Food Habits and Growth of Young-of-Year Striped Bass in Cherokee Reservoir, Tennessee

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Abstract: Of 109,675 striped bass (*Morone saxatilis*) stocked in June 1979 in Cherokee Reservoir, Tennessee, only 72 were recaptured. They were stocked at a mean total length of 3.5 cm and averaged 21.7 cm after 1 year of growth. After stocking, striped bass consumed mostly Crustacea, with Chironomidae being the primary food source for the rest of the year. Striped bass switched from invertebrates to fish (primarily Clupeidae) at 20 cm or approximately 1 year after stocking. Condition values (K) ranged from 0.8 to 1.3.

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As a result of persistence and dedication of many researchers within the past decade, a very popular game fishery for striped bass (*Morone saxatilis* Walbaum) has developed in many inland waters. These freshwater populations have aided in controlling clupeid numbers and have provided an important recreational fishery.

Since the late 1950s, striped bass introductions into inland waters have become an integral part of many state fishery programs. Successful hatchery procedures have permitted some states to utilize local sources of brood fish in support of a yearly stocking program. Tennessee has maintained such a program since the late 1960s by stocking fry and juveniles into reservoirs in the middle and eastern sections of the state. These include Barkley, Boone, Cherokee, Chickamauga, Kentucky, Melton Hill, Norris, J. Percy Priest, Tims Ford, and Watts Bar reservoirs (Cottrell, pers. commun.).

Since the initial stocking of striped bass in Tennessee, limited research has been conducted to determine various aspects of the life history of young-of-year and yearlings. Studies by Van Den Avyle et al. (1983) on Watts Bar Reservoir, Richardson (1982) on Norris Reservoir, and Saul (1981) on Cherokee Reservoir have been the most complete to date.

The purpose of this investigation was to analyze the diet composition of young-of-year striped bass. In addition, growth increments and condition values for young-of-year striped bass were determined for the duration of this study.

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Methods

The study was done on Cherokee Reservoir in East Tennessee. It is located on the main stem of the Holston River and is surrounded by agricultural and industrial development. This eutrophic, multi-purpose storage impoundment was formed in 1941 by the Tennessee Valley Authority (TVA). At full pool, Cherokee covers 12,591 ha with a maximum depth of 46 m. This reservoir is used for power generation, flood control, and recreational purposes (Saul 1981).

On 26–28 June 1979, approximately 110,000 striped bass fingerlings from Tennessee Wildlife Resources Agency's Eagle Bend Hatchery were stocked at Quarryville access area ramp in the upper end of the reservoir. Prestock samples of zooplankton, fish, and substrate organisms revealed this area was rich in food items and low in potential predators. After stocking, collections of striped bass began on 10 July 1979 with areas up to 8 km on either side of the stocking site being sampled. Fish were collected every 2 weeks with a 9.5 mm × 1.8 m × 15.2 m straight seine on each collection date at 5 to 8 sites per night until November 1979. Monthly samples began in November 1979 and continued through June 1980. From August 1979 through June 1980, fish were also collected with gill nets 45.7 m long by 1.8 m deep with mesh sizes of approximately 13, 19, 25, and 32 mm. Electrofishing was also utilized on most collection dates (at night) with a boom-type 230 V (5000 watt) high cycle AC generating unit. Sampling was continued on each collection data until no striped bass were collected. All specimens were preserved in 10% formalin for later analysis.

Gut analyses were performed on all striped bass collected during the study (the gut included the entire digestive tract from the esophagus to the anus). Food items were identified under a 40× binocular dissecting scope to the lowest practical taxa. Unidentifiable materials were classified as miscellaneous. Total length in centimeters and weight in grams were recorded for each fish.

Numerical abundance of foods (by actual numbers consumed) and frequency of occurrence of foods in all fish captured were tabulated. Coefficients of condition (K) were calculated using Hile (1936) where $K = \frac{100W}{L^3}$, with weight in g and total length in cm.

Results and Discussion

Food Habits

Of the 72 guts examined from Cherokee striped bass from July 1979 to June 1980, none were empty. Young-of-year striped bass consumed more Chironomidae larvae and pupae than all other food organisms. By numerical abundance, their diets consisted of 52% Chironomidae, 16% Crustacea, and 4% fish. Chironomidae occurred in 71% of all stomachs, Crustacea in 14%, and fishes in 8% (Table 1).

When food habits were examined by collection sites at monthly intervals, Chironomidae were again determined to have been ingested more frequently. In July and August 1979, young-of-year striped bass consumed Chironomidae almost exclusively. In the fall and early winter, they consumed not only Chironomidae, but also Crustacea and some Clupeidae. Clupeidae were not prevalent in their diets until the spring of 1980 when the striped bass were 1 year old. It is hypothesized that when these fish were stocked, the individual clupeids were too large to be utilized by the young-of-year striped bass. Very few 1+ fish were captured in 1980, indicating few 1979 fish survived the winter.

Table 1. Food items in 72 guts of striped bass by percent of total numbers consumed and by frequency of occurrence in all Cherokee samples.

Food organisms	Percent of total	Frequency of occurrence (%)
Insects		
Chironomidae larvae	30.6	63.7
Chironomidae pupae	21.8	6.8
Chaoborus larvae	3.9	0.7
Hydracarina	2.4	0.4
Neuroptera larvae	1.0	0.5
Ephemeroptera	0.5	0.1
Hymenoptera pupae	3.4	0.1
Crustaceans		
Ostracoda	1.5	0.2
Cladocera	7.8	7.6
Argulus sp.	1.5	0.2
Copepoda	4.9	6.4
Fish		
Clupeidae	3.4	6.9
Morone chrysops	0.5	1.4
Miscellaneous	15.8	4.6

When young-of-year striped bass were divided into 2.5 cm length classes, food habits of each length class could be examined (Table 2). There were several length class shifts from one food item to another. Fish from 2.6 to 5.0 cm consumed Crustacea, while fish from 5.1 to 10.0 cm ate Chironomidae. Striped bass from 10.1 to 15.0 cm exhibited a gradual shift from Chironomidae back to Crustacea, while those from 15.1 to 17.5 cm ingested Chironomidae again. These shifts could be explained by relative abundances of food organisms due to location in the reservoir or seasonal variability. As the fish grew longer, more clupeids appeared in their diets. Striped bass more than 20 cm in length consumed primarily clupeids.

Studies by Stevens (1965), Gomez (1970), Harper and Jarman (1971), Humphries and Cumming (1971), Wigfall and Barkuloo (1975), Higginbotham (1979), Pelren (1981), and Richardson (1982) indicated diets consisting of Crustacea and Chironomidae for smaller length classes. Most refer to a diet shift from Crustacea and aquatic insects to fish at a shorter length (100 to 150 mm) than was found in this study. This was probably because clupeids spawned earlier than in past years and were too large to be utilized by the striped bass when they were stocked.

Table 2. Striped bass food consumption (by actual numbers) by length classes.

Food organisms	Length class[a]										
	1	2	3	4	5	6	7	8	9	10	11
Insects											
Chironomidae larvae	7.4	73.8	76.6	47.5	1.9	100.0		33.3			
Chironomidae pupae	1.1	9.3	7.4	6.3	0.5			8.3			
Chaoborus larvae			1.0	2.1	0.9						
Ephemeroptera					0.2						
Neuroptera larvae			0.8								
Hymenoptera pupae		0.3	0.6	0.2							
Hydracarina		0.6	0.7	0.4							
Crustaceans											
Ostracoda		0.1	0.3	2.1							
Cladocera	14.9	9.6	1.6	41.0	61.0						
Argulus	4.2		0.2	0.1							
Copepoda	68.1	2.5	6.9		35.5						
Fish											
Clupeidae								58.4		58.3	66.7
Morone chrysops											25.0
Miscellaneous	4.3	3.8	3.9	0.3						41.7	8.3

[a] Length classes are as follows:

1 = 2.6–5.0 cm
2 = 5.1–7.5 cm
3 = 7.6–10.0 cm
4 = 10.1–12.5 cm
5 = 12.6–15.0 cm
6 = 15.1–17.5 cm
7 = 17.6–20.0 cm
8 = 20.1–22.5 cm
9 = 22.6–25.0 cm
10 = 25.1–27.5 cm
11 = 27.6 cm and above

Growth

Striped bass stocked in Cherokee Reservoir in June 1979 at an average length of 3.5 cm, were captured up to 1 year later at a mean length of 21.7 cm. This growth rate compares favorably to most published data for the species. Differences could be attributed to general diet preferences, forage bases, habitats, and seasonality in various parts of the country. Estimates for 1 year's growth in striped bass were relatively close in all 4 Tennessee studies. In most cases, length estimates for anadromous populations were lower than Cherokee values and, on the average, less than those of landlocked populations (Table 3). It must be noted that there were very high numbers of white bass (*Morone chrysops*) in Cherokee during the collection period. It has been noted by Tennessee Wildlife Resources Agency biologists that during years of high white bass numbers, low numbers of striped bass survive (D. Bishop and D. Peterson, pers. commun.).

Mean condition values (K) for striped bass (Table 4) for their first year of growth in Cherokee Reservoir ranged from 0.8 to 1.3. Although these condition values reflect a small sample size, they appear consistent in comparisons with local data of larger sample sizes. These values approximated Texas

Table 3. Selected growth estimates of striped bass.

Author	Study location	Actual or back-calculated total length (mm) at age I[a]
Present study	Cherokee Reservoir, Tenn.	217
Higginbotham (1979)	Watts Bar Reservoir, Tenn.	182
Axon (1979)	Herrington Lake, Ken.	280
TVA (1975)	Cherokee Reservoir, Tenn.	175
Weaver (1975)	J. Percy Priest Reservoir, Tenn.	216
Smith (1973)	Savannah River, Ga.	163 (152)
Humphries and Cumming (1973)	Culture Ponds in Weldon, N.C.	170
Erickson et al. (1971)	Keystone Reservoir, Okla.	279 (261)
Bason (1971)	Delaware Estuary	109 (102)
Neal (1971)	Kerr Reservoir, Okla.	212 (198)
Mensinger (1970)	Keystone Reservoir, Okla.	259
Ware (1970)	Florida	282
Chadwick (1966)	Sacramento-San Joaquin River System, Calif.	97 (91)
Heubach et al. (1963)	Sacramento-San Joaquin River System, Calif.	122 (114)
Trent (1962)	Albemarle Sound, N.C.	100
Mansueti (1961)	Chesapeake Bay, Md.	139 (130)
Stevens (1957)	Santee-Cooper Reservoir, S.C.	231 (216)
Scruggs (1955)	Santee-Cooper Reservoir, S.C.	198
Valdykov and Wallace (1952)	Chesapeake Bay, Md.	118 (110)
Merriman (1941)	New England and Long Island, N.Y.	114
Merriman (1941)	Hudson River, N.Y.	292
Scofield (1928)	California	104 (97)

[a] Numbers in parentheses are measured fork lengths (FL) of fish in study; total length (TL) was calculated by using the conversion factor 1.07 for FL to TL (Mansueti 1961).

Table 4. Condition factors (K) of striped bass by 2.5 cm length classes.

Total length (cm)	Sample size (*N*)	K
2.6– 5.0	1	0.76
5.1– 7.5	15	0.77
7.6–10.0	40	0.87
10.1–12.5	5	0.91
12.6–15.0	2	1.08
15.1–17.5	1	1.15
17.6–20.0		
20.1–22.5	2	1.07
22.6–25.0		
25.1–27.5	2	1.05
>27.5	4	1.28

Instrument's (1973) estimates of striped bass in the Hudson River (0.9 to 1.2), Weaver's (1975) estimates for striped bass in J. Percy Priest Reservoir, Tennessee (0.8 to 1.6), and Richardson's (1982) estimates of striped bass in Norris Reservoir, Tennessee (0.7 to 1.4). Cherokee values were less than those of Ware (1970), which ranged from 1.3 to 2.7 in Florida striped bass. These differences could be attributed to a longer growing season or larger forage base in Florida than in the other studies. A drop in Cherokee condition values between striped bass 17.5 and 27.5 cm in length could be due to a scarcity of forage during the winter-spring months or an artifact resulting from a small sample size. If the condition values between fish 15.0 and 27.5 cm are averaged, they result in a value of 1.08, which is equal to that of the previous length class. This is probably due to a combination of the 2 factors mentioned above.

In conclusion, it is noted that Cherokee striped bass did reach nearly average sizes in their first year, despite that they were unable to take advantage of the forage base early in their life cycle. It must also be noted that there appeared to be relatively poor survival, taking into account the large number of fish stocked and the small number of fish captured.

Literature Cited

Axon, J. R. 1979. An evaluation of striped bass introductions in Herrington Lake. Ky. Dep. of Fish and Wildl. Resour., Fish. Bul. 63.

Bason, W. H. 1971. Ecology and early life history of striped bass, *Morone saxatilis*, in the Delaware Estuary. Icthyol. Assoc. Bul. 4. Middletown, Del.

Chadwick, H. K. 1966. Variation in the growth of young striped bass (*Roccus saxatilis*) in the Sacramento-San Joaquin system. Calif. Fish and Game, Inland Fish. Adm. Rep. 66-11. Mimeo.

Erickson, K. E., J. Harper, G. C. Mensinger, and D. Hicks. 1971. Status and artificial reproduction of striped bass from Keystone Reservoir, Oklahoma. Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm. 25:513–522.

Gomez, R. 1970. Food habits of young-of-year striped bass, *Roccus saxatilis* (Walbaum), in Canton Reservoir. Proc. Okla. Acad. of Sci. 50:79–83.

Harper, J. L. and R. Jarman. 1971. Investigation of striped bass, *Morone saxatilis* [Walbaum), culture in Oklahoma. Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm. 25:501–512.

Heubach, W., R. J. Toth, and A. M. McCready. 1963. Food of young-of-the-year striped bass (*Roccus saxatilis*) in the Sacramento-San Joaquin River system. Calif. Fish and Game 49:224–239.

Higginbotham, B. 1979. Growth, food habits, maturation, and distribution of the striped bass (*Morone saxatilis*) in Watts Bar Reservoir, Tenn. Master's thesis. Tenn. Tech. Univ., Cookeville, Tenn.

Hile, R. 1936. Age and growth of the cisco, *Leucichthys artedi* (Lesueur), in the lakes of the northeastern highlands, Wisconsin. U.S. Bur. of Fish. Bul. 48(19):211–317.

Humphries, E. T. and K. B. Cumming. 1971. Food habits and feeding selectivity of striped bass fingerlings in culture ponds. Proc. Annu. Conf. Southeast. Assoc. of Game and Fish Comm. 25:522–536.

———. 1973. An evaluation of striped bass fingerling culture. Trans. of the Am. Fish Soc. 102:13–20.

Mansueti, R. J. 1961. Age, growth, and movements of the striped bass, *Roccus saxatilis,* taken in size selective fishing gear in Maryland. Chesapeake Sci. 2:9–36.

Mensinger, G. C. 1970. Observations on the striped bass, *Morone saxatilis,* in Keystone Reservoir, Okla. Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm. 24:447–463.

Merriman, D. 1941. Studies on the striped bass, *Roccus saxatilis,* of the Atlantic Coast. U.S. Dep. Int., Fish. and Wildl. Serv. Fish. Bul. 50:1–77.

Neal, W. E. 1971. Landlocked striped bass of John H. Kerr Reservoir, a 10-year summary of research and management activities. Va. Comm. Game and Inland Fish Proj. F-5.

Pelren, D. W. 1981. Results from post stocking seine checks on Tims Ford and J. Percy Priest Reservoirs, Tenn. Tenn. Wildl. Resour. Agency. Mimeo.

Richardson, J. M. 1982. Food habits and growth of young-of-year striped bass in Norris Reservoir, Tenn. Master's thesis. Univ. of Tenn., Knoxville.

Saul, B. M. 1981. Food habits and growth of young-of-year striped bass in Cherokee Reservoir, Tenn. Master's thesis. Univ. of Tenn., Knoxville.

Scofield, E. C. 1928. Striped bass studies. Calif. Fish and Game 14:29–37.

Scruggs, G. D., Jr. 1955. Reproduction of resident striped bass in Santee-Cooper Reservoir, S.C. Trans. of the Am. Fish. Soc. 85:144–159.

Smith, L. D. 1973. Life history studies of striped bass. Dep. of Nat. Resour., Game and Fish Div., Fish Sect. Sport Fish. Div., Brunswick, Ga.

Stevens, R. E. 1957. The striped bass of the Santee-Cooper Reservoir. Proc. of the Annu. Conf. Southeast. Assoc. Game and Fish Comm. 11:253–264.

———. 1965. A report on the operation of the Moncks Corner striped bass hatchery. S.C. Wildl. Mar. Resour. Dep.

Tennessee Valley Authority (TVA). 1975. Fish inventory data, Cherokee Reservoir. Div. of For., Fish., and Wildl. Dev. Publ. Norris, Tenn.

Texas Instruments. 1973. Hudson River ecology study in the area of Indian Point. First Annu. Rep. to Consolidated Edison Co., New York, N.Y.

Trent, W. L. 1962. Growth and abundance of young-of-year striped bass, *Roccus saxatilis* (Walbaum), in Albemarle Sound, N.C. Master's thesis. N.C. State Univ., Raleigh.

Van Den Avyle, M. J., B. J. Higginbotham, B. T. James, and F. J. Bulow. 1983. Habitat preferences and food habits of young-of-year striped bass, white bass, and yellow bass in Watts Bar Reservoir, Tennessee, North Am. J. of Fish. Manage. 3:163–170.

Vladykov, V. D. and D. H. Wallace. 1952. Studies of striped bass, *Roccus saxatilis* (Walbaum), with special reference to the Chesapeake Bay region during 1936–1938. Bul. of the Bingham Oceanogr. Collection, Yale Univ., New Haven, Conn. 14(1):132–177.

Ware, F. J. 1970. Some early life history of Florida's inland striped bass, *Morone saxatilis*. Proc. of the Annu. Conf. Southeast. Assoc. of Game and Fish Comm. 24:439–447.

Weaver, O. R. 1975. A study of the striped bass, *Morone saxatilis,* in J. Percy Priest Reservoir, Tennessee. Master's thesis. Tenn. Tech. Univ., Cookeville.

Wigfall, M. and J. M. Barkuloo. 1975. A preliminary report on the abundance and biology of stocked striped bass in the Choctawhatchee River System, Florida. Proc. of the Annu. Conf. Southeast. Assoc. of Game and Fish Comm. 29: 152–161.