

# FACTORS AFFECTING FOOD INTAKE BY THE SHORTNOSE GAR

WILLIAM M. LEWIS and RICHARD VANDERHORST  
*Fishery Research Laboratory and Department of Zoology  
Southern Illinois University, Carbondale*

**ABSTRACT.** — Two experimental designs supplemented by field observations were utilized to investigate factors affecting the food intake by the shortnose gar and the effectiveness of this gar as a predator. Variations in susceptibility to capture on the part of the forage affected the gar's ability to utilize different organisms. The shortnose gar does not appear to be any more effective as a predator than does the largemouth bass and the channel catfish. During a part of the year invertebrate forms were a major item in the gar's diet. It was suggested that the "beak" of the gar is an adaptation for capturing benthic organisms. Rainfall caused a major increase in the utilization of terrestrial organisms.

On the basis of earlier studies (Lewis et al., 1961; Lewis and Helms, 1964; and Anthony, 1964) Lewis (1967) has pointed out that stomach analyses of fishes from established populations do not reveal the potential of a predator to utilize forms that are particularly susceptible to capture. In a given body of water such forms are rather rapidly eliminated or drastically reduced in number (Bremer, 1965). Thus, subsequently they do not appear as food items by stomach analysis. In the studies mentioned above, variation in susceptibility to capture between various organisms of forage size is demonstrated to exist. Lewis and Helms

(1964) concluded that susceptibility to capture is a characteristic of the forage species and that the ability of different predator fishes to capture a given forage organism is similar. In the present investigations it was postulated that this conclusion might not hold for the gar pikes (*Lepisosteus*), which, according to the literature (TABLE 1), appear to be highly piscivorous, and which are phylogenetically separated and morphologically different from the largemouth bass (*Micropterus salmoides*), smallmouth bass (*M. dolomieu*), and channel catfish (*Ictalurus punctatus*), which were considered in the earlier studies.

Using the experimental design employed in the earlier works mentioned above and by collections of fish from the wild, an investigation was made of the ability of the shortnose gar (*L. platostomus*) to utilize various forage organisms, contributions of different food organisms to the seasonal diet of this gar in the wild, effects of rainfall on food intake, and effects of the presence of highly vulnerable forage on food intake.

## PROCEDURES

Individual shortnose gar ranging in weight from 0.8 to 1.1 pounds were held

TABLE 1.—Stomach Contents of the Gar Pikes as Reported by Other Authors.

Reference	Species	Months of sample	Number of specimens	Percent stomachs full	Food items—percent					
					Fishes		Insects		Other	
					Occ.	Vol.	Occ.	Vol.	Occ.	Vol.
1	Alligator	.....	21	1	100	100	0	0	0	0
	Spotted	.....	28	28	100	.....	0	0	45	.....
	Longnose	.....	297	38	83	.....	14	.....	5	.....
2	Shortnose	Feb-June	2,410	8	76	.....	.....	.....	23	.....
	Shortnose	July-Aug	217	34	100	100	0	0	0	0
	Longnose	Jan-May	155	20	99	.....	1	.....	0	0
3	Spotted	Feb-June	448	23	70	76	19	8	38	16
4	Longnose	June-Aug	204	66	100	99	5	0	2	1
5	(not stated)	.....	89	44	94	.....	0	0	3	.....

References: (1) Bonham, K. (1940); (2) Holloway, A. D. (1954); (3) Hunt, B. P. (1952); (4) Lagler, K. F. and F. V. Hubbs (1940); (5) Scott, W. (1938).

in six stock watering tanks. The tanks were four feet in diameter, two feet deep, and were filled to the 16-inch level. The tanks were located indoors and were illuminated 12 hours each day. Two lots of gar were used; one in 1965 and another in 1966. It was necessary to hold each lot approximately a month in the presence of food before the fish commenced feeding. The first lot was held at 70 to 73°F., and the second lot at 83°F. In any one trial two forage species were offered. In the majority of trials the complement was maintained at five organisms of each species. In two trials ten individuals of each species were used since all of the tadpoles were eaten when only five were offered. In all cases the complement was replenished once each day. The duration of the trials varied as is indicated in TABLE 2. Utilization of the forage was measured in terms of number of forage organisms eaten per gar per day.

In evaluation of forage utilization in the pond habitat, a group of identical 0.1-acre drainable ponds were utilized. The ponds could be refilled by gravity from a reservoir. They were free of vegetation and had a shoreline slope of one to one with a depth of five feet at the drain and four feet at the upper end. The water turbidity ranged from 20 to

40 p.p.m. silicon dioxide and was due primarily to silt.

Each of three ponds was stocked with 500 of each species of the forage being investigated. In some cases this was one species, while in other cases two or three species were stocked. Two of the three ponds were then stocked with six gar, the size of which ranged from 0.5 to 1.5 pounds. The ponds were permitted to remain undisturbed for ten days. At the end of this time the gar were removed by seining, the ponds were drained and the remaining forage organisms counted. The difference in numbers of forage organisms between the pond without gar and those with gar was considered to be the forage utilized by the gar. To verify forage utilization, stomach analyses were made on half of the gar at the time they were removed.

Investigations of the feeding habits of the gar in the wild were carried out in the Big Muddy River, a large, turbid tributary of the Mississippi. Sampling was done two to three miles above the confluence of the river with the Mississippi. Fish were collected by use of electro-fishing equipment mounted on a boat. When possible, sampling was done once each week and an attempt was made to obtain 20 fish per trip. However,

sampling conditions did not always permit achieving these goals. Particular emphasis was placed upon determination of seasonal changes in food, the utilization of terrestrial vs. aquatic food, the utilization of invertebrate life vs. fishes, and the effect of rainfall upon stomach contents.

### RESULTS

Under conditions of confinement in the tanks there was significant utilization of all species of forage offered (TABLE 2). However, there occurred a greater utilization of tadpoles than of other forms. On the assumption that confinement rendered all of the forms more vulnerable, the greater utilization of tadpoles could indicate

a preference for this organism. In the pond trials (TABLE 3) it is evident that vulnerability played a role similar to that observed in the earlier studies with bass and channel catfish. The utilization of less vulnerable forms such as the bluegill (*Lepomis macrochirus*) and fathead minnow (*Pimephales promelas*) was less than that which occurred in the tanks. Utilization of the forms previously considered to be vulnerable was again high. Thus the utilization of bullfrog tadpoles (*Rana catesbeiana*), crayfish (*Procambarus blandingi*), and black bullhead (*Ictalurus melas*) fingerlings was notably high.

TABLE 2.—Utilization of Forage Organisms by Shortnose Gar in Tanks.

Forage species	No. organisms offered each day	Gar days	No. forage eaten/gar/day
Golden shiner.....	5	12	0.62
Bullfrog tadpole <sup>1</sup> .....	5	.....	0.12
Pond crayfish.....	5	46	1.81
Fathead minnow.....	5	.....	1.14
Fathead minnow.....	5	65	3.19
Bullfrog tadpole.....	5	.....	2.00
Fathead minnow.....	5	25	2.52
Bullfrog tadpole.....	5	.....	2.85
Fathead minnow.....	5	34	1.04
Bullfrog tadpole.....	5	.....	5.00
Fathead minnow.....	5	20	2.70
Bullfrog tadpole.....	5	.....	4.65
Bluegill.....	5	14	2.10
Bullfrog tadpole.....	5	.....	5.00
Bluegill.....	10	64	1.45
Bullfrog tadpole.....	10	.....	4.80
Black bullhead.....	5	7	3.10
European carp.....	5	.....	3.11
Black bullhead.....	10	8	2.75
European carp.....	10	.....	5.70

<sup>1</sup> Initial trial after confinement of shortnose gar in tanks may account for poor utilization.

TABLE 3.—Utilization of Forage Organisms by Shortnose Gar in 0.1-acre Ponds.

Forage species	Utilization-Organisms/gar/day				
	Trial 1	Trial 2	Trial 3	Trial 4	Mean
Crayfish.....	2.91	2.23	.....	.....	2.57
Crayfish.....	2.34	7.20	7.30	.....	5.61
Bullfrog tadpole.....	3.40	5.60	5.65	.....	4.85
Golden shiner.....	0.10	0.33	0.00	0.00	0.11
Crayfish.....	3.58	2.57	2.12	0.80	2.76
Bullfrog tadpole.....	2.74	2.04	2.18	0.58	1.88
Fathead minnow.....	0.30	0.28	0.33	0.22	0.28
Bullfrog tadpole.....	3.32	2.71	6.30	5.60	4.48
Fathead minnow.....	1.15	0.30	0.90	0.23	0.64
Bluegill.....	0.00	0.00	0.48	2.39	0.72
Fathead minnow.....	1.13	1.56	.....	.....	1.34
Black bullhead.....	2.96	5.79	.....	.....	4.37
Black bullhead.....	4.35	3.92	.....	.....	4.13
Bullfrog tadpole.....	3.91	6.62	.....	.....	5.26
Black bullhead.....	5.90	6.40	.....	.....	6.15
European carp.....	1.85	2.80	.....	.....	2.32

The stomach contents of 102 shortnosed gar taken from the wild revealed a greater utilization of insects than has been previously reported. A large percent of this material was terrestrial beetles. The benthic organisms consumed consisted almost entirely of naiads of one of the burrowing mayflies (*Hexagenia* sp.).

With the progression of the season there occurred a notable shift in the food utilized. During some periods terrestrial and nektonic insects were most heavily utilized, while during others benthic invertebrates or fishes were more important (TABLE 4). Rainfall affected both the composition of the stomach contents and the level of intake. The percent of stomachs containing food was twice as

great following a rain than just prior to the rain. The content prior to the rain was entirely aquatic in source while that following the rain was entirely terrestrial (TABLE 5).

A comparison may be made between food intake of gar under field conditions with natural food available and under experimental conditions in which they were held in the presence of highly vulnerable food forms. Thus, the average percent of stomachs containing food in the wild was 38, while in the presence of crayfish and tadpoles 89 percent contained food (TABLE 5).

#### DISCUSSION

The ability of the shortnose gar to catch forage organisms is similar to

TABLE 4.—Seasonal Variation in the Food of Shortnose Gar in the Big Muddy River During 1966.

	Percent Occurrence					
	Fishes	Terr. insects	Aquatic insects	Benthos	Crayfish	Misc.
March.....	0	23	67	0	0	0
April.....	0	42	15	43	0	0
May.....	24	43	17	0	16	0
June.....	8	35	8	47	2	0
July.....	36	4	12	0	12	36 <sup>1</sup>
August.....	47	29	0	18	0	6
September.....	52	14	9	19	5	1
October.....	100	0	0	0	0	0

<sup>1</sup> Plant material and debris.

that of the largemouth bass and channel catfish. In the pond environment, organisms that had been previously classed as vulnerable were most heavily utilized. The non-vulnerable forms, although readily utilized in the confinement of tanks, were poorly utilized in the ponds even when offered exclusively.

Some degree of adaptation and specialization in feeding of the shortnose gar is evident from the data. In tanks there was evidence of preference for the bullfrog tadpole. This organism is not palatable to the chan-

nel catfish (Anthony, 1964); it is, however, readily utilized by the largemouth bass. The extent to which the gar utilized naiads of the burrowing mayfly in the river environment suggests that the "beak" of the gar could be an adaptation for feeding on benthic forms, perhaps including infauna. Stomachs of largemouth bass of similar size collected along with the gar and apparently from the same habitat did not contain naiads of the mayfly.

The pronounced seasonal change in the stomach contents of the gar indicates considerable adaptability and,

TABLE 5.—Effects of Heavy Rainfall on the Percent of Full Stomachs and Occurrence of Terrestrial Food Items in Stomachs of the Shortnose Gar.

Sampling conditions	Percent containing food	Percent occurrence terrestrial
All samples.....	38 <sup>1</sup>	22
Sample preceding rain.....	33	0
Sample after rain.....	77	77
Vulnerable forage in ponds.....	89 <sup>2</sup>	....

<sup>1</sup> In comparison, Holloway (1954) reported 34 percent of 217 stomachs of shortnose gar sampled in July and August to contain food.

<sup>2</sup> Based on 42 shortnose gar held in ponds with tadpoles and crayfish.

of course, reflects seasonal availability.

Rainfall is shown to have a pronounced effect on food intake. The percent of stomachs containing food was twice as great following a rain. The composition also changed from no terrestrial food before the rain to 100 percent after.

The gar in the river were apparently not feeding at their maximum rate. The percent of stomachs containing food was only 38 as compared with 89 percent for gar in ponds with vulnerable forage organisms. Lewis (1967) has indicated that the food intake of predacious fishes in the wild may typically be minimal. Their maximum intake possibly is several times greater. Variations in rate of growth are associated with this variation in food intake.

#### LITERATURE CITED

- ANTHONY, MARK. 1964. The utilization of selected forage organisms by channel catfish. Ph.D. Dissertation, So. Ill. Univ., Carbondale. 45 pp.
- BONHAM, K. 1940. Food of gars in Texas. Trans. Am. Fish. Soc. 70:356-362.
- BREMER, DALE J. 1965. Changes in populations of forage organisms associated with predation by largemouth bass and bluegill. M.A. Thesis, So. Ill. Univ., Carbondale. 26 pp.
- HOLLOWAY, A. D. 1954. Notes on the life history and management of the short-nose and longnose gars in Florida waters. Jour. Wildl. Mgt. 8(4):438-449.
- HUNT, B. P. 1952. Food relationships between Florida spotted gar and other organisms in Tamiami Canal, Dade County, Florida. Trans. Am. Fish. Soc. 82:13-33.
- LAGLER, K. F., and F. V. HUBBS. 1940. Food of the longnosed gar (*Lepisosteus osseus oxyurus*) and the bowfin (*Amia calva*) in southern Michigan. Copeia 1940:4:239-241.
- LEWIS, W. M. 1967. Predation as a factor in fish populations. Proc. Reservoir Fisheries Resources Symposium, Apr. 5-7, Athens, Ga. (In Press).
- LEWIS, W. M., and D. R. HELMS. 1964. Vulnerability of forage organisms to largemouth bass. Trans. Am. Fish. Soc. 93(3):315-318.
- LEWIS, W. M., GERALD E. GUNNING, EDWARD LYLES, and W. LEIGH BRIDGES. 1961. Food choice of largemouth bass as a function of availability and vulnerability of food items. Trans. Am. Fish. Soc. 90(3):277-280.
- SCOTT, W. 1938. The food of *Amia* and *Lepisosteus*. Invest. Ind. Lakes and Streams. 1:112-115.

Manuscript received January 9, 1968.