In recent years it has been proposed by many fisheries biologists that an extremely heavy harvest of fish from a lake will cause the fishing success for the succeeding year to decrease. It has been further opined that heavy cropping will have a depressant effect upon the fish population. From the creel census figures herein presented, and from the rotenone sampling data, there is no evidence to indicate that a harvest in excess of 100 pounds of fish per acre will be of sufficient effect on the fish population to seriously curtail the fishing success for the ensuing year. It is too early at this writing to determine the effect of removing over 200 pounds of fish per acre. Subsequent creel data from Bussey Lake will indicate the approximate poundage which can be harvested from a lake of this type and still have continued good fishing for subsequent years.

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FOOD AND FEEDING HABITS OF LONGNOSE GAR IN CENTRAL MISSOURI

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ABSTRACT

Food habits, feeding habits, and relative vulnerability of various prey species to predation by young longnose gar were studied as part of a general life history research project. Stomach analysis of yearling and older gar revealed a predominant fish diet with gizzard shad the most common species found. Seventy-six per cent of the stomachs of these gar were empty. Regurgitation is probably the major cause of the high percentage of empty stomachs of gar caught in gill nets. The stomachs of young-of-the-year longnose gar contained almost entirely fish, with various minnows the most common items. Feeding habits of the young gar are described. An experiment concerning the

relative vulnerability of prey to predation revealed wide differences in the ability of various species to avoid capture by the gar.

INTRODUCTION

The longnose gar, *Lepisosteus osseus* (Linnaeus), occurs throughout eastern United States ,and is very abundant in some areas. In areas where the gar is abundant, concern has arisen as to the effect of gar on other fishes. This concern is usually based on studies which have shown that fish make up most of the diet of the longnose gar (Lagler and Hubbs, 1940; Bonham, 1941; Lagler, Obrecht, and Harry, 1943; and others). The species of fish eaten differs in each study area and appears to depend to a large extent upon availability. Some studies indicate that the gar is a competitor (Hunt,1953), or a predator (Holloway, 1954) of more desirable species.

Due to the lack of information on this and other aspects of the life history of the longnose gar in Missouri, a study consisting of age and growth, reproduction, food habits, and certain laboratory experiments was performed (1). Part of the data was presented in a

(1) Netsch, Norval F. 1961. Some aspects of the life history of the longnose gar *(Lepisosteus osseus* Linnaeus) in Missouri. M. A. Thesis, Univ. of Mo., Columbia. 82 pp.

previous publication (Netsch and Witt, 1962). The remainder of the data—food habits, feeding habits ,and the relative vulnerability of various species of prey to predation by gar—is presented in this report.

FOOD HABITS

Young-of-the-year longnose gar—Nineteen young gar ranging from 4.7 to 10.6 inches total length (average 6.9 inches) were taken from Perche and Loose creeks located in central Missouri. These are relatively clear streams characterized by small to medium size pools connected by short rapids. The lower reaches of both are subject to flooding from the Missouri River during periods of high water .

The young gar were captured by dip net and preserved in ten per cent formalin immediately after capture. In the laboratory, the stomach was removed and the contents were identified, items counted, and the volume of the items was obtained by water displacement in a graduated cylinder after excess moisture was removed by blotting with paper towels.

The contents of the seventeen stomachs that contained food are shown in Table 1. Fishes made up 98 per cent of the volume, and occurred in all stomachs containing any food. Shiners *(Notropis* spp.) were the most common genera found. Bluntnose minnows *(Pimephales notatus)* and darters *(Etheostoma* spp.) made up lesser amounts. The largemouth bass *(Micropterus salmoides)* found consisted of one young-of-the-year specimen, which due to its size, accounted for twelve per cent of the volume of all foods present. The algae which was found in one stomach may have been ingested accidentally while feeding for other food items. No crustaceans or other items were found in any of the stomachs examined.

Yearling and older gar—The stomachs were examined of 129 longnose gar taken in gill nets from the Osage and Pomme De Terre rivers in the upper reaches of Lake of the Ozarks near Fairfield, Missouri. If the stomach contained any food, it was wrapped in a cheesecloth bag, labeled with pertinent data, and preserved in ten per cent formalin. Laboratory analysis was similar to the method described in the previous section.

The stomach contents of the 31 yearling and older gar that contained food are shown in Table 2. Fish made up 97 per cent of the volume of all foods with burrowing mayfly larvae *(Hexagenia* spp.) composing the remaining three per cent. Gizzard shad *(Dorosoma cepedianum)* occurred in 53 per cent of the stomachs, and made up 63 per cent by volume. Catfish *(Ictalurus* spp.) occurred in 6 per cent of the stomachs, and made up 13 per cent by volume of all foods. Drum *(Aplodinotus grunniens)* and longear sunfish *(Lepomis megalotis)* made up lesser amounts of the contents. Sixteen per cent of the contents were unidentified fish.

Ninety-eight (76 per cent) of the stomachs examined were empty. A high percentage of empty stomachs has also been noted by other workers. This has been attributed to regurgitation by some (Bonham, 1941), although not noted in other studies. Evidence in this study indicates that at least some regurgitation did occur while the gar were entangled in the gill nets. Several stomachs of dead gar contained water, but no food, which might be expected if regurgitation and drowning occurred. Another indication of regurgitation is the comparison of empty stomachs of the gar captured in gill nets (76 percent) and the young gar captured by dip net and preserved immediately (11 percent) which would eliminate the possibility of regurgitation after capture.

FEEDING HABITS

In another aspect of the study, young gar were kept in tanks and fed live minnows as food (Netsch and Witt, 1962). This experiment offered an excellent opportunity to observe the feeding habits of the young-of-the-year longnose gar.

The gar made few unnecessary movements. Their normal position was to lie motionless, except for a vibrating action of the pectorals, either at the surface of the water or with the caudal fin resting on the bottom with the body inclined at an approximate 20 degree angle. The method of capturing a minnow varied. The gar would frequently lie completely motionless until a minnow swam into striking position. This position varied with the size of the gar, but was usually when the minnow was within one-half to two inches of the snout of the gar. Then, with a very quick lateral movement of the head, the gar would seize the minnow between the long jaws. After the minnow ceased struggling, it was usually turned until its head was pointed toward the gullet prior to swallowing. This was accomplished by the gar briefly relaxing its grip on the minnow, and at the same time, making quick lateral movements of the head and forward lunging movements of the body. The long sharp teeth in the jaws of the gar served as an efficient trap, and the minnow had little chance of escape once it was caught.

Another method commonly used by the gar in feeding was to follow a minnow in a slow but continuous stalk in an attempt to get within striking position. Even when a minnow was apparently in such a position, the gar would not always attempt to catch it. If stalking one minnow, and another swam by closer than the first the gar would usually begin to stalk the second. If the gar did not capture a minnow after stalking for a minute or even less, it would frequently give up and would wait motionless for some time before starting to stalk another minnow.

The gar were observed to be successful in capturing a minnow in 40 to 70 per cent of the attempts. The young gar were not observed to attempt to take a minnow which was not moving. In no cases were dead minnows taken, even when no other food was present. One gar fed actively on live minnows, but did not take a small crayfish which was placed in the tank for a one week period.

Limited observations of adult gar feeding naturally in the wild revealed similar methods, except for a more rapid stalk. On several

occasions, fairly large gar were observed lying in water three-four inches deep, apparently waiting for some unsuspecting prey to come along. Adult gar probably attempt to capture about any species of fish that happens to be nearby. The author has fished for gar using spinning tackle with large minnows for bait on a number of occasions. Almost without exception, every gar that saw the bait would take it without hesitation. One gar even took a fishing companion's bait, and then swam on without stopping, took the author's bait, and continued his course until we both set the hooks.

RELATIVE VULNERABILITY OF VARIOUS SPECIES TO PREDATION BY YOUNG LONGNOSE GAR

As a part of a growth and metabolism experiment (Netsch and Witt, 1962), young-of-the-year longnose gar were fed various species of minnows for food. It was soon discovered that certain species of the minnows were taken in greater numbers than others in spite of the fact that the gar showed no apparent preference for any particular species. Observations revealed that there was a considerable difference in the ability of different species to avoid being caught. In order to further investigate these observations, an experiment was conducted to measure the relative vulnerability of some common fishes to predation by young Longnose gar.

The species to be tested were placed in a circular tank containing 170 gallons of water and 10 young-of-the-year longnose gar which had not been fed for twelve hours. The gar ranged in total length from 10.4 to 12.4 inches (average 11.4 inches). A group of test species were introduced in the morning, and those remaining were removed and counted eight hours later. Due to limited time, only two groups were presented. Each group consisted of four species with ten individual fish representing each species. All of the specimens tested were seined from a local pond or stream the day before use, and were of a size that *could* be eaten by the gar.

The results of the experiment (Table 3) show some interesting differences in behavior and vulnerability of the species tested to predation by the gar. Largemouth bass were very curious and would swim freely about the tank, but always stayed just out of striking distance of the gar. Upon several occasions, a gar would stalk a bass which would simply swim backward, just out of range of the gar. The bass were exceptionally alert and outmaneuvered the gar on all occasions. Green sunfish *(Lepomis cyanellus)* exhibited a great deal of caution, and stayed far enough away from the gar so as not to provoke an attack. When a gar attempted a stalk, the green sunfish would swim very quickly out of the way. Orangethroat darters *(Etheostoma spectabile)* avoided a great deal of predation apparently because of their habit of remaining motionless on the bottom at the sides of the tank most of the time. Since the gar seemed to prefer a slow, but moving subject, the orangethroats were generally overlooked. The bluegill *(Lepomis macrochirus)*, Johnny darter *(Etheostoma nigrum)*, redfin shiner *(Notropis umbratilis)*, stoneroller *(Campostoma anomalum)*, and creek chub *(Semolilus atromaculatus)*, swam slowly around the tank and appeared to be unaware of the gar's presence or approach. These species appeared to be unable or too slow to swim away quickly enough when the gar struck at them, which, of course, resulted in their untimely end.

DISCUSSION

There are few reports in the literature containing data on the food habits of young-of-the-year gar. Forbes and Richardson (1920) stated that young "gar-pike" will live very well on mosquito larvae. Cahn (1927) indicated that the food of young gar is almost entirely

entomostraca, and after they reach about 2.5 inches long, approximately 50 percent of their diet is fish.

Three- to four-inch long gar were observed to feed quite actively upon live Cladocera in an aquarium during the present study, indicating that the young gar were familiar with this type food. They would stalk and capture individual Cladocera just as large gar fed on minnows. The gar apparently turn to fish for food when less than about four inches, as the smallest gar used in the stomach analysis was 4.7 inches, and none contained any food other than fish, mayfly larvae, and occasional algae.

The predominant fish diet is retained for life, as shown by this and many other studies. Other foods are nearly always minor in importance. The effect of this diet on desirable fishes is difficult to determine accurately, and would require a more exhaustive study than this for a reliable answer. It is logical to assume that the gar would at least compete for food with other piscivorous species in the same water. Serious competition apparently did occur in certain isolated areas, such as oxbow lakes, which were sampled in other locations.

Longnose gar either do or would prey on nearly any species of fish, as shown by food habit studies, and observation. Fortunately, desirable sport fishes make up only a small portion of the food in most reports. Catfish were the only popular fish of importance consumed by gar in this study. The results of the relative vulnerability experiment indicate that two Missouri sport fishes, the largemouth bass and green sunfish, are, at least to some extent, able to avoid the predation of longnose gar. Certain other species in the experiment exhibited less ability to avoid being captured.

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TABLE 1. Stomach Contents of 17 Young-of-the-Year Longnose Gar Captured by Dip Net in Perche and Loose Creeks, Central Missouri.

Food Item	Percent by Volume	Frequency of Occurrence
Shiners	48	24
Bluntnose minnow	10	18
Darters	6	24
Largemouth bass	12	6
Unidentified fish	22	47
Algae	2	6

TABLE 2. Stomach Contents of 31 Yearling and Older Longnose Gar Captured by Gill Nets in the Osage and Pomme De Terre Rivers, Missouri.

Food Item	Percent by Volume	Frequency of Occurrence
Gizzard Shad	63	53
Catfish	13	6
Drum	5	3
Longear sunfish	Trace	3
Unidentified fish	16	36
Burrowing mayfly larvae	3	19

TABLE 3. Relative Vulnerability of Eight Species of Fishes to Predation by Young Longnose Gar.

Prey Species	Number Placed In Tank	Number Remaining After Eight Hours
Group 1		
Green sunfish	10	10
Redfin shiner	10	4
Bluegill	10	3
Johnny darter	10	2
Group 2		
Largemouth bass	10	10
Orangethroat darter	10	7
Stoneroller	10	4
Creek chub	10	2