eggs and milt were free flowing (Figure 3) only in fish which had lost the mucus covering. This greatly facilitated the selection and handling of ripe fish. The eggs were incubated in hatching jars at a water temperature of 72°F. Somites developed approximately 48 hours following fertilization. Movement was first observed approximately 72 hours after fertilization. Hatching began on April 14 and was completed on April 15. Active and continuous swimming was observed on April 21 and the fry were stocked into ponds previously cleared of fish.

Figure 3 — Taking eggs and milt from river redhorse.

Growth of these fry was rapid, but not as rapid as that experienced in natural waters by two juvenile specimens collected in Alabama (Table 1).

TABLE 1—JUVENILE RIVER REDHORSE COLLECTED IN ALABAMA. TOTAL LENGTHS EXPRESSED TO NEAREST MILLIMETER.

Location	Date	Mean Total length	Number	Range	Reference
Pond reared	4/21/67	13	8	12-15	Authors' collection
Pond reared	5/15/67	25	14	22-26	Authors' collection
Pond reared	5/30/67	38	6	36-39	Authors' collection
Pond reared	7/26/67	94	14	90-97	Authors' collection
Pond reared	8/ 9/67	104	26	97-112	Authors' collection
North River, Ala.	7/21/66	107	1	....	Authors' collection
Cahaba River, Ala.	7/15/54	161	1	....	Auburn Univ. 790

Rapid growth coupled with possible occupation of habitat not normally sampled may possibly account for the apparent scarcity of juvenile river redhorse. Observation of specimens reared in 15-gallon aquaria revealed that young river redhorse were extremely wary and skittish, even with daily feeding. This perhaps in part also explains the difficulty in capturing juveniles.

Dissection of pond-reared specimens revealed that the diagnostic character of reduced number of thickened pharyngeal teeth is valid for specimens as small as 22 mm total length. However, thickening of the teeth is more obvious in specimens of 36 mm total length and larger.

Food Preference

Stomach analyses during March, 1967 indicated that the river redhorse fed largely on bivalve mollusk. The primary bivalve mollusk consumed was the Asiatic clam, *Corbicula spp.* Small particles of shell from the Asiatic clam were predominant in all river redhorse on which stomach analyses were conducted. Other food items that were present, but in insignificant quantities, included larval Ephemeroptera, Chironominae, and Tichoptera. It is felt that the strong molar-like pharyngeal teeth found in the river redhorse facilitates the utilization of bivalve mollusk as a food item.

Movement

Seasonal sampling revealed a resident population of river redhorse in the Cahaba River. As evidenced by Figure 4, there occurred a buildup of large river redhorse during March; however, the source of this buildup is uncertain. Possibly a number of redhorse ascend the Cahaba River from the Alabama River. It is equally plausible that the buildup is simply a concentration of the resident redhorse population. Because the sampled area was small, and the sampling tool was ineffective in deep pools, it is quite possible that sampling during periods other than March excluded the larger redhorse.

In an attempt to further evaluate movement of river redhorse, 286 adults were collected, tagged and returned to the Cahaba River during 1967. To date only four tagged fish have been recaptured. Three were captured with electric shocking equipment and one by hook and line. All four were recaptured while on shoals during the 1967 spawning season. One fish exhibited no movement over a 12-day period while during the same period one moved 15 miles upstream. The other two recaptured had each moved 10 miles upstream during a 22-day period.

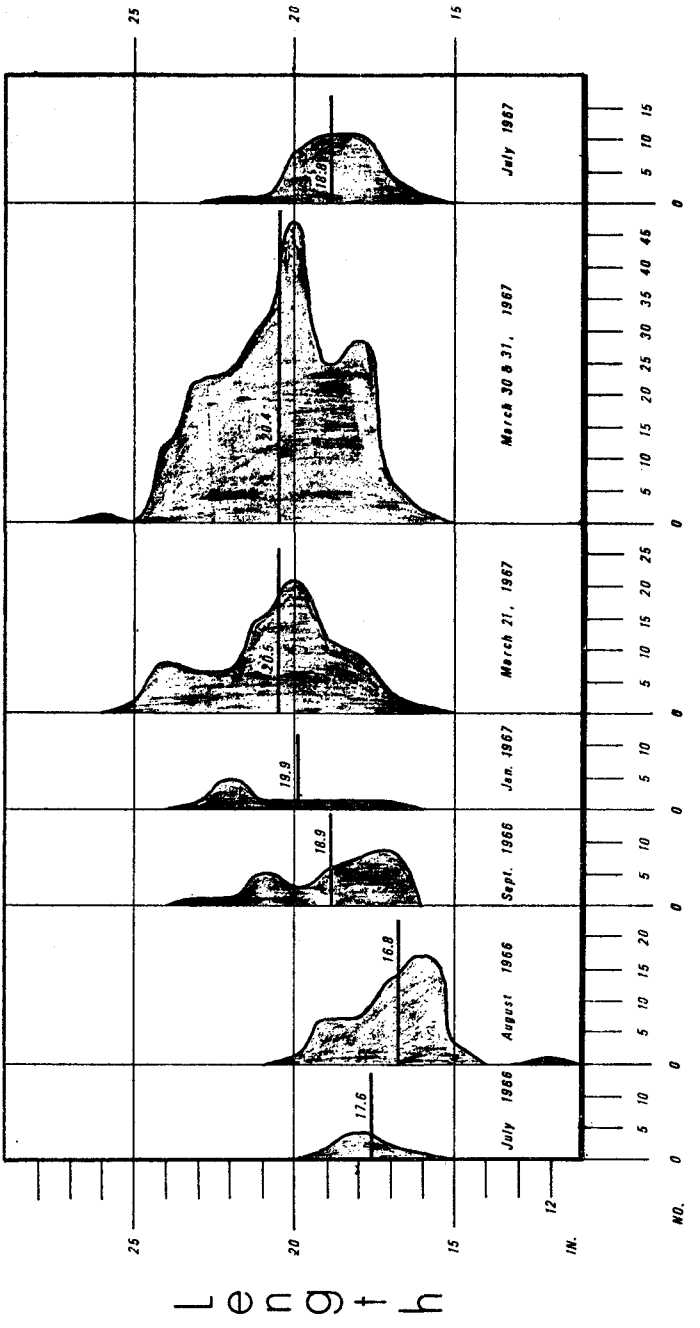

Figure 4 — Length frequency of river redhorse collected during 1966-67. Straight line through curve indicates average size of fish collected during each sampling period.

SPORT FISH POTENTIAL

Non-game Sport Fish

The definition of a sport fish is any fish taken by anglers for recreational purposes. It is interesting to note that the designation of non-game fish into categories such as rough fish, trash fish, or coarse fish, is the result of inability to utilize these species in a sporting capacity. Such classifications do not necessarily denote an inferior fish.

Cahaba River Redhorse Fishery

At present the Cahaba River affords a sport fishery for the river redhorse. The major portion of the annual yield is during the spawning season although a few are taken during other periods, usually incidentally, by bait fishermen. A small number of anglers bait areas to concentrate this species.

The principal methods used by sport fishermen to catch shoaling redhorse are: snaring (Figure 5), whereby a wire loop attached to a stout pole is passed over the fish's head and drawn tight, and snagging with unbaited treble hooks. There is also some interest in gigging and bow fishing, both of which are legal methods for taking non-game fish in Alabama.

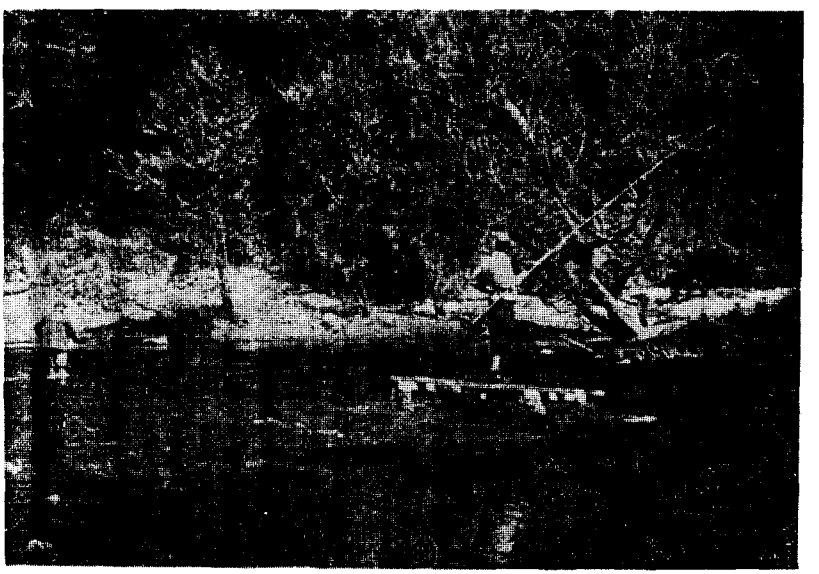

Figure 5 — Snaring shoaling river redhorse in the Cahaba River.

The large size and visibility of the fish during the spawning activities undoubtedly explains much of this species' appeal to redhorse fishermen. Interestingly, fishermen note the sexual dimorphism evident at this time and refer to the males as "horses" and the females as "mares." The flesh is palatable although bony and is often "scored" before cooking.

Present fishing pressure for river redhorse in the Cahaba River is light. Observation indicates that most of the shoaling populations are not visited by fishermen due to inaccessibility.

Management as a Sport Fish

The present policy is one of non-restricted utilization of this redhorse as a sport fish. The possibility of overfishing by anglers appears rather remote at this time. However, the high degree of vulnerability during the spawning activities would seem to indicate that this possibility cannot be entirely disregarded. It is felt that a much heavier rate of ex-

ploitation will be possible before there is a need to consider restricting fishing during the shoaling period.

As a species of fish becomes of interest to anglers, a need for sound management of the fishery is often seen. This is particularly true in the case of species which have suffered severe reduction due to habitat alteration, over-exploitation, or other causes. In addition to the life history study, the authors have attempted to obtain greater utilization of river redhorse by sport fishermen through the publication of a popular article (Hackney and Tatum, 1966) and public educational media.

Attempts to sell the public on the utilization of lightly sought non-game fish are well taken. However, when a demand is developed for fishes formerly thought of in this respect, the biologist must be prepared to take whatever actions are necessary to preserve the fishery thus created.

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CENTRARCHID FOOD HABITS IN A NEW AND OLD RESERVOIR DURING AND FOLLOWING BASS SPAWNING

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ABSTRACT

Stomach contents were examined from 1,288 longear sunfish, 827 green sunfish, 1,099 bluegill, 246 largemouth bass, 144 smallmouth bass, and 304 spotted bass collected from shoreline areas of a reservoir in the process of filling and from one 15 years old, during and following bass spawning, 3 May-25 June, 1965. Young-of-the-year and bass 8.0 inches or more in length are not included.

This study suggests that in the new reservoir the food supply was ample in relation to the centrarchid population demand. In the older reservoir the opposite was true, resulting in more efficient utilization of all available foods, including appreciable quantities of bass eggs and young. However, availability was influenced to a marked extent by size of predators and prey as well as abundance. The result was food "skimming," whereby the larger fish usurped the tendipedids and large cladocerans, leaving only smaller prey available for newly hatched largemouth young.

INTRODUCTION

Haskell (1965) deplored the emphasis on measuring fish mortality without identifying causes. Among questions he asked was, "how avail-