The Food Habits of Adult Striped Bass from Lake Hamilton, Arkansas, Before and During an Extreme Drawdown

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Abstract: Adult striped bass (*Morone saxatilis*) ranging in size from 483 to 940 mm TL in a west central Arkansas reservoir (3,000 ha) fed predominantly on gizzard shad (*Dorosoma cepedianum*) and threadfin shad (*D. petenense*) throughout a 2-year study. Heavy feeding on threadfin shad occurred 1 winter due to colder than normal water temperatures which rendered threadfin shad sluggish and more susceptible to predation. Other species of fish and invertebrates comprised only a minor portion of food items regardless of time of year. An increasing trend in larger size shad consumed by larger striped bass sampled was observed and this positive correlation was significant ($P < 0.05$). Significantly higher weights of gizzard shad per striped bass stomach were recorded during a 2.7-m extreme fall-winter drawdown than the winter before. An index of fullness (% full stomachs) indicated increased predation by striped bass in the crowded drawdown conditions. The major food items of striped bass did not change significantly during an extreme drawdown and sport fish were minimally preyed upon even with the resulting 20% reduction in lake surface area. Adult striped bass did feed actively during the cooler months; therefore, use of a substantial lake drawdown to control certain prey species can be effective during winter as well as during the warmer months in a lake with an established striped bass population.

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Numerous food habit studies of striped bass have been conducted over the years in various states throughout the nation. In the past 10 to 15 years, increased stocking of this large, pelagic predator in inland, warm water impoundments has raised inquiries about its feeding selectivity in freshwater. This is especially true of various organized sport fishermen groups, such as black bass clubs, some of which feel the decrease in black bass fishing in certain aging reservoirs is due to stocking of striped bass and the resultant predation on black bass. While previous studies have demonstrated the importance of shad in the diet of striped bass (Stevens 1958, Neal 1967, Ware 1974, and Combs 1978), striped bass food habits during a period of extreme lake drawdown have not been well documented. In an attempt to quantify the feeding habits of adult striped bass in Arkansas reservoirs and to ascertain if they would change during an extreme fish management drawdown (2.7 m), the food habits of striped bass were studied on Lake Hamilton in west central Arkansas.

Lake Hamilton, a 3,000-ha hydropower reservoir with an average depth of 8.1 m, was built south of Hot Springs, Arkansas in 1931 by the Arkansas Power and Light Company. Striped bass were introduced into the lake by the Arkansas Game and Fish Commission in 1974. An annual 1.2-m drawdown is usually conducted from October to early March on Lake Hamilton to provide flood control storage and aquatic vegetation control and to allow lake residents to repair seawalls and docks. The Arkansas Game and Fish Commission, in cooperation with Arkansas Power and Light, conducted a 2.7-m drawdown in November–January 1981–82 to control an underutilized population of large, adult gizzard shad. From 1975 to 1979, gizzard shad comprised approximately 50% of the total fish biomass in Lake Hamilton (Filipek and Gibson 1982). The basic premise of the 2.7-m drawdown was that an extreme drawdown on the lake (20% reduction in surface area) would concentrate the shad with predators capable of utilizing them as postulated by Lewis (1967). The colder winter water temperatures were not expected to inhibit striped bass feeding significantly since personal observations and studies (Hollis 1952) indicate that striped bass feed substantially during the winter months at certain latitudes.

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Methods

Gill nets were set at least once a month (3 nets per set) from September 1980 through September 1982 on Lake Hamilton. The majority of net sets were overnight and in the mid-lower lake zone, although some in the upper lake region were limited to evening sets due to heavy fishermen use in this area. Nets were multi-filament nylon gill nets of the following dimensions: 0.06 x 2.4 x 30.5 m, 0.08 x 3.0 x 91.4 m, and 0.09 x 3.0 x 91.4 m. Striped bass were weighed and measured, scale samples taken, and stomachs excised immediately after netting. Stomach contents were examined and food items identified, counted, measured, and recorded. The weight of food items was either taken upon examination of stomach contents or derived from length weight relationships computed from recent cove rotenone data.

Analysis of stomach content data using various statistical tests was performed. These included correlation and regression on total lengths of shad versus interval groups of striped bass and comparison of mean weight of stomach contents before and during the drawdown.

Results and Discussion

During the 2-year sampling period, a total of 116 adult striped bass ranging from 483 to 940 mm TL were netted and examined for food organisms. Of the striped bass stomachs examined, 84 (72.4%) contained food items, the majority (98.7%) of which were fish and fish remains (Table 1). Shad was the dominant food organism in striped bass stomachs by weight (84.9%), number, (92.8%) and frequency of occurrence (76.2%). This data reinforces what fishery biologists have documented in other states with inland striped bass fisheries (Domrose 1963, Stevens 1958, Neal 1967, Ware 1970). However, several of these studies were on reservoirs without established populations of both gizzard shad and threadfin shad in the same system. Gizzard shad made up the majority of food items by weight in Lake Hamilton striped bass (58.9%), which was >3 times the next highest item by weight (threadfin shad—18.2%). All other fish food organisms were of minor importance in the diet of Lake Hamilton striped bass both before and during the 2.7-m drawdown (unidentified fish, which occurred in 17.9% of the stomachs with food items, were probably shad but were too digested to identify).

Table 1. Food items of 116 Lake Hamilton adult striped bass in percent numbers, weight, and frequency of occurrence.

Food item	Percent by Number	Percent by Weight	Percent by Frequency of occurrence
Gizzard shad	16.4	58.9	42.9
Threadfin shad	59.6	18.2	17.9
Unidentified shad	16.8	7.8	35.7
Total shad	92.8	84.9	76.2
Rainbow trout	0.5	5.2	2.4
Lepomis spp.	0.9	3.8	7.1
Unidentified fish	2.9	3.6	17.9
Golden shiner	0.1	1.0	1.2
Brook silversides	1.2	0.1	9.5
Notropis spp.	0.7	0.1	3.6
Orconectes sp.	0.7	1.3	3.6
Hexagenia sp.	<0.1	0.1	1.2
Totals	100.0	100.0	

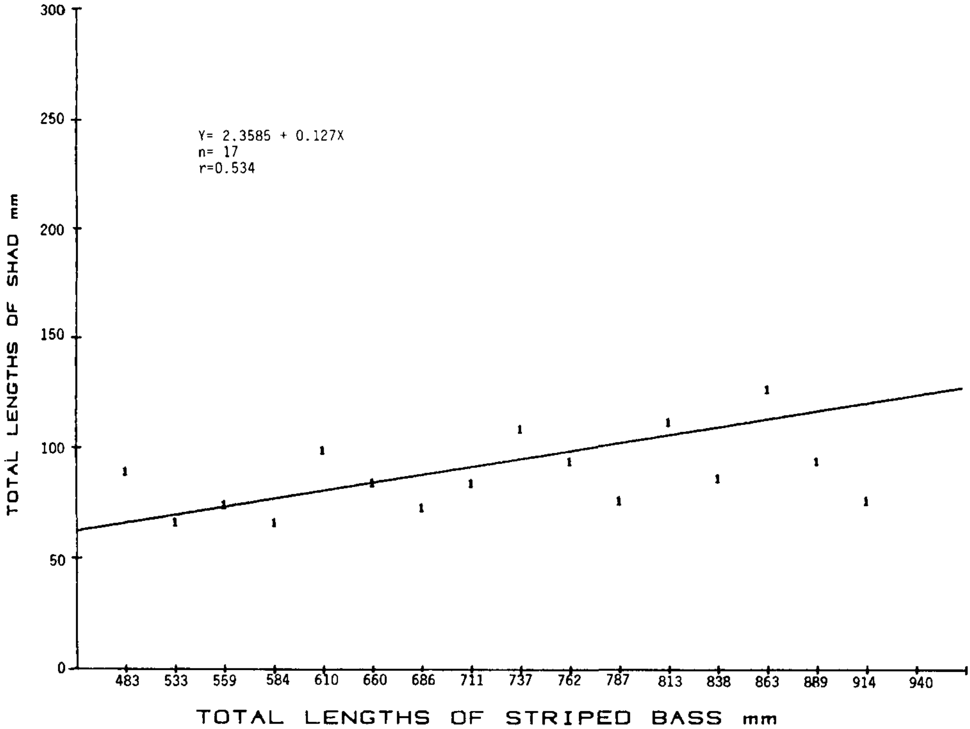

Figure 1. Relationship between mean total lengths of all shad consumed and striped bass length groups in Lake Hamilton, Arkansas.

Mean lengths (TL) of gizzard, threadfin, and unidentified shad consumed by striped bass were 122 mm, 74 mm, and 81 mm, respectively ($N =$ 788 total shad ranging from 44 to 356 mm). Mean lengths of all shad and striped bass length groups (25-mm groups) were positively correlated ($r =$ 0.53) and this correlation was significant ($t = 2.45$, df = 15, $P < 0.05$). Combs (1978) demonstrated a significant relationship between the mean lengths of gizzard shad consumed and striped bass length groups in Keystone Reservoir, Oklahoma. A regression line, plotted using Lake Hamilton striped bass length groups and combined shad length data, shows the relationship existing during the 2-year study (Fig. 1).

There were no major seasonal differences in food habits in Lake Hamilton striped bass with shad making up the majority of food items consumed in all seasons. The occurrence of 4 rainbow trout (*Salmo gairdneri*) in striped bass stomachs in the winter and a few crayfish (*Orconectes* sp.) in the late summer may indicate that striped bass were preying on whatever organisms were present at that time or in that area. Trout are stocked in Lake Hamilton in the winter months as a put-and-take fishery and crayfish are more available to the striped bass in late summer when the fish move up lake to preferred cooler water temperatures.

Stomach contents were compared for the periods from November 1981 through January 1982, during which there was a 2.7-m drawdown, and November 1980 through January 1981, during which there was a regular (yearly) 1.2-m drawdown. Striped bass stomach contents during the 2 winter periods represented 46.9% of the total estimated weight of the stomach contents for the entire study from September 1980 through September 1982. This suggests that the potential to reduce the shad population by substantially drawing down the lake during the winter did exist since the striped bass were feeding actively during the cooler months.

Although the total mean estimated weight per striped bass stomach was slightly higher during the 2.7-m drawdown, a student's *t*-test comparing the 2 winter periods showed no significant difference at the 0.05 level. A large die-off of threadfin shad due to colder than average weather the winter before the 2.7-m drawdown had a substantial effect on the mean estimated weight due to increased utilization of the threadfin shad by striped bass. Threadfin shad comprised 51.6% of the stomach contents the winter before the 2.7-m drawdown and only 12.6% the winter during the 2.7-m drawdown (Table 2). The data was skewed by 3 striped bass which were feeding heavily on the dying threadfin shad and contained 64.5% of the total threadfin shad recorded from all stomachs. The winter of the 2.7-m drawdown was fairly mild without a noticeable threadfin shad die-off. Threadfin shad densities were not substantially different the winter before (1,292 threadfin shad/ha) or during the extreme drawdown (1,619 threadfin shad/ha) given the relative variability of cove rotenone sampling. Mean weights of gizzard shad per striped bass stomach

Table 2. Comparison of prey composition and percent full stomachs of adult striped bass before (November 1980 to January 1981 and during (November 1981 to January 1982) an extreme 2.7-m drawdown.

Prey	Before		Prey	During	
	% by number	% by weight		% by number	% by weight
Gizzard shad	5.2	29.1	Gizzard shad	13.9	65.2
Threadfin shad	81.4	51.6	Threadfin shad	32.7	12.6
Unidentified shad	10.0	5.4	Unidentified shad	42.5	12.1
Total shad	96.5	86.1	Total shad	89.1	89.9
Lepomis spp.	1.6	12.2			
Unidentified fish	0.7	1.4	Unidentified fish	10.9	10.1
Brook silversides	0.5	0.1	Total	100.0	100.0
Notropis spp.	0.7	0.2			
Total	100.0	100.0			
$FI^a = \frac{30}{39} = 76.9\%$			$FI = \frac{14}{14} = 100.0\%$		

[a] $\text{Fullness Index} = \frac{\text{number of full stomachs}}{\text{total number of striper stomachs}}$

were significantly higher ($Z = 3.05$, df $= 51$, $P < 0.05$) the winter during the drawdown than the winter before (54.9 g of gizzard shad/stomach in 1981–82 vs. 22.2 g of gizzard shad/stomach in 1980–81).

A non-parametric statistical test (large scale comparison of 2 proportions) was performed to compare predation by striped bass before the drawdown versus during the drawdown. A comparison of 2 proportions was done using numbers of striped bass stomachs without food items for the 2 time periods. A Z-value was calculated for each category of shad using the proportion of zeros (stomachs without a food item) for each category during each winter period.

P_2 = number of zeroes in each category divided by total number of striper stomachs in the winter of 1980–81

P_1 = number of zeros in each category divided by total numbers of stomachs in the winter of 1981–82

n_1 = total number of striped bass stomachs in the winter of 1981–82

n_2 = total number of stomachs in the winter of 1980–81

$$Z = P_2 - P_1 / \sqrt{P_1 (1 - P_1) \div n_1 + P_2 (1 - P_2) \div n_2}$$

The Z-values showed a significantly higher ($P < 0.01$) number of stomachs with no gizzard shad during the winter before the 2.7-m drawdown than during the extreme drawdown. This suggests an increase in predation by striped bass on gizzard shad during the 2.7-m drawdown and this is underlined by cove rotenone data from 1979 to 1982. While threadfin shad densities showed no significant change (actually a slight increase), gizzard shad biomass decreased from an average of 17.2 kg/ha from 1979 to 1981 (before drawdown) to 6.3 kg/ha in 1982 (after extreme drawdown). Also, an index of fullness, FI, was calculated for the 2 winter periods in the following manner:

$$FI = \frac{\text{number of stomachs with food items}}{\text{total number of stomachs examined}}$$

While all (100%) of the striped bass examined during the extreme drawdown period contained food items in their stomachs, only 76.9% of those examined the winter before the drawdown contained prey.

A comparison was made between the size of gizzard shad consumed before and during the extreme drawdown. Threadfin shad was excluded from this analysis because of low tolerance to and lethargic activity in the unusually cold 1980–81 winter temperatures (<4°C.). This is demonstrated by a few striped bass stomachs containing the majority of the threadfin shad observed in 1980–81 (1 striped bass contained 149 70-mm threadfin shad). The weighted mean size of 33 gizzard shad consumed by 8 striped bass in the winter before the 2.7-mm drawdown was 132 mm TL. For the same period during the drawdown, the weighted mean size of 14 gizzard shad consumed by nine striped bass was 179 mm TL. This prey size difference between periods was not significant ($P < 0.05$) due to the large variance in prey lengths before the drawdown. The total lengths of the 8 striped bass sampled in the period before the drawdown were larger (836 mm TL) than the nine stripers sampled during the drawdown (775 mm TL) which had consumed the larger shad.

During the extreme drawdown, only 2 major groups of food items were found in striped bass stomachs: shad and unidentified fish remains. However, in the same time period before the drawdown, striped bass were more euryphagous, feeding on shad, brook silversides (*Labidesthes sicculus*), *Lepomis* spp., minnows (*Pimephales* and *Notropis* spp.), and unidentified fish. It is possible that native predatory fish (*Micropterus* and *Pomoxis* spp.) cropped off the littoral forage species during the extreme drawdown while striped bass concentrated on the prey species most abundant in their preferred pelagic habitat.

Catch per unit effort (CPUE) of striped bass with gill nets in 1981–82 was lower than CPUE before the drawdown. It is hypothesized that, because of the substantial reduction in total lake surface area (20%) during the drawdown, striped bass had to travel less to secure food items due to the physical crowding of prey species and therefore were less susceptible to passive entanglement gear. This hypothesis is supported by a comparison of the percentage of striped bass stomachs with food items before the drawdown (76.9%) to striper stomachs with food items during the drawdown (100%).

Conclusions

Adult striped bass in a large, open-water Arkansas reservoir fed predominantly on gizzard shad (by weight) throughout the year and heavily on threadfin shad during the cold winter months of 1980–81 when threadfin were lethargic, dying off, and more susceptible to depressed water temperatures. Other species of fish and invertebrates comprised only a minor proportion of food items regardless of the time of year. Of 849 food items identified, not one was a black bass.

An increasing trend in size of shad consumed and size of striped bass examined was observed, and the positive correlation between these 2 variables was significant ($P < 0.05$). Larger striped bass generally fed upon larger prey items as evidenced by gizzard shad up to 356 mm TL being consumed by the larger stripers.

Weights of gizzard shad per striper stomach were significantly higher during the extreme winter drawdown than the winter before, suggesting increased predation by striped bass in the crowded drawdown conditions. The difference in total weight of all shad per stomach may have been larger if a threadfin shad die-off that occurred in the severe winter before the drawdown had not skewed the data.

The variety of adult striped bass diet was more limited during the extreme drawdown (only 2 taxa of fish eaten) than before it (5 taxa), although predominant food organisms were shad in both cases. Striped bass were also more difficult to sample during the drawdown perhaps due to the decreased mobility necessary for striped bass to capture prey in the crowded drawdown conditions.

Striped bass fed actively during the cooler months and, therefore, use of a drawdown to control prey species may be effective during winter as well as summer in lakes with striped bass fisheries. Winter drawdowns create less animosity between lake residents and managing agencies and coordinate well with flood control schemes of large multi-use reservoirs. The possibility of water quality problems developing in the winter should be considered by the biologist responsible for the lake in question.

Utilization of an often overabundant prey species, such as gizzard shad, by a sport species capable of filling the usually vacant pelagic niche in large reservoirs is beneficial to the total fishery of a lake in many cases. Predation by striped bass on native sport fish, especially black bass, was nil in the Arkansas reservoir examined in this study.

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