To the Graduate School:

I am submitting herewith a thesis written by John Michael Richardson entitled "Food Habits and Growth of Young-of-Year Striped Bass in Norris Reservoir, Tennessee." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Wildlife and Fisheries Science.

J. Larry Wilson, Major Professor

We have read this thesis
and recommend its acceptance:

Thomas K. Hill, Sr.

Richard Strange

David A. Evans

Accepted for the Council:

L. Evan Pell
Vice Chancellor
Graduate Studies and Research

FOOD HABITS AND GROWTH OF YOUNG-OF-YEAR STRIPED BASS IN NORRIS RESERVOIR, TENNESSEE

A Thesis

Presented for the

Master of Science

Degree

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John Michael Richardson

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ABSTRACT

Of 187,000 striped bass fingerlings stocked in 1979, only 13 were recovered. Two hundred twenty-nine young-of-year striped bass were collected in 1980 from the initial stocking of 180,000. Crustacea and chironomids were the dominant food items ingested by striped bass under 15.0 cm in total length. Striped bass were 12.5 cm in length when fish became important in the diet; however, striped bass as small as 7.5 cm would occasionally utilize fish as a food source. Striped, white, and black bass food habits were compared. Striped and white bass utilized both benthic and open-water food sources. Striped bass were almost always collected over soft substrate types of clay or silt or a combination of the two.

Striped bass fingerlings stocked in July 1980 at an average length of approximately 4 cm grew to an average length of 19.7 cm by December 1980.

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CHAPTER I

INTRODUCTION

Striped bass (Morone saxatilis), a historically anadromous fish, were reported to be able to complete their life cycle in land-locked freshwater (in Santee-Cooper Reservoir, S. C.) by Scruggs (1955). Subsequent to this, many attempts were made to stock adult striped bass and fry into other reservoirs in hopes of producing striped bass fisheries by means of natural reproduction, but these attempts resulted in little or no success (Stevens 1957, Surber 1957, Bailey 1975). Striped bass were considered for stocking in reservoirs for two reasons: (1) to control large clupeid (Dorosoma spp.) populations by occupying a new under-utilized open-water "niche," and (2) to provide a new and different type of sport fishery. Stevens (1957) reported that the primary diet of adult striped bass in Santee-Cooper Reservoir was clupeid fishes. With the advent of improved culture techniques and the realization that maintaining a successful striped bass sport fishery means repeated annual stockings of fingerlings, several states have now established a striped bass fishery in one or more reservoirs (Bailey 1975).

The Tennessee Wildlife Resources Agency (TWRA) has, since the mid-to-late 1960's, successfully introduced striped bass fingerlings into several Tennessee lakes. Earlier attempts at stocking striped bass fry into a few selected reservoirs has been deemed unsuccessful. Notably, Watts Bar Reservoir was stocked with 900,000 fry in 1964 with no striped bass fishery being established (Bailey 1975).

Since those earliest attempts, the improvement of culture techniques and the building of the new Eagle Bend hatchery facility at Clinton, Tennessee, in 1977 have allowed the TWRA to expand its striped bass management plan. The agency is now in the third year of a five-year management plan committed to stocking 5 fish/acre/year in nine different reservoirs. Those reservoirs currently being stocked are Norris, Cherokee, Watts Bar, Tims Ford, J. Percy Priest, Kentucky, Boone, Old Hickory, and Melton Hill. These reservoirs were chosen on the basis of water quality, forage base, and suitable habitat. Additional introductions of striped bass fingerlings into other Tennessee reservoirs will occur only if those reservoirs meet the aforementioned criteria, and only if the TWRA and its hatchery facilities can provide fingerlings for future stockings in addition to those required to maintain present striped bass fisheries in the management plan reservoirs (Cottrell, personal communication).

This study was commissioned by the TWRA in 1979 and began in July of the same year. The proposal involved two concurrent projects concerning food habits, growth, and distribution of young-of-year (y-o-y) striped bass and yearling striped bass. The present study was conducted on Norris Reservoir and the other on Cherokee Reservoir, in order to compare food habits and growth between striped bass fingerlings in two separate impoundments. The length of each study (field collections) was 18 months. No comprehensive studies concerning striped bass in Tennessee had been conducted prior to Weaver's (1975) research on food habits and growth of adult striped bass in J. Percy Priest Reservoir. Since then, and prior to this study, only

four major research projects involving striped bass have been completed. Stooksbury (1977), Schaich (1979), and Waddle (1979) reported on biotelemetry studies of striped bass movements and habitat preferences in J. Percy Priest and Cherokee Reservoirs, respectively. Higginbotham's (1979) research of striped bass in Watts Bar Reservoir has been the only study concerning food habits and distribution of y-o-y striped bass in Tennessee.

The objectives of this study were: (1) to determine the food habits of y-o-y striped bass and yearling striped bass and compare them with those of white bass (Morone chrysops) and other species, (2) to determine at what size y-o-y striped bass convert from an invertebrate diet of zooplankton and benthos to a piscine diet, (3) to determine the location of y-o-y and yearling striped bass within the reservoir and any seasonal movements, and (4) to improve predictive methods for determining areas of the reservoir most suitable for future stockings based on food habits of y-o-y striped bass immediately after stocking.

CHAPTER II

LITERATURE REVIEW

Intensive research of striped bass has been conducted ever since they were introduced into California waters in 1879 (Scofield 1931). Worth (1881) was among the first to successfully propagate striped bass artificially. Pearson (1938), Raney (1952), and Scofield (1931) gave early detailed descriptions of striped bass life histories. Many studies have concerned anadromous populations in coastal waters and rivers. Hatton (1941) found that y-o-y striped bass in the Sacramento River, California, consumed primarily Crustacea. Heubach et al. (1963) reported that fish were unimportant in the diet of y-o-y California striped bass and that Neomysis, copepods, cladocerans, amphipods, and chironomids were the most utilized food items. Availability of forage was an important factor in the fact that 95% of striped bass in the 125 to 304 mm length range consumed fish (Manooch 1973). The most important food items of y-o-y striped bass in three Virginia rivers were mysids, insects, decapods, and fish (Markle and Grant 1970). Wigfall and Barkuloo (1975) found that striped bass from Florida coastal rivers averaged 174 mm standard length at 12 months and consumed primarily crustaceans, fish, and insects. Mean growth of Appalachicola River, Florida, striped bass was determined to be 180 mm fork length at the end of one year (U. S. Fish and Wildlife Service 1980). Young-of-year striped bass (<75 mm) in the Hudson River, New York, consumed cladocerans and copepods, whereas amphipods

became more important in the diet of bass 76 to 150 mm in length (Texas Instruments 1979).

Until Scruggs (1955) reported on the ability of land-locked populations of striped bass to complete their life cycle in Santee-Cooper Reservoir, South Carolina, all striped bass studies had been concerned only with anadromous populations. Since Stevens' (1957) report on the food habits of adult striped bass in the same reservoir, many states have initiated striped bass stocking programs in reservoirs in order to provide a new sport fishery and to try to control shad populations. With the advent of these stocking programs many new striped bass studies were initiated concerning food habits and growth in bodies of fresh water. Many of these studies involved food habits of fingerling striped bass in culture ponds. Sandoz and Johnston (1965) reported that striped bass fingerlings up to 85 mm total length utilized cladocerans, copepods, and insects. Copepods were the main food items of striped bass from 10 to 30 mm in length supplemented by cladocerans and insects (Harper et al. 1968, Humphries and Cumming 1971). These investigators also determined that cladocerans and insects, and copepods, to a lesser degree, were utilized most often by stripers in the 30 to 60 mm range, and that cladocerans and insects were the major food items consumed by striped bass from 60 to 100 mm standard length. Harper and Jarman (1971) indicated that Cladocera was the major food source for striped bass fry in the 5 to 9 mm total length range. In a study concerning feeding selectivity of striped bass fry and fingerlings in North Carolina culture ponds,

Meshaw (1969) reported that striped bass selected for the copepod Cyclops and selected against the cladocerans Bosmina, Ceriodaphnia, and Daphnia.

Stevens (1957) first reported on food habits and growth of adult striped bass in reservoirs and found shad to the dominant food item. Weaver (1975) indicated that this was also true of adult striped bass in J. Percy Priest Reservoir, Tennessee. Other studies have been concerned with food habits and growth of y-o-y striped bass in reservoirs. Gomez (1970) determined the food habits of y-o-y striped bass in Canton Reservoir, Oklahoma, to be similar to those of culture pond stripers in Oklahoma. Striped bass attained an average length of 25.8 cm (10.15 in) total length in Keystone Reservoir, Oklahoma (Mensinger 1971). Ware (1971) reported that striped bass grew to an average of 28.2 cm (11.1 in) their first year in Florida inland lakes, and that fish was the major food for all length classes. The average length for yearling striped bass in Lake of the Ozarks was reported by Hanson and Dillard (1975) to be 15.7 cm (6.2 in). Striped bass in Kentucky grew to a maximum of 31 cm (12.2 in) in one year but a successful fishery was not established (Axon 1979). McCloskey (1980) determined first year growth to be 176.6, 134.2, and 125.6 mm fork length for striped bass in three Kansas lakes. Ager (1979) reported that insects were the primary food of y-o-y striped bass less than 61 mm in length, while fish was important in the diet of all stripers greater than 61 mm. Striped bass reached an average of 18.2 cm total length their first year in Watts Bar Reservoir, Tennessee (Van Den Avyle and Higginbotham 1979). Higginbotham (1979) found that y-o-y

striped bass in Watts Bar consumed primarily copepods and cladocerans with dipterans occurring in a significant number of stomachs. He also determined that fish constituted a major portion of the diet based on percentage weight of all food items.

Biotelemetry studies concerning movements and habitat preferences of striped bass in Tennessee reservoirs were reported by Stooksbury (1977), Schaich (1979), and Waddle (1979).

CHAPTER III

DESCRIPTION OF STUDY AREA

Norris Reservoir is located on the Clinch River and in Campbell, Anderson, Union, Claiborne, and Grainger counties. It is formed by Norris Dam located at Clinch River Kilometer 128 (Mile 79.8). Norris Dam was completed by the Tennessee Valley Authority in 1936 and is a multipurpose reservoir intended for power generation, flood control, and recreation. At normal pool level (el. 310.9 m) the dam backs up 90 km of the Powell River and 116 km of the Clinch River. Shoreline length at this elevation is 1286 km and the area of the reservoir is 13,840 hectares. Total drainage area at the dam is 7542 km^2 (Moss 1967). Norris Reservoir is a deep (maximum depth approximately 61 m), relatively clear water, mesotrophic impoundment characterized by steep banks and deep coves. Visibility is frequently 2.5 to 3 m in the clearer portions of the lower reservoir. Exposed points consist either of rocky outcroppings, gravel, clay or clayey silt, silt, or a hard clay shale.

CHAPTER IV

MATERIALS AND METHODS

Collection Period from June 1979 through May 1980

The TWRA has traditionally stocked striped bass fingerlings in Norris Reservoir (Figure 1) at Clinch River Kilometer 244 (Mile 151.5), a riverine portion of the lake with a variable flow rate. In order to determine the abundance of zooplankton, benthic organisms, forage fish, and potentially competing predatory fish, a pre-stock collection was initiated on June 28. Seven sites, up to 26.5 km down stream, were selected to be sampled based on their accessibility by truck and distance from the main channel. Fish were sampled by two quarter hauls of a 3.2 mm x 1.2 m x 6.1 m straight seine. Invertebrates were collected in the following manner: (1) two 5 m horizontal tows with a 22.9 cm diameter plankton net (60 mesh) and (2) two Ekman dredge samples of 232.2 cm^2 each. The initial pre-stock collection was made during the afternoon. Thereafter, all collections, including the 1980 pre-stock collection, were performed at night because striped bass fingerlings move from deeper water to shallower after sunset (see Results and Discussion concerning movements).

A total of 187,000 striped bass were stocked during 1979. Of the total, 92,000 were introduced during the week of 3-10 July, with the remainder stocked one month later (3 August). Average length of fingerlings stocked ranged from 3.8 to 7.0 cm with the majority falling in the 3.8 to 4.5 cm range. Bi-weekly post-stock collections were initiated immediately after the first stocking and included the stocking

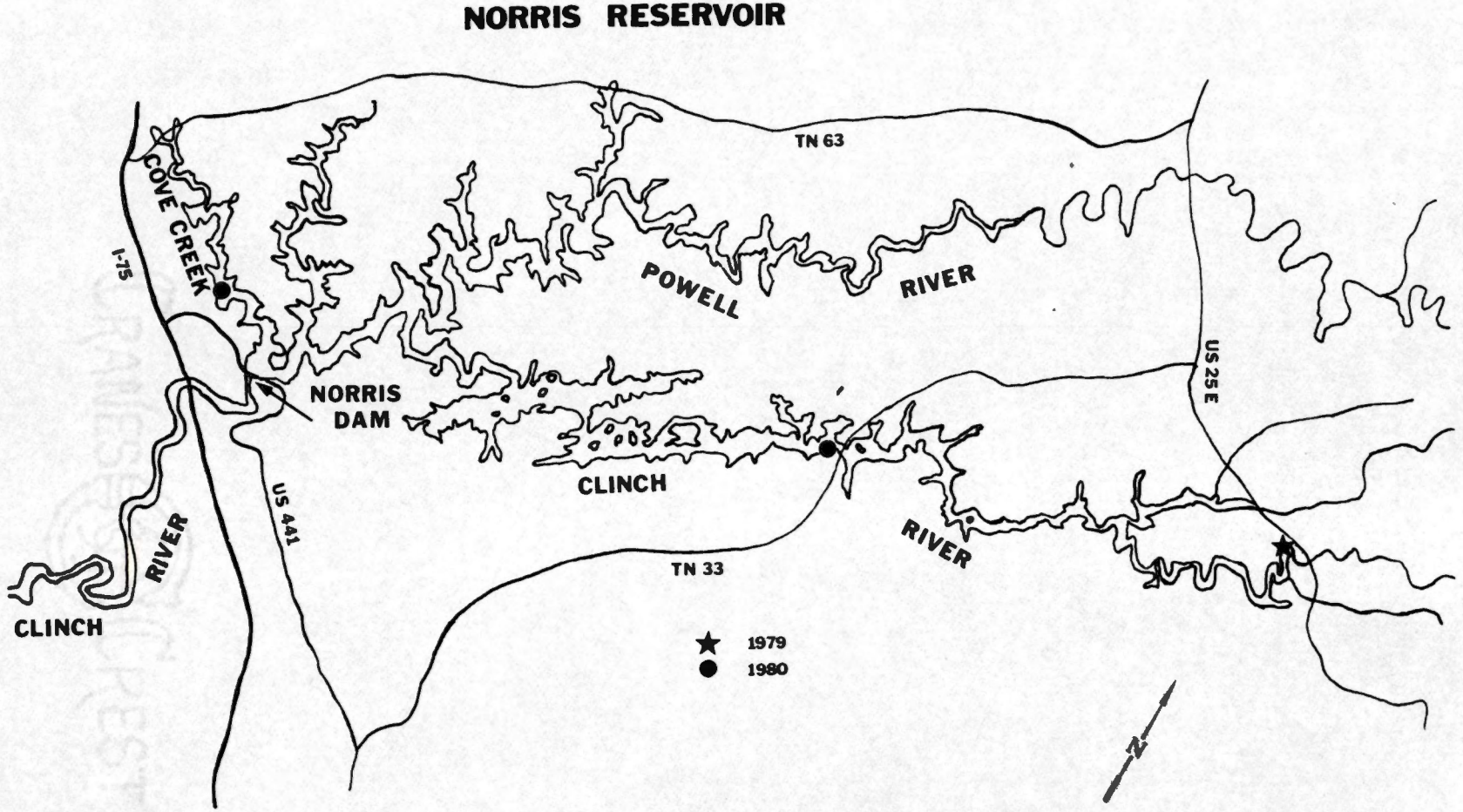


Figure 1. Map of Norris Reservoir showing stocking sites for 1979 at the 25E public access and 1980 at Beech Island and Cove Creek.

site and adjacent accessible locations. Almost all sites sampled were those that were readily accessible by truck because of TWRA success in capturing y-o-y striped bass from boat ramps and other lake accesses. Fish were sampled through October by a minimum of two quarter hauls of a 9.5 mm x 1.8 m x 15.7 m straight seine. Thereafter, through May 1980, fish were collected monthly using 12 gill nets 45.7 m long x 1.8 m having mesh sizes (3 nets each) of 12.7, 19.1, 25.4, and 31.8 mm. Nets were either anchored on shore or floated and fished in sets of two or three nets tied together. Shallow water, deep water, and shallow to deep water sets were used. Zooplankton communities were sampled at each site in the same manner as for pre-stock sampling. Benthos samples were collected, as in pre-stock methods, quarterly at regular sampling sites and represented highwater, summer pool, and low water winter pool periods. All samples during the collection period were preserved in the field in a 10% formalin solution. Twenty-two sites were sampled from Clinch River Kilometer 135 (Mile 84.5) to the stocking site at Clinch River Kilometer 244 (Mile 151.5). The normal post-stock collections consisted of five sites sampled each trip.

Collection Period from June 1980 through December 1980

Due to the apparent poor survival of the 1979 stocking of striped bass, the TWRA decided to stock the 1980 fingerlings at two sites in the lower portion of the reservoir. The sites to be selected would be based on cursory examinations of the pre-stock samples. On the night of July 1, pre-stock collections were conducted at five sites in the same manner as the 1979 sample. Beech Island access at Clinch River Kilometer 191 (Mile 119) was selected as a stocking site due to

the good densities of zooplankton and Cove Creek Public Access near Point 3 was recommended as the other stocking site because of availability of fry and low numbers of predators. Approximately 90,000 striped bass fingerlings, averaging 3.8 to 4.5 cm in length, were stocked at each site. Bi-weekly post-stock collections were initiated and continued through October. One collection each was conducted for the months of November and December. Fish were collected by shoreline seining and gill netting in the manner of the 1979 samples. Electrofishing gear was also used in conjunction with these methods. The electrofishing gear consisted of a 5.5 m flat-bottomed boat rigged with two T-poles supporting two cables each; a 5000-watt, 220-volt AC generator supplied the current for the electric field. Seining was discontinued at the end of September due to lack of success of capturing larger length classes of striped bass, and electrofishing and gill netting were used exclusively to collect the fish samples from October through December. Zooplankton and benthos communities were sampled as in 1979. Thirteen additional sites were sampled in 1980, mostly in the vicinity of Cove Creek and Beech Island. Post-stock collections alternated between these two stocking site areas in order to insure an adequate striped bass sample size for 1980.

Food Habit Analysis

Benthos and zooplankton samples were analyzed to determine qualitatively what was available at each site. Benthos samples were sifted through standard brass substrate sieves of 10, 20, and 40 mesh (holes per in^2), and the entire contents of each sieve was picked and sorted. Zooplankton samples from a known volume were sub-sampled by

vigorously shaking the contents and then drawing off 2 or 5 ml volumes, using a Hensen-Stempel pipette, until 200 organisms were counted. Total organisms per sample were determined from the ratio of total volume of the sample to total volume subsampled. Benthos and zooplankton organisms were placed in petri dishes, identified, and enumerated using a 40X dissecting scope.

All fish examined for food habits were measured to the nearest millimeter (TL) and weighed to the nearest tenth of a gram. All fish were weighed and measured in the laboratory after they had been changed from a 10% formalin solution to a 40% alcohol solution. Striped bass were also weighed and measured prior to storage in the alcohol solution after rehydration in water (changed periodically) until no formalin odor was detected. This was done in order to obtain a weight for each fish that would approximate the live weight for that fish.

The abdominal cavity of all fish examined for food habits was opened by an incision between the pelvic fins using dissecting scissors. The incision was continued anteriorly to the isthmus and then posteriorly to the anus. A vertical incision was made on the right side of the fish from the anus to the top of the abdominal cavity along with another incision from the isthmus through the opercle. This flap of tissue was folded up and the entire stomach and gut removed. The stomach and intestine were then cut length-wise and the entire contents washed and scraped into a petri dish. All food organisms were identified under a 40X dissecting scope. On rare occasions the contents were subsampled by placing the contents in an aqueous solution and

stirring before being withdrawn in 5 ml Hensen-Stempel volumes. This occurred only when large numbers of partially digested zooplankton made it difficult to adequately separate, identify, and count each organism. All food items were counted and identified to the lowest practical taxa.

Food habits of all striped bass collected during the study were examined. White bass were also examined for food habits along with largemouth bass (Micropterus salmoides), smallmouth bass (M. dolomieui), and spotted bass (M. punctatus). Up to 30 white bass were examined from any site where striped bass were collected; only 10 white bass were examined from other sites where striped bass were not captured. Up to 10 black bass were examined from any site where striped bass were collected.

Data Analysis

All food habit and growth data were analyzed using the UTCC Decsystem-10 and SAS 1979. Food habits were analyzed to indicate percent of total and frequency of occurrence of food items in the diet in order to determine trends that may be a result of differences due to type of fish, length class, months, or sites. A coefficient of condition, K, was calculated using Fulton's formula (Bagenal and Tesch 1978):

$$K = \frac{W10^5}{L^3}$$

W = weight in grams

L = total length in millimeters

Condition factors were calculated for each fish and average condition factors were determined for each length class. Weight-length relationships were calculated for striped bass and white bass based on the logarithm of average weight in grams ($\overline{W}$) to the logarithm of average length in cm ($\overline{L}$). Thus, $\log \overline{W} = a' + b' \log \overline{L}$ where a' is the y-axis intercept, b' is the slope of the regression line (Ricker 1975).

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CHAPTER V

RESULTS AND DISCUSSION

Of 187,000 striped bass fingerlings stocked in 1979 only 13 were recovered. No 1+ striped bass were collected the following year, thus survival of the 1979 year class was considered extremely poor. Lake conditions and the condition of the stocked fish might help explain the poor survival. Developmental problems occurred in some hatchery ponds at Eagle Bend that resulted in high numbers of striped bass fingerlings exhibiting pugheadedness. Although it was thought that not many of these pugheads were actually stocked, 7 of the 13 y-o-y striped bass collected in 1979 displayed some degree of the condition. Grinstead (1971) reported that pugheaded striped bass suffered higher mortality rates than did normal stripers in Canton Reservoir, Oklahoma.

Abnormal amounts of rainfall occurred during the spring of 1979 resulting in high-water conditions in the reservoir. A considerable current existed at the stocking site; this probably presented a hostile environment to the fingerlings considering the fact that they were raised in pond conditions. The fact that the fingerlings had been seined, handled, and transferred to the stocking site and then introduced into rapid flowing water, in conjunction with the pugheaded condition of the fingerlings probably resulted in the poor survival of the 1979 year class. To help document this, a 19 km section of the reservoir was sampled using a boat to get to the best seining

sites. Sampling occurred within 5 days of stocking 95,000 fingerlings and only one striped bass was collected.

Survival of 1980 year-class fingerlings appeared to be relatively good. Of the 180,000 fingerling striped bass stocked that year, 229 were recovered. Lake conditions were just opposite from the year before. Rainfall was below average for the spring and summer and lake levels were the lowest in several years. Stocking sites were in the mid-to-lower portion of the reservoir and none of the 1980 fingerlings (at the hatchery) exhibited any degree of pugheadedness.

Zooplankton and benthos availability both prior to stocking and at major striped bass collection sites is presented in Tables 1 and 2. Relative abundance between sites could not be determined accurately because sampling techniques were qualitative at best. No attempt was made to correlate food habits with food item abundance in the environment for the same reason. Boynton et al. (1976), however, reported that y-o-y striped bass in the Potomac River consumed food items (zooplankton and benthos) proportional to their abundance in the environment.

Food Habits

As mentioned above, 13 y-o-y of the 242 striped bass collected during this study were captured in 1979. The remainder were collected in 1980 and identified as y-o-y. Gut analyses were performed on all of the striped bass. Food habits were also examined for 269 white bass captured during 1979 and 1980. These were mostly y-o-y or 1-year-old fish. Ninety black bass collected during the two-year study were also examined for food habits. Of the 242 striped bass stomachs

TABLE 1

PRESTOCK ANALYSES OF PREDATORS,[a] PLANKTON,[b] AND BENTHOS[c]

Prestock Sites	Predators/m^3	Plankton/m^3	Benthos/m^2
June 1979			
Clinch River Kilometer 217	0.3	22	560
Beech Grove Access	0.2	73	603
Indian Creek Access	0.1	70	150
Clinch River Kilometer 244[d]	< 0.1	10	323
Big Sycamore Access	< 0.1	510	1,746
Coffman Camp Access	0.7	36	1,487
July 1980			
Beech Grove Access	1.0	323	409
Black Fox Access	0.8	7,647	862
Beech Island Access[d]	1.5	11,891	302
Pellissippi Point	0.4	1,015	625
Cove Creek Public Access[d]	0.2	442	323

[a]Number of predators, including fry and fingerlings, per m^3 based on two quarter hauls using a 3.2 mm x 1.2 m x 6.1 m straight seine.

[b]Number of plankton organisms per m^3 based on two 5 m tows using a 22.9 cm diameter plankton net (60 mesh).

[c]Number of benthic organisms per m^2 based on two Ekman grabs of 232 cm^2 each.

[d]Stocking sites for respective years.

TABLE 2

ZOOPLANKTON AND BENTHOS AVAILABLE AT MAJOR STRIPED BASS COLLECTION SITES

	Zooplankton				Benthos				
Site and Date	Cladocera/m^3	Leptodora kindti/m^3	Copepoda/m^3	Chaoborus/m^3	Chironomidae/m^2	Ephemeridae/m^2	Annelida/m^2	Ostracoda/m^2	Ceratopogonidae/m^2
Beech Island									
8-79	602		352		388		453	194	
9-79	1,270	529	665	2	388		453		
10-79	415	36	549		625		1,185	43	
7-80	11,097	2,311	7,546	119	625	22		237	43
Cove Creek Public Access									
7-80	376		107	7	200			65	
8-80	109	2	289	17	200				
9-80	19		216		200	22			
10-80	34		46		200				
12-80	0	0	0	0	200				
Clinch River Kilometer 188									
8-80	41		114						
9-80	109	7	527	10					

examined, 31 or 12.8% were empty. Nine (3.3%) of the white bass contained no food items, and seven (7.7%) of the black bass stomachs were empty.

When food habits, expressed as percent of total food items in stomachs (Table 3), are examined for all fish of each species, comparisons can be made between species in terms of those organisms ingested in the greatest numbers. Black bass had a much more varied diet than did white or striped bass. This is reflected in the use of all food items except Leptodora. Striped and white bass consumed Crustacea in the same proportions with Crustacea comprising 74% of the total diet of striped and white bass (in terms of numbers). White bass, however, utilized the cladoceran Leptodora to a much greater extent than did striped bass, whereas it was not consumed at all by black bass. Black bass utilized chironomids (35% of diet) much more than did striped (14%) or white bass (7%). Aquatic insects accounted for 49% of the total numbers of food items found in black bass, whereas striped and white bass consumed insects as 20% of their diet. Crustacea made up only 29% of the food items consumed by black bass; fish represented 8% of their diet as compared to 3% for white and 1% for striped bass.

Though percent of total numbers for fish was relatively low, it was a much more important food item than indicated in Table 1 due to the fact that fish, when present in the diet, will usually have the largest volume and weight of any other food item in the gut. The importance of this can be seen in Table 4 where 66% of the white bass, 50% of the black bass, and 38% of striped bass stomachs contained fish of some type. Frequency of occurrence indicated what percent of each

TABLE 3

PERCENT OF TOTAL NUMBERS OF FOOD ITEMS IN STOMACHS OF STRIPED, WHITE, AND BLACK BASS

	Striped Bass (N=242)	White Bass (N=269)	Black Bass (N=90)
Dorosoma sp.		1	1
Coleoptera			1
Lepomis sp.			1
Pimephales sp.			1
Unidentified fish	1	2	4
Chironomidae larvae	12	5	29
Chironomidae pupae	2	5	6
Copepoda	39	23	10
Cladocera[a]	28	9	19
Leptodora kindti	7	42	
Ostracoda			1
Unidentified insects		1	2
Ephemeridae		2	1
Ephemeroptera[b]			1
Chaoborus larvae	6	7	7
Annelida	2		7
Miscellaneous	1	1	4
Ceratopogonidae larvae			2

[a]Exclusive of *Leptodora kindti*.

[b]Exclusive of Ephemeridae.

CRANESBILL CREST

TABLE 4

FREQUENCY OF OCCURRENCE (%) OF FOOD ITEMS IN STOMACHS OF STRIPED, WHITE, AND BLACK BASS

	Striped Bass (N=242)	White Bass (N=269)	Black Bass (N=90)
Pisces	38	66	50
Dorosoma sp.	15	24	7
Cyprinidae		5	4
Centrarchidae	2	10	11
Lepomis sp.	2	4	6
Unidentified fish	26	36	39
Insecta	69	62	59
Diptera	64	56	48
Chironomidae	60	51	47
Ceratopogonidae	10	9	9
Chaoborus sp.	24	16	8
Ephemeroptera	14	16	14
Ephemeridae	9	14	8
Megaloptera	2	5	2
Hemiptera		3	3
Hymenoptera		1	1
Unidentified insects	7	8	20
Crustacea	44	30	19
Cladocera	36	20	10
Copepoda	34	24	10
Ostracoda	6	1	2
Annelida	3	4	1
Miscellaneous	48	29	50

species consumed a particular food item. Although Table 3 indicated that Crustacea comprised 74% of the diet of striped and white bass, only 44% of the striped bass and 30% of the white bass consumed Crustacea. Interpretation of such data can be misleading when a small number of individual fish are consuming large numbers of small food items.

Information in Table 4 establishes the importance of chironomids and other insects in the diet of striped and white bass. Although these items did not comprise a large percentage of the diet, a large percentage of fish utilized them. Sixty percent of all striped bass stomachs contained chironomids while 69% contained aquatic insects in general. Whereas chironomids represented only 10% of the organisms ingested by white bass, 51% of all white bass consumed them. Aquatic insects in general were found in 62% of white bass stomachs.

While shad comprised 1% of the total diet of black bass, only 7% of their stomachs contained this food item. Shad occurred in striped and white bass stomachs 2 to 3 times as often as in black bass. This might best be explained by the tendency of striped and white bass to occupy the more open-water areas of the lake. However, littoral forage fish such as Cyprinidae and Centrarchidae occurred in similar percentages of white and black bass stomachs, while cyprinids did not occur at all in striped bass. Centrarchids were found in only 2% of striper's stomachs. White bass utilizing cyprinids or centrarchids as frequent as black bass could be due to the fact that while white bass may occupy open-water areas more so than black bass, the former also spend a great deal of time in shallow water areas. This was

evident by the ease of collecting them by shore-line seining at any time of day. White bass movements in and out of shallow areas were probably dependent on prey availability. Striped bass, contrarily, will only move into shallow water at night (see movements). The absence of cyprinids and the low frequency of centrarchids in striped bass guts probably reflects this behavior.

Striped bass food habits were similar to those of white bass in the consumption of chironomids and Crustacea, as a whole, but differed in the types of Crustacea consumed and the overall frequency of fish and types of fish ingested (Tables 3, 4). Food habits of striped bass were similar to black bass food habits only in the frequency of consumption of Diptera (Chrironomidae, Ceratopogonidae, etc.), Ephemeroptera, and Megaloptera. White bass food habits appeared to be intermediate between those of striped and black bass. Similarities with the black bass food habits existed in the frequency and type of piscine diet, excluding Dorosoma, along with the frequencies of most of the aquatic insects in the diet.

Food Habits by Month and Length Class

Monthly food habits of striped, white, and black bass may vary greatly depending upon average size of fish, food types, and food type availability. Regardless of how these variables affect each species, certain trends and shifts in diets may occur among species.

Definite shifts in the food habits of striped, white, and black bass occurred over the months of the study (Tables 5-7). In July, fish occurred in over one-third of striped bass stomachs, but by September, the occurrence of fish in the diet had dropped to

TABLE 5

FREQUENCY OF OCCURRENCE (%) OF FOOD ITEMS IN STOMACHS OF STRIPED BASS, JULY-DECEMBER 1980

Month No. of Fish	July 34	Aug. 47	Sept. 55	Oct. 58	Nov. 27	Dec. 8
Dorosoma sp.	6		11	31	26	50
Labidesthes sicculus				2		
Coleoptera						
Lepomis sp.	3	9				
Morone sp.	3					
Micropterus sp.						
Pimephales sp.						
Pomoxis sp.						
Unidentified fish	35	36	7	26	48	12
Unidentified Cyprinidae						
Uniden. Centrarchidae						
Chrionomidae larvae	53	40	65	47	93	
Chironomidae pupae	15	26	49	31	19	
Copepoda	12	17	55	36	48	
Cladocera[a]	3	26	52	41	37	
Leptodora kindti				2	11	
Ostracoda	6	21	4			
Unidentified insects	3		2	16	15	
Ephemeridae	12	4	13	7	15	
Ephemeroptera[b]	3	6	13	3		
Chaoborus larvae	3	9	40	28	41	
Annelida			2	10		
Argulus sp.	3				4	
Unidentified Crustacea			5	9	30	
Miscellaneous	21	21	56	79	59	25
Ceratopogonidae larvae	44	15	5			
Megaloptera	15		2			
Odonata			2			
Hemiptera						
Tricoptera						

[a]Exclusive of *Leptodora kindti*.

[b]Exclusive of Ephemeridae.

TABLE 6

FREQUENCY OF OCCURRENCE (%) OF FOOD ITEMS IN STOMACHS OF WHITE BASS, JULY-DECEMBER 1980

Month	July	Aug.	Sept.	Oct.	Nov.	Dec.
No. of Fish	92	33	17	14	6	2
Dorosoma sp.	10	45	65	57	17	
Labidesthes sicculus			6			
Coleoptera						
Lepomis sp.	9					
Morone sp.		3				
Micropterus sp.	1					
Pimephales sp.						
Pomoxis sp.	4					
Unidentified fish	51	30	24		67	
Unidentified Cyprinidae	1					
Uniden. Centrarchidae	12	6				
Chironomidae larvae	37	33	47	7	67	
Chironomidae pupae	20	18	29	71	67	
Copepoda	18	24	24	21		
Cladocera[a]	2	18	18	14		
Leptodora kindti	10					
Ostracoda	1					
Unidentified insects	8	3	24		17	
Ephemeridae	5	6		7	50	
Ephemeroptera[b]	2		6	7	17	
Chaoborus larvae	2	24	24	50		
Annelida	1	9	12		33	
Argulus sp.		9				
Unidentified Crustacea	11	3		7		
Miscellaneous	12	55	65	57	57	100
Ceratopogonidae larvae	13	3				
Megaloptera	4		6			
Odonata						
Hemiptera						
Tricoptera	1					

[a]Exclusive of *Leptodora kindti*.

[b]Exclusive of Ephemeridae.

TABLE 7

FREQUENCY OF OCCURRENCE (%) OF FOOD ITEMS IN STOMACHS OF BLACK BASS, JULY-NOVEMBER 1980

Month No. of Fish	July 24	Aug. 39	Sept. 15	Oct. 0	Nov. 2
Dorosoma sp.	17	5			
Labidesthes sicculus		3			
Coleoptera		5	7		
Lepomis sp.	12		7		
Morone sp.					
Micropterus sp.			7		
Pimephales sp.			7		
Pomoxis sp.	4	2			
Unidentified fish	71	41	13		
Unidentified Cyprinidae		3			
Uniden. Centrarchidae	12				
Chironomidae larvae	21	49	67		
Chironomidae pupae	21	8	67		100
Copepoda	4	5	20		
Cladocera[a]		5	40		50
Leptodora kindti					
Ostracoda		5			
Unidentified insects	8	18	27		50
Ephemeridae	4	10			100
Ephemeroptera[b]		13	13		
Chaoborus larvae			33		50
Annelida			7		
Argulus sp.		5			
Unidentified Crustacea			13		
Miscellaneous	75	41	27		
Ceratopogonidae larvae	17	10			
Magaloptera	4				
Odonata					
Hemiptera		3	7		
Tricoptera					
Hymenoptera			7		

[a]Exclusive of Leptodora kindti.

[b]Exclusive of Ephemeridae.

approximately 11%. The same trend occurred in black bass but not in white bass; fish occurred in a high percentage of white bass stomachs every month. By October, the percentage of striped bass containing fish in the stomach had again risen to over 30% and increased thereafter. At the same time, chironomids remained a rather prominent food item in the diet of striped and white bass. There was a substantial increase in the frequency of occurrence of chironomids in black bass. Crustacea and Chaoborus supplemented the diet of striped and black bass in September when the occurrence of fish had dropped. Striped, white, and black bass all utilized ceratopogonids and megalopterans (predominantly Sialis) in the early months, but none whatsoever after September. This was probably due to availability of the food items more so than to selectivity of larger food items, because striped, white, and black bass were all utilizing chironomids to a large extent late in the year.

When monthly food habits by length class are examined (Tables 8-10), the trend that is most apparent is the fact that as each length class (classes 3-7) initially occurs in any month (July-December), fish are somewhat important in the diet, but then become less important in following months for the same length class (Figure 2). This was probably reflective of the fact that as a smaller length class showed up in later months it was representative of the slower growing fish of the year class. Thus, these fish were competing with larger length classes of their own species at the same time and were just not competitive enough for the forage species, and/or were being outstripped in relative growth by the forage fish. This was indicative that they

TABLE 8

PERCENT OF TOTAL NUMBERS OF FOOD ITEMS IN STOMACHS OF STRIPED BASS BY LENGTH CLASS EACH MONTH FOR 1980

Month	July	July	Aug.	Sept.	July	Aug.	Sept.	Oct.	Nov.	Aug.	Sept.	Oct.	Nov.	Sept.	Oct.	Nov.	Sept.	Oct.	Nov.	Dec.	Oct.	Nov.	Dec.	Nov.	Dec.	Dec.	Dec.	Nov.
Length Class[a]	1	2	2	2	3	3	3	3	3	4	4	4	4	5	5	5	6	6	6	6	7	7	7	8	8	9	10	11
Dorosoma sp.					17						1			33	2		67	17	11	33	34	5	100	15	100		67	22
Labidesthes sicculus																		2										
Lepomis sp.						1				20																		
Morone sp.																												
Pimephales sp.																												
Pomoxis sp.																												
Unidentified fish		8			67	3				33				17	2	1		5	11	33	14	7		15				11
Unidentified Cyprinidae																												
Chirnomidae larvae		42	6	10		75	15	1	11	20	25	1	29			36		3	63			80		62				56
Chirnomidae pupae		4		2		2	5	3	5	7	4				2			14			24							
Copepoda	100		34	11		1	31	50	59		11	56	46															
Cladocera[b]		23	56	73		10	34	29	24		40	32	19		90	37												
Leptodora kindti													1															
Ostracoda		3	2			5																						
Unidentified insections																		3	5		3							
Ephemeridae		1								7				17		1		35			3							
Ephereroptera[c]										7																		
Chaoborus larvae				3		1	12	8	1		17	6	4			23						2						
Annelida							1	8				4																
Argulus sp.																												
Unidentified Crustacea																												
Miscellaneous		1	1	1	17	1	1			7	1			33	2	1	33	21	11	33	21	5		7			33	11
Ceratopogonidae larvae		10				1																						
Megaloptera		2																										
Hemiptera																												

[a] Length classes (total length) are as follows:
1 = 2.6 to 5.0 cm.
2 = 5.1 to 7.5 cm.
3 = 7.6 to 10.0 cm.
4 = 10.1 to 12.5 cm.
5 = 12.6 to 15.0 cm.
6 = 15.1 to 17.5 cm.
7 = 17.6 to 20.0 cm.
8 = 20.1 to 22.5 cm.
9 = 22.6 to 25.0 cm.
10 = 25.1 to 27.5 cm.
11 = > 27.5 cm.

[b] Exclusive of Leptodora kindti.

[c] Exclusive of Ephemeridae.

TABLE 9

PERCENT OF TOTAL NUMBERS OF FOOD ITEMS IN STOMACHS OF WHITE BASS BY LENGTH CLASS EACH MONTH FOR 1980

Month	July	July	Aug.	Sept.	July	Aug.	Sept.	Oct.	Aug.	Sept.	Oct.	Aug.	Sept.	Oct.	Nov.	May	July	Aug.	Sept.	Oct.	Nov.	Mar.	Apr.	May	Sept.	Oct.	Nov.	Dec.	Apr.	May	May	Dec.	May
Length Class[a]	1	2	2	2	3	3	3	3	4	4	4	5	5	5	5	6	6	6	6	6	6	7	7	7	7	7	7	7	8	8	9	9	10
Dorosoma sp.		3			10	5			27			60	36	20			20		17	2					33	1	2						
Labidesthes sicculus																			4														
Lepomis sp.		4			4																												
Morone sp.						1																											
Pimephales sp.																																	
Pomoxis sp.		1			3																												
Unidentified fish	1	22	1		29	4			7									33	9		6	6	50		33		9				50		100
Unidentified Cyprinidae					1																												
Chironomidae larvae	9	18	21	17	19	8	24	1	7	11			7		23		30	33	9		71	31					28		1				
Chironomidae pupae	8	5	1	2	6	1	55		3	5	1			60	6				4	40	12					97	4						
Copepoda[b]	55	19	62			5	21	45		30	4								4	2													
Cladocera	2		11	82	3	60		43		18										25		50							97				
Leptodora kindti	14	3														99								99						99			
Ostracoda																																	
Unidentified insects	1	2			1				7				7						9								2				50		
Ephemeridae		1			3	1			3						66		30				12						38						
Ephemeroptera[c]		1											7		3																		
Chaoborus larvae	1	6	4			1		11	7	33	95								26	30		12											
Annelida	1					5			3				21								1						11						
Argulus sp.						1			3																								
Unidentified Crustacea	3	1																															
Miscellaneous		3			1	4			30	1		40	14	20	3		10	33	17	1			50		33	1	6	100			100		
Ceratopogonidae larvae	7	6			1	1																											
Megaloptera	1				3								7				10																
Hemiptera																																	
Unidentified Centrarchidae		5			13	2			3																								

[a]Length classes (total length) are as follows:
1 = 2.6 to 5.0 cm.
2 = 5.1 to 7.5 cm.
3 = 7.6 to 10.0 cm.
4 = 10.1 to 12.5 cm.
5 = 12.6 to 15.0 cm.
6 = 15.1 to 17.5 cm.
7 = 17.6 to 20.0 cm.
8 = 20.1 to 22.5 cm.
9 = 22.6 to 25.0 cm.
10 = 25.1 to 27.5 cm.

[b]Exclusive of Leptodora kindti.

[c]Exclusive of Ephemeridae.

TABLE 10

PERCENT OF TOTAL NUMBERS OF FOOD ITEMS IN STOMACHS OF BLACK BASS BY LENGTH CLASS EACH MONTH FOR 1980

Month	July	Aug.	Sept.	July	Aug.	Sept.	Nov.	July	Sept.	Nov.	Sept.
Length Class[a]	2	2	2	3	3	3	3	4	4	4	5
Dorosoma sp.	2				3			17			
Labidesthes sicculus					2						
Coleoptera					3						
Leopmis sp.				11							
Morone sp.											
Pimephales sp.						1					
Pomoxis sp.				2	2						
Unidentified fish	15	6	100	35	21			17	2		
Unidentified Cyprinidae					2						
Chironomidae larvae	15	27		11	33	41			2		10
Chironomidae pupae	11	2		7	3	7	12		16	40	2
Copepoda		10				9		50			
Cladocera[b]		23			3	16	79		76		43
Leptodora kindti											
Ostracoda		8									
Unidentified insects	2	4		4	5	1				20	2
Ephemeridae	2	1			5		6			40	
Ephemeroptera[c]		6			2						5
Chaoborus larvae						9	3		2		37
Annelida						13					
Argulus sp.		1			2						
Unidentified Crustacea									2		
Miscellaneous	13	6		20	14	1		17			2
Ceratopogonidae larvae	28	6		7	2						
Megaloptera	4										
Hemiptera		1									

TABLE 10 (CONTINUED)

Month Length Class[a]	July 2	Aug. 2	Sept. 2	July 3	Aug. 3	Sept. 3	Nov. 3	July 4	Sept. 4	Nov. 4	Sept. 5
Unidentified Centrarchidae	7			4							

[a] Length classes (total length) are as follows:
1 = 2.6 to 5.0 cm.
2 = 5.1 to 7.5 cm.
3 = 7.6 to 10.0 cm.
4 = 10.1 to 12.5 cm.
5 = 12.6 to 15.0 cm.

[b] Exclusive of Leptodora kindti.

[c] Exclusive of Ephemeridae.

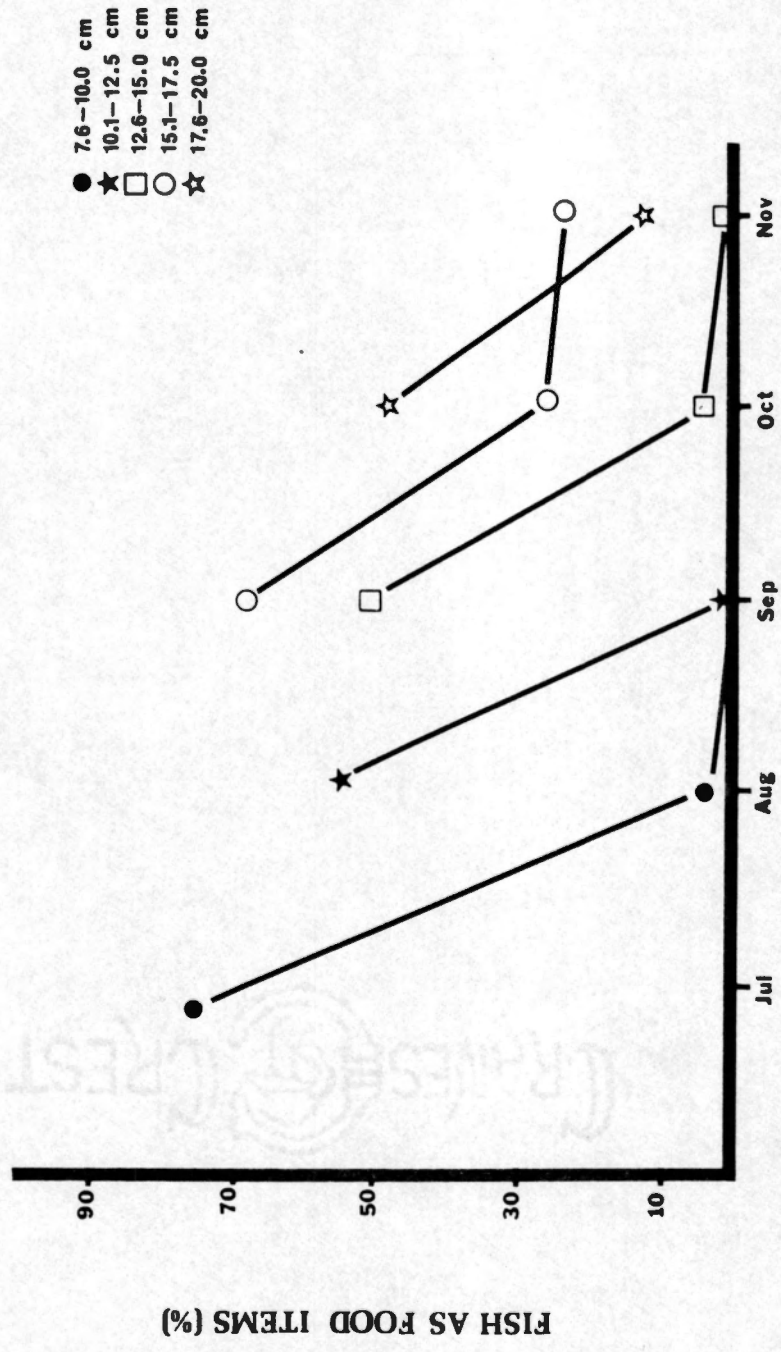


Figure 2. Percent of total numbers of food items in stomachs of 7.6-20.0 cm striped bass during 1980.

(forage species) were not really available to the slower growing striped or white bass as food items.

Another interesting fact is that white bass of length classes 6-8 captured in March, April, and May, ingested Cladocera almost exclusively. This was probably a result of poor availability of appropriate size forage species. Small gizzard shad and threadfin shad were seldom collected in large numbers prior to the summer of 1980 and threadfins were virtually nonexistent as a result of previous winterkill. Fish were important in the diet of length class 3 striped, white, and black bass in the month that that length class initially occurred. This indicated that the faster growing fish of each species would readily utilize fish in major proportions of their diet if the appropriate size forage was available.

On the other hand, when food habits of each species were analyzed by length class only (Tables 11-16), it was not until length class 5 that over half (88%) of the striped bass stomachs contained fish. Seventy-four percent of all white bass in length class 2 had fish in their gut, while 53% of length class 3 black bass contained fish. Chironomids and Crustacea were the major food items ingested by striped and white bass less than 15 cm in total length. Fish were also important, in terms of frequency of occurrence, in the diet of striped and white bass in the 5 to 15 cm range. Chironomids and fish were the dominant food items consumed by striped bass in length classes 6-11, with burrowing mayfly nymphs (Ephemeridae) also being important as a food item for length class 6. Though fish and chironomids occurred in a majority of the stomachs of the larger

TABLE 11

FREQUENCY OF OCCURRENCE (%) OF FOOD ITEMS IN STOMACHS OF STRIPED BASS BY LENGTH CLASS

Length Class[a]	1	2	3	4	5	6	7	8	9	10	11
No. of Fish	2	54	93	42	16	21	9	2	1	1	1
Pisces		22	20	40	88	76	100	100		100	100
Dorosoma sp.			1	7	50	52	100	100		100	100
Cyprinidae											
Centrarchidae		2	2	5							
Lepomis sp.		2	2	5							
Unidentified fish		20	19	33	50	29	56	50			100
Insecta	50	65	76	81	69	38	44	50			100
Diptera	50	61	73	79	56	24	33	50			100
Chironomidae	50	57	68	74	50	24	33	50			100
Ceratopogonidae		33	8								
Chaoborus		9	35	38	19		11				
Ephemeroptera		11	17	10	31	10					
Ephemeridae		9	6	7	31	10					
Megaloptera		9		2							
Hemiptera											
Hymenoptera											
Unidentified insects		2	3	14	19	10	11				
Crustacea	100	33	67	52	12						
Copepoda	100	30	46	50							
Ostracoda		11	9								
Cladocera	50	20	60	43	12						
Miscellaneous		24	42	52	81	89	50			100	

[a]Length classes (total length) are as follows:
1 = 2.6 to 5.0 cm.
2 - 5.1 to 7.5 cm.
3 = 7.6 to 10.0 cm.
4 = 10.1 to 12.5 cm.
5 = 12.6 to 15.0 cm.
6 = 15.1 to 17.5 cm.
7 = 17.6 to 20.0 cm.
8 = 20.1 to 22.5 cm.
9 = 22.6 to 25.0 cm.
10 = 25.1 to 27.5 cm.
11 = > 27.5 cm.

TABLE 12

FREQUENCY OF OCCURRENCE (%) OF FOOD ITEMS IN STOMACHS OF WHITE BASS BY LENGTH CLASS

Length Class[a]	1	2	3	4	5	6	7	8	9	10
No. of Fish	15	92	52	37	19	29	16	6	2	1
Pisces	7	74	69	59	74	72	75	50	50	100
Dorosoma sp.		9	19	38	47	48	44	33		
Cyprinidae		5	10	3	5	3				
Centrarchidae		16	13	5		3	6			
Lepomis sp.		8	4	3		3	6			
Unidentified fish	7	54	37	19	26	21	38	17	50	100
Insecta	93	56	62	57	68	69	62	67	50	
Diptera	93	54	60	51	53	55	44	67		
Chironomidae	93	50	56	43	42	52	44	50		
Ceratopogonidae	20	15	12		5					
Chaoborus	7	11	19	30	11	21	19	17		
Ephemeroptera		7	12	27	42	31	19	17		
Ephemeridae		4	12	27	37	28	19	17		
Megaloptera	7	2	6	5	16	3	6			
Hemiptera		4	6		5					
Hymenoptera					11			17		
Unidentified insects	7	7	4	19	11	7	6		50	
Crustacea	60	29	42	35	5	14	19	50		
Copepoda	60	25	33	32		7	6			
Ostracoda		2		3						
Cladocera	40	14	33	22	5	10	12	50		
Miscellaneous	7	11	17	54	53	52	56	50	50	

[a]Length classes (total length) are as follows:
1 = 2.6 to 5.0 cm.
2 = 5.1 to 7.5 cm.
3 = 7.6 to 10.0 cm.
4 = 10.1 to 12.5 cm.
5 = 12.6 to 15.0 cm.
6 = 15.1 to 17.5 cm.
7 = 17.6 to 20.0 cm.
8 = 20.1 to 22.5 cm.
9 = 22.6 to 25.0 cm.
10 = 25.1 to 27.5 cm.

TABLE 13

FREQUENCY OF OCCURRENCE (%) OF FOOD ITEMS IN STOMACHS OF BLACK BASS BY LENGTH CLASS

Length Class[a]	1	2	3	4	5
No. of Fish	0	30	45	10	5
Pisces		47	53	50	40
Dorosoma sp.		3	4	30	
Cyprinidae			4	10	20
Centrarchidae		3	18		20
Lepomis sp.			9		20
Unidentified fish		43	40	40	
Insecta		67	53	50	80
Diptera		57	43	30	40
Chironomidae		53	47	30	40
Ceratopogonidae		20	4		
Chaoborus		3	7	10	40
Ephemeroptera		20	11	10	20
Ephemeridae		7	9	10	
Megaloptera		7			
Hemiptera		3	2		20
Hymenoptera			2		
Unidentified insects		23	18	20	20
Crustacea		20	16	30	20
Copepoda		10	9	20	
Ostracoda		7			
Cladocera		3	13	10	20
Miscellaneous		50	44	60	80

[a]Length classes (total length) are as follows:
1 = 2.6 to 5.0 cm.
2 = 5.1 to 7.5 cm.
3 = 7.6 to 10.0 cm.
4 = 10.1 to 12.5 cm.
5 = 12.6 to 15.0 cm.

TABLE 14

PERCENT OF TOTAL NUMBERS OF FOOD ITEMS IN STOMACHS OF STRIPED BASS BY LENGTH CLASS

Length Class[a]	1	2	3	4	5	6	7	8	9	10	11
No. of Fish	2	54	93	42	16	21	9	2	1	1	1
Dorosoma sp.					1	18	18	27		67	22
Labidesthes sicculus						1					
Coleoptera											
Lepomis sp.											
Pimephales sp.											
Unidentified fish		2			1	7	10	13			11
Unidentified Cyprinidae											
Unidentified Centrarchidae											
Chironomidae larvae	19	17	12	9	25	16	46	53			56
Chironomidae pupae	1	2	3	1	1	10	10				
Copepoda	80	23	36	50							
Cladocera[b]		48	23	30	53						
Leptodora kindti			15								
Ostracoda		2									
Unidentified insects						3	1				
Ephemeridae					1	25	1				
Ephemeroptera[c]											
Chaoborus larvae		1	6	6	6						
Annelida			3	3							
Unidentified Crustacea											
Miscellaneous		1			2	19	11	7		33	11
Ceratopogonidae larvae		3									
Megaloptera											
Hemiptera											
Hymenoptera											

[a]Length classes (total length) are as follows:
1 = 2.6 to 5.0 cm.
2 = 5.1 to 7.5 cm.
3 = 7.6 to 10.0 cm.
4 = 10.1 to 12.5 cm.
5 = 12.6 to 15.0 cm.
6 = 15.1 to 17.5 cm.
7 = 17.6 to 20.0 cm.
8 = 20.1 to 22.5 cm.
9 = 22.6 to 25.0 cm.
10 = 25.1 to 27.5 cm.
11 = > 27.5 cm.

[b]Exclusive of Leptodora kindti.

[c]Exclusive of Ephemeridae.

TABLE 15

PERCENT OF TOTAL NUMBERS OF FOOD ITEMS IN STOMACHS OF WHITE BASS BY LENGTH CLASS

Length Class[a]	1	2	3	4	5	6	7	8	9	10
No. of Fish	15	92	52	37	19	29	16	6	2	1
Dorosoma sp.		1		1	2	1	1			
Labidesthes sicculus										
Coleoptera										
Lepomis sp.		1								
Pimephales sp.										
Unidentified fish		5	1	1	4		1		33	100
Unidentified Cyprinidae					1					
Unidentified Centrarchidae		1								
Chironomidae larvae	8	21	4	4	3	1	2			
Chironomidae pupae	8	7	4	2	2	9	22			
Copepoda	55	33	41	38		1				
Cladocera[b]	2	8	10	7		6	1	23		
Leptodora kindti	14	17	30	14	68	71	68	76		
Ostracoda										
Unidentified insects				4					33	
Ephemeridae				5	14	2	3			
Ephemeroptera[c]										
Chaoborus larvae		2	7	22	1	7				
Annelida					2		1			
Unidentified Crustacea	3									
Miscellaneous				1	2	1	1		33	
Ceratopogonidae larvae	7	1								
Megaloptera					1					
Hemiptera		1								
Hymenoptera					1					

[a]Length classes (total length) are as follows:
1 = 2.6 to 5.0 cm.
2 = 5.1 to 7.5 cm.
3 = 7.6 to 10.0 cm.
4 = 10.1 to 12.5 cm.
5 = 12.6 to 15.0 cm.
6 = 15.1 to 17.5 cm.
7 = 17.6 to 20.0 cm.
8 = 20.1 to 22.5 cm.
9 = 22.6 to 25.0 cm.
10 = 25.1 to 27.5 cm.

[b]Exclusive of *Leptodora kindti*.

[c]Exclusive of Ephemeridae.

TABLE 16

PERCENT OF TOTAL NUMBERS OF FOOD ITEMS IN STOMACHS OF BLACK BASS BY LENGTH CLASS

Length Class[a]	2	3	4	5
No. of Fish	30	45	10	5
Dorosoma sp.			4	
Labidesthes sicculus		1	5	
Coleoptera		1		1
Lepomis sp.		1		
Pimephales sp.	7	4	5	
Unidentified fish			1	3
Unidentified Cyprinidae	1			
Unidentified Centrarchidae	21	37	1	9
Chironomidae larvae	4	7	10	1
Chironomidae pupae	17	7	25	
Copepoda	13	17	37	36
Cladocera[b]				
Leptodora kindti	5			
Ostracoda	5	2	2	1
Unidentified insects	1	1	2	
Ephemeridae	3			4
Ephemeroptera[c]		8	1	32
Chaoborus larvae		10		
Annelida			1	
Unidentified Crustacea	7	3	6	6
Miscellaneous	8	1		
Ceratopogonidae larvae	1			
Megaloptera				1
Hemiptera				
Hymenoptera				

[a]Length classes (total length) are as follows:
1 = 2.6 to 5.0 cm.
2 = 5.1 to 7.5 cm.
3 = 7.6 to 10.0 cm.
4 = 10.1 to 12.5 cm.
5 = 12.6 to 15.0 cm.

[b]Exclusive of *Leptodora kindti*.

[c]Exclusive of Ephemeridae.

length class white bass, Leptodora was the dominant food item in terms of total organisms ingested. This is misleading because of the high numbers of Leptodora that occurred in white bass of the larger length classes captured in the early part of the year. Fish, chironomids, and Crustacea were the most important food items for all length classes of black basses in terms of frequency of occurrence. Chironomids and Crustacea were the dominant food items ingested (percent of total numbers). Chrionomids, however, became less important in length classes 4 and 5 and were supplanted with Cladocera and Chaoborus.

Food Habits by Site

No general trends were established when food habits were examined according to site and date of collection (Appendixes A-F). There was not a dominant food item that was ingested at every site in terms of total numbers ingested. Much variability existed in terms of which food item was being utilized by striped, white, or black bass at any site at any date that collections were made. Leptodora, chironomids, and copepods were the most important food items for striped bass in 1979, whereas chironomids, copepods, other Cladocera, and fish were the organisms most utilized as a food source by 1980 y-o-y striped bass. Striped bass food habits appeared to be less variable in numbers of dominant food organisms ingested than those of white and black bass. White bass consumed mostly fish, chironomids, Cladocera, copepods, and Chaoborus while food items most important in the diet of black bass were fish, chironomids, Crustacea, and other aquatic insects.

Some interesting comparisons, illustrating site variability, can be observed when food habits of striped and white bass from one

site are compared to those of another site from collections made in the same month. Eighty-two percent of striped bass collected at Cove Creek Public Access in October 1980 had fish in the gut, but only 12% of the stripers captured at Clinch River Kilometer 188 (Mile 117) (also in October) contained fish. White and striped bass generally had similar food habits at the same site. However, 62% of white bass stomachs examined from Clinch River Kilometer 188 (Mile 117) in October 1980 and 56% of those from the same site in September contained fish. Only 3% of striped bass collected in September at that site had fish in their gut. From these comparisons it was evident that food selection by striped, white, and black bass (concerning the frequency that forage fish are consumed) might be dependent on forage availability at any one site at any time of year. It was also apparent that at sites where forage availability might be somewhat limited, white bass were better able to utilize that resource than were striped bass. It was interesting to note that at the Cove Creek site in October, where a large percentage (82%) of the striped bass had consumed fish, white bass were not collected. It is important to state that the conclusions drawn, concerning utilization of forage species when their availability is limited, is based on assumptions and not on actual data, because the sites were not sampled in a manner to determine forage availability.

From the data, it is an appropriate assumption that striped bass fingerlings fed opportunistically. Striped bass were able to utilize both open water and benthic (chironomids, burrowing mayflies, and annelids) food resources. During electrofishing in clear water

striped bass were often observed and collected from a position immediately above the substrate.

The results of this study, indicating that Crustacea and Diptera are the major food items of striped bass less than 10 cm in length and that chironomids and fish are most important in the diet of striped bass greater than 10 cm in length, were similar to those results of studies conducted on several other reservoirs and in culture ponds (Sandoz and Johnston 1965, Harper et al. 1968, Gomez 1970, Humphries and Cumming 1971, and Higginbotham 1979).

Growth

Striped bass fingerlings stocked in July 1980 averaged approximately 4.0 cm in total length. Average length of y-o-y striped bass collected 6 months later in December was 19.7 cm. Average weight of these fish was 86.3 gms (preserved weight). This was a 15.7 cm growth increment for the 6 months period. The largest striped bass collected was a y-o-y fish collected in November that was 29.5 cm in length and weighed 367.7 gms. Overall growth for 1980 was considered good.

Striped bass collected in the Cove Creek area appeared to have better growth than those collected near the stocking site at Beech Island, assuming that striped bass collected at Cove Creek were fish actually stocked at that site and that those collected at Clinch River Kilometer 188 (Mile 117) (3.2 km below Beech Island) were actually stocked at Beech Island. These assumptions are feasible considering that the two stocking sites are approximately 69 km apart.

The average length of y-o-y striped bass collected by electrofishing at Cove Creek on 6 October 1980 was 14.7 cm, whereas the average length of those collected at Clinch River Kilometer 188 (Mile 117) on 21 October was 10.5 cm. These differences, in reviewing food habit data, could be due to the increased amount of competition with white bass that was evident at sites in the upper areas of the reservoir. Notably, that white bass captured along with striped bass at the same sites were better able to utilize any forage fish as a food resource. White bass were not as numerous in Cove Creek as they appeared to be elsewhere, and this was reflected in the food habits and growth of striped bass collected there.

There is no first-year growth data for striped bass presented in this study since no yearling fish were collected in 1980. As mentioned previously, this was indicative of poor survival for the 1979 year-class. Growth for 1979 y-o-y striped bass was also poor. Striped bass collected in October averaged only 8.6 cm in total length. This was the last month that any 1979 year-class stripers were collected.

When growth of 1980 stock of striped bass in Norris Reservoir is compared to growth of stripers in other reservoirs, it must be considered to be among the best attained anywhere. Growth of 19.7 cm by the month of December compared favorably with data from other studies that were for one year's growth. Scruggs (1955) found that striped bass in Santee-Cooper Reservoir, South Carolina, averaged 19.8 cm at the end of one year. Weaver (1975) reported growth of 21.6 cm for year-old striped bass in J. Percy Priest Reservoir, Tennessee. Striped bass grew more in Norris Reservoir in six months time than

they did for one year (18.2 cm) in Watts Bar Reservoir, Tennessee (Van Den Avyle and Higginbotham 1979). Ware (1971) reported the highest one-year growth increments (28.2 cm) of any study, based on data from four inland Florida lakes. His data indicated that y-o-y striped bass averaged around 18 cm in December and ranged from approximately 12 to 29 cm which was less than the growth determined in this study for the same amount of time. However, Ware (1971) also reported that striped bass growth was more rapid in the cooler months of fall and winter. Striped bass growth in Tennessee probably slows down in this period.

Young-of-year white bass for 1980 grew to a maximum of 19 cm by December of that year. This figure, however, represents only one fish collected that month. Average length of white bass collected in November was 16.8 cm. Growth of white bass for one year was determined by scale analysis. Average length of those fish captured in 1980 and confirmed as yearling fish was 18.4 cm. This was less than the average first-year's growth of 20.6 cm for white bass in Center Hill Reservoir, Tennessee (Webb and Moss 1967), but was greater than 1979-80 white bass growth (14 cm) in Cherokee Reservoir, Tennessee (Saul 1981).

Weight to length relationships for striped and white bass were described by the equation $\log \overline{W} = -2.49 + 3.48 \log \overline{L}$ and $\log \overline{W} = -2.18 + 3.22 \log \overline{L}$, respectively. Slopes above 3.0 indicated allometric growth which signified a greater increment of weight added per increment of length. Positive allometric growth should result in healthy robust fish with good condition factors.

Condition

Mean condition factors for striped and white bass are presented in Table 17. Condition factors ranged from 0.73 for striped bass 2.6 to 5.0 cm in length to 1.36 for those greater than 27.5 cm in length. These values compare favorably to those of Cherokee striped bass which ranged from 0.76 to 1.28 (Saul 1981). White bass condition factors ranged from 0.67 to 1.21 and were slightly less at the smaller length classes than conditions factors of white bass in Cherokee Reservoir (Saul 1981).

Movements and Habitat Preferences

Dispersal from the stocking site varied greatly during the two-year study and was dependent on the location of the stocking site and food availability. Striped bass in 1979 dispersed rapidly from the stocking site. This rapid downstream movement was most probably due to the relatively strong current that existed at the stocking site. The majority of striped bass collected that year were captured 48 km downstream at the Beech Island access. Some of these fish had traveled that distance in less than six weeks.

Striped bass stocked in 1980 showed relatively small dispersal movements. The majority of those fish collected in the upper portions of the reservoir were captured within 4 km of the stocking site at Beech Island. Most of the striped bass collected in the Cove Creek area of Norris Reservoir were captured adjacent to the stocking site. Striped bass captured the greatest distances from the stocking site

TABLE 17

MEAN CONDITION FACTORS (K) FOR STRIPED BASS AND WHITE BASS BY LENGTH

Length (cm)	N	Striped Bass	N	White Bass
2.6-5.0	2	0.73	15	0.67
5.1-7.5	54	0.74	92	0.85
7.6-10.0	93	0.82	52	0.92
10.1-12.5	42	0.81	37	0.96
12.6-15.0	16	0.90	19	1.05
15.1-17.5	21	0.89	29	1.05
17.6-20.0	9	0.94	16	1.13
20.1-22.5	2	1.05	6	1.17
22.6-25.0	1	1.05	2	1.13
25.1-27.5	1	1.06	1	1.21
> 27.5	1	1.36		

in the weeks immediately following stocking were generally the largest collected that particular night.

Striped bass moved in and out of shallow water relative to darkness. Young-of-year fish were never collected in shallow water during the day. The only time that striped bass were not collected at the Cove Creek stocking site was when that site was seined just after dawn. Electrofishing at that same site prior to sunset also resulted in no striped bass being caught; several were collected soon after sunset.

Striped bass were always collected over soft clay points or substrates that were clayey or silty or both. They were never collected over rocky points or gravel overlying hard packed clay or other similar hard surfaces. This preference for soft substrate sites was probably due to the fact that these sites best met habitat requirements for chironomid larvae, burrowing mayfly nymphs, and annelids. Higginbotham (1979) reported that most y-o-y striped bass in Watts Bar Reservoir were collected over sandy substrates. In the Hudson River, y-o-y striped bass were most often collected over sand or gravel but sometimes were collected over soft bottoms (Rathjen and Miller 1957).

Parasites

Two parasitic nematodes were found in the digestive tracts of striped, white, and black bass in the following percentages: 15, 32, and 32%, respectively. These were identified as Camallanus sp. and Spinotectus sp. (Bernard, personal communication). Black bass

were also found to be parasitized to a greater extent by the acanthocephalan Neoechinorhynchus sp. All three of these organisms are common fish parasites. Ware (1971) reported heavy mortalities of year-class 1 striped bass in two Florida lakes due to heavy infestations of the marine nematode Goezia. Norris fish did not seem to be adversely affected by their nematode parasites. Although digestive tracts of black bass parasitized by Neoechinorhynchus sp. often appeared to be in less than good condition, it was not apparent externally.

Recommendations

As a result of this study it is recommended that the Cove Creek area of Norris Reservoir be considered as a permanent stocking site (or one of several) for the future stockings of striped bass fingerlings. These data indicated that Cove Creek is of minor importance as a white bass spawning area and that the upper Clinch River portion of the reservoir is the main white bass spawning area. Thus, stocking in the upper Clinch River should be avoided regardless of prestock analyses of benthos and zooplankton because competition with white bass will be maximized. Results of the study also indicated that striped bass grew faster and utilized forage fish at a smaller length class in the Cove Creek area than those collected along with white bass in the upper portions of the reservoir. White bass in the upper Clinch River were larger in size than the striped bass fingerlings at time of stocking and presented a higher degree of competition.

Prestock sampling should be performed as near to the stocking date as possible to insure reliability of data. Sampling for zooplankton should be performed at night in off-shore areas where the water is greater than 3 m in depth. Zooplankton generally exhibit shore avoidance and are light sensitive. A 0.5 m plankton net with calibrated flow meter should be the type gear used. Undulating vertical tows over a distance of 50 to 100 m is the sampling method recommended in order to quantify relative population densities between sites. However, reservoir conditions may dictate day-to-day population shifts. Drastic changes in population densities may occur in less than one day in riverine portions of the reservoir or even in lower portions of the reservoir where flow is created by power generation or discharges at the dam (Bunting, personal communication). This is a factor to be kept in mind when time and money are major considerations. Thus, with the reliability of data questionable, sampling may be irrelevant.

It is also recommended that at least two sites be stocked in any year in order to insure survival of the stock. These sites should be selected based on white bass, zooplankton, benthos, and forage fish densities. The sites with the lowest white bass densities should be most suitable for stocking.

For future studies of young-of-year striped bass food habits, it is recommended that forage fish availability be determined by continued shore-line sampling using a 3.2 mm mesh straight seine.

CHAPTER VI

SUMMARY

1. Of 187,000 fingerlings stocked in 1979, 13 were recovered. This was indicative of poor survival. Two hundred twenty-nine y-o-y striped bass were collected in 1980 from the initial stocking of 180,000 fingerlings.

2. Chironomids and Crustacea were the major food items (in terms of toal numbers ingested) for striped bass up to 15 cm in total length. Fish, however, were of importance in the diet of striped bass in the 5 to 15 cm range, in that a substantial percentage of striped bass in this length range were utilizing fish at some level. Chironomids and fish were the dominant food items consumed by striped bass greater than 15 cm in total length. Burrowing mayfly nymphs (Ephemeridae) supplemented the diet of striped bass in the 15.1 to 17.5 cm range. A majority of striped bass greater than 12.6 cm in length were utilizing fish in their diet. Striped and white bass utilized benthic food sources in addition to open-water sources.

3. Striped bass fingerlings had grown to an average of 19.7 cm total length by December 1980. This was excellent growth when compared to that in other reservoirs.

4. Striped bass were usually collected over soft substrate types of clay or silt or a combination of the two.

5. Ideally, the largest available striped bass fingerlings should be stocked at the earliest possible data. This would allow striped bass fingerlings to gain a competitive advantage over white

bass when forage was limited, provided that striped bass were larger in size than the white bass at time of stocking. When this is not feasible, it is recommended that potential stocking sites be thoroughly sampled to determine which sites have the best combination of high zooplankton, benthos, and forage densities along with the lowest number of predators and competitors (white bass). The sites best meeting these criteria should be the sites of optimum growth and survival of fingerling striped bass. The Cove Creek area should be considered as a permanent stocking site based on data indicating that white bass spawn primarily in the Clinch River arm of the reservoir and not in Cove Creek.

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APPENDIXES

APPENDIX A

TABLE 18

FREQUENCY OF OCCURRENCE (%) OF FOOD ITEMS IN STOMACHS OF STRIPED BASS AT EACH COLLECTION SITE 1979-1980

	Collection Site and Date																					
	Black Fox Access 10-79	Clinch River Kilometer 240 8-79	Beech Island Access 8-79	10-79	7-80	8-80	Cove Creek Public Access 7-80	8-80	9-80	10-80	11-80	12-80	Clinch River Kilometer 199 7-80	Rabbitt Island 8-80	Clinch River Kilometer 188 8-80	9-80	10-80	Cove Creek .8 km above Lindsey Mill 9-80	2.4 km below Point 4 8-80	9-80	Cove Creek 2 km above Lindsey Mill 9-80	Point 4 8-80
No. of Fish	5	1	2	5	23	6	8	23	9	33	27	8	3	1	10	31	25	10	6	2	3	1
Pisces			50	20	17	17	75	9	22	82	52	62	100	100	80	3	12	30	83	100	33	100
Dorosoma sp.							25		11	48	26	50				3	8	30		50		
Cyprinidae																						
Centrarchidae							12							100	20				17			
Lepomis sp.							12							100	20				17			
Unidentified fish			50	20	17	17	62	9	11	39	48	12	100	100	70		8	10	83	50	33	100
Insecta	60	100	50	80	91	83	12	17	11	52	100			100	100	97	100	80	67	100	33	
Diptera	40	100	50	80	87	83		17	11	36	100			100	100	97	100	70	33	100		
Chironomidae	40	100	50	60	78	83		13	11	36	96			100	100	87	92	70	33	100		
Ceratopogonidae					65	50		4							30	10						
Chaoborus	20		50	40	4	17					41				30	71	64					
Ephemeroptera				20	22	17				9	15			100		26	12	30	33	100	33	
Ephemeridae				18	17	17				9	15			100		3	4	30		100	33	
Megaloptera					22													10				
Hemiptera																						
Hymenoptera																						
Unidentified insects	17						12			9	15					3	24					
Crustacea	100	100	100	100	17	100	38	4		12	52				70	87	80	60			33	
Copepoda	20	100	50	40	13	100	25	4		3	48				10	81	80	50				
Ostracoda					9	67									60	6						
Cladocera	100	100	50	100		100	12			12	37				60	71	80	60			33	
Miscellaneous				60	17	17	25	13	44	88	59	25	33		40	58	68	60	33	100	33	

APPENDIX B

TABLE 19

FREQUENCY OF OCCURRENCE (%) OF FOOD ITEMS IN STOMACHS OF WHITE BASS AT EACH COLLECTION SITE 1979-1980

	Collection Site and Date																																					
	Clinch River Kilometer 238 8-79	Beech Grove Access 7-80	Clinch River Kilometer 217 7-79	9-79	10-79	Black Fox Access 8-79	9-79	10-79	7-80	8-80	Clinch River Kilometer 240 8-79	Pellissippi Point 4-80	7-80	Beech Island Access 8-79	9-79	10-79	7-80	8-80	Clinch River Kilometer 167 5-80	Cove Creek Public Access 3-80	7-80	11-80	12-80	Clinch River Kilometer 199 7-80	8-80	Rabbit Island 8-80	Clinch River Kilometer 188 8-80	9-80	10-80	Clinch River Kilometer 201 8-80	Cove Creek .8 km above Lindsey Mill 9-80	10-80	2.4 km below Point 4 8-80	9-80	Point 4 8-80
No. of Fish	2	8	3	5	10	5	2	4	8	1	19	4	2	18	3	20	43	1	8	2	1	6	2	30	2	4	2	9	13	6	1	1	2	7	15
Pisces	50	100	100	20	20	100	50	50	62	100	79	75	100	83	33	30	49	100	62	50	100	67		97	100	100	100	56	62	67	100		50	100	80
Dorosoma sp.		62	100	20			50			100		25		39		25	5		25			17		7	100		100	33	62	50	100			100	47
Cyprinidae	50	12				40					47																								
Centrarchidae						20		25	25		5						9		12					47		50									
Lepomis sp.						20		25			5						7		12					17											
Unidentified fish		75			20	60		25	38		47	50	100	56	33	5	37	100	25	50	100	67		63		50		22		17	100		50	14	33
Insects	100	12	33	100	100	40	50	75	50		100	75		22	100	70	81	100	50	100		100		17		50		89	92	83	100	100	100	14	67
Diptera	100	12	33	80	90	20	50		50		95	75		22	100	65	77	100	25	100		83		17		50		78	92	83	100		100		67
Chironomidae	100	12	33	80	80	20			38		95	75		17	67	60	77	100	12	100		83		17		50		78	85	67	100		50		47
Ceratopogonidae				20							47			6			28																	7
Chaoborus sp.					40		50		12		16			6	67	40	2		25	100								44	54	33			100		27
Ephemeroptera	100			80	90	20		75			5	25				25	16		25			50						11	7			100			13
Ephemeridae	100			80	90	20		75			5	25				25	12		25			50							7						13
Megaloptera	100				30			25			5				33		9																		
Hemiptera					10						37																							14	
Hymenoptera					20							25																								
Unidentified insects				20	20				12		5				67	10	14		12			17						44							7
Crustacea				60	40		50	25	38		21	25		33	100	65	35	100	62	50				3		75		56	23	33			100		33
Copepoda				20	30		50	25	38		11			33	100	55	33	100	12							50		44	23	33			100		27
Ostracoda					10						5						2																		
Cladocera				60	20		50	25	25		5	25		22	33	65	16		50	50				3		75		33	15	17			50		7
Miscellaneous				60	20		50	50	12	100		75		44	33	15	21		12			67	100	3	100	25	100	56	54	67		100		86	53

APPENDIX C

TABLE 20

FREQUENCY OF OCCURRENCE (%) OF FOOD ITEMS IN STOMACHS OF BLACK BASS AT EACH COLLECTION SITE 1979-1980

	Collection Site and Date																		
	Black Fox 10-79	7-80	8-80	Beech Island Access 10-79	7-80	8-80	Cove Creek Public Access 8-80	9-80	11-80	Clinch River Kilometer 199 7-80	8-80	Rabbit Island 8-80	Clinch River Kilometer 188 8-80	9-80	Clinch River Kilometer 201 8-80	Cove Creek .8 km above Lindsey Mill 9-80	2.4 km below Point 4 8-80	9-80	Point 4 8-80
No. of Fish	6	4	2	4	10	8	3	1	2	10	3	1	4	10	1	1	7	3	10
Pisces	33	100	50	25	60	25	100	100		90	33	100	25	30			86		40
Dorosoma sp.		75	50							10	33								
Cyprinidae	17			25								100		10					
Centrarchidae	17	25								50				20			14		
Lepomis sp.	17	25								20				10					
Unidentified fish		75			60	25	100	100		80		100	25	10			86		30
Insecta	83		50	75	80	50	67		100		67		100	100	100	100	29	100	50
Diptera			50	50	70	38	67		100		67		75	100	100	100	29	67	50
Chironomidae			50	25	70	38	67		100		67		75	100	100	100	29	67	50
Ceratopogonidae					40	25	33				33								
Chaoborus sp.				25					50					50					
Ephemeroptera			50		10				100				75	20			29		20
Ephemeridae			50		10				100				25						20
Megaloptera	17				10														
Hemiptera	17						33							10					
Hymenoptera														10					
Unidentified insects	33			50	20	38	33		50				25	30	100		14	33	
Crustacea	17			25		25			50		33		20	50		100	14		20
Copepoda	17			25		12				10						100			20
Ostracoda						12					33			20					
Cladocera									50				25	50		100	14		
Miscellaneous	83	100	100	50	70	62				70	67		25	20			14	67	50

APPENDIX D

TABLE 21

PERCENT OF TOTAL NUMBERS OF FOOD ITEMS IN STOMACHS OF STRIPED BASS AT EACH COLLECTION SITE 1979-1980

	Collection Site and Date																							
	Black Fox Access 10-79	Clinch River Kilometer 240 8-79	Beech Island Access 8-78	10-79	7-80	8-80	Cove Creek Access 7-80	8-80	9-80	10-80	11-80	12-80	Clinch River Kilometer 199 7-80	Rabbit Island 8-80	Clinch River Kilometer 188 8-80	9-80	10-80	Cove Creek .8 km above Lindsey Mill 9-80	2.4 km below Point 4 8-80	9-80	Point 4 8-80	Cove Creek 2 km above Lindsey Mill 9-80
No. of fish	6	1	2	5	23	6	6	23	9	33	27	8	3	1	10	31	25	10	6	2	1	3
Dorosoma sp.									14	5		67						1		44		
Labidesthes sicculus																				6		
Coleoptera																						
Lepomis sp.															1				7			
Morone sp.																						
Micropterus sp.																						
Pimephales sp.																						
Pomoxis sp.																						
Unidentified fish			4		1		6	7	14	4		11	89	50	2				47	6	100	20
Unidentified Cyprinidae														50								
Chironomidae larvae		94	2		62	6		7	14	3	25				76	17	1	6	7			
Chironomidae pupae		4		1	7			4		4	2				2	5	1	1	13			
Copepoda		1	86	37	4	32	72	67		4	42				1	28	54	13				
Cladocera[a]		1				58	20			68	23				10	34	30	76				40
Leptodora kindti	99		6	60							1											
Ostracoda					4	2									5							
Unidentified insects										1												
Ephemeridae					1					5								1				20
Ephemeroptera[b]																			13			
Chaoborus larvae			2	1	1						6				1	14	7					
Annelida																1	6					
Argulus sp.																						
Unidentified Crustacea																						
Miscellaneous					1			11	57	6	1	22	11		1	1		2	13	38		20
Ceratopogonidae larvae					15			4							1							
Megaloptera					3															6		
Odonata																						
Hemiptera																						
Tricoptera																						
Hymenoptera																						
Unidentified Centrarchidae																						

[a]Exclusive of Leptodora kindti.

[b]Exclusive of Ephemeridae.

APPENDIX E

TABLE 22

PERCENT OF TOTAL NUMBERS OF FOOD ITEMS IN STOMACHS OF WHITE BASS AT EACH COLLECTION SITE 1979-1980

	Collection Site and Date																																					
	Clinch River Kilometer 238 8-79	Beech Grove Access 7-80	Clinch River Kilometer 217 7-79	9-79	10-79	Black Fox Access 8-79	9-79	10-79	7-80	8-80	Clinch River Kilometer 239 8-79	Pellissippi Point 4-80	Beech Island Access 8-79	9-79	10-79	7-80	8-80	Clinch River Kilometer 167 5-80	Cove Creek Public Access 5-80	7-80	11-80	12-80	Clinch River Kilometer 199 7-80	8-80	Rabbit Island 8-80	Pellissippi Point 7-80	Clinch River Kilometer 188 8-80	9-80	10-80	Clinch River Kilometer 201 8-80	Cove Creek .8 km above Lindsey Mill 9-80	10-80	2.4 km below Point 4 8-80	9-80	Point 4 8-80
No. of Fish	2	8	3	5	10	5	2	4	8	1	19	4	18	3	20	43	1	8	2	1	6	2	30	2	4	2	2	9	13	6	1	1	2	7	15
Dorosoma sp.		26	80				1			50			3			1					1		4	50			60	1	1	2	33			44	9
Labidesthes sicculus																																	6		
Coleoptera																																			
Lepomis sp.						5		1								2							13												
Morone sp.						2																													
Micropterus sp.									1																1										
Pimephales sp.											1																								
Pomoxis sp.						2																	6												
Unidentified fish		59				64		1	4		2		14	1		5	25		6	100	6		47		3	100				33		2	6	7
Unidentified Cyprinidae		2				23					1																							
Unidentified Centrarchidae																2							16		4									
Chironomidae larvae	26	9		16	1				5		51	1	1	2	1	20			31		33		4		4			14		29	33		3		9
Chironomidae pupae			20	1	1	2			2		33		1	1		8	50				6		6		1			9	24	1					2
Copepoda				10	26		1	20	39				72	28	52	36	25								5			22	20	55			68		42
Cladocera[a]					6						1	97				1			50				3		74			29	25	9			23		1
Leptodora kindti				58	44		97	72	14				3	49	41	6		99																	
Ostracoda					7				1					2		2					1							1							2
Unidentified insects																2					43														2
Ephemeridae	66			11	11	2		3								1					1							23	29	2		3		13
Ephemeroptera[b]					1		1		23		1		1	18	5				12		6				6									
Chaoborus larvae					1			3	1																1									2
Annelida																3												1			50			
Argulus sp.																																			
Unindentified Crustacea																3																			2
Miscellaneous				1				1	1	50		1	3			2					4	100	1	50	1		40	1		2		50		38	9
Ceratopogonidae											4					8																			1
Ceratopogonidae larvae																																			
Megaloptera	6							1								1																		6	
Hemiptera											4																								
Tricoptera									1																										
Hymenoptera					1																														

[a]Exclusive of Leptodora kindti.

[b]Exclusive of Ephemeridae.

APPENDIX F

TABLE 23

PERCENT OF TOTAL NUMBERS OF FOOD ITEMS IN STOMACHS OF BLACK BASS AT EACH COLLECTION SITE 1979-1980

	Collection Site and Date																		
	Black Fox 10-79	7-80	8-80	Beech Island Access 10-79	7-80	8-80	Cove Creek Public Access 8-80	9-80	11-80	Clinch River Kilometer 199 7-80	8-80	Rabbit Island 8-80	Clinch River Kilometer 186 8-80	9-80	Clinch River Kilometer 201 8-80	Cove Creek .8 km above Lindsey Mill 9-80	2.4 km below Point 4 8-80	9-80	Point 4 8-80
No. of Fish	6	4	2	4	10	8	3	1	2	10	3	1	4	10	1	1	7	3	10
Dorosoma sp.		31	20							2	11								
Labidesthes sicculus																			2
Coleoptera	24			7		3							5						
Lepomis sp.	3	8								9									
Morone sp.																			
Micropterus sp.																			
Pimephales sp.																			
Pomoxis sp.,										2							2		
Unidentified fish		31			12	9	27	100		35		50	9				15		8
Unidentified Cyprinidae	3			5								50							
Unidentified Centrarchidae										11									
Chironomidae larvae			20	12	21	32	18				33		36	36	50		19	20	40
Chironomidae pupae				2	14	3			15				9	7		33	2	20	
Copepoda	41			56						26				8		17			30
Cladocera[a]									69				9	23		33	51		
Leptodora kindti																			
Ostracoda						21					22								
Unidentified insects	9			7	5	10	9		3				5	1	50		2	40	
Ephemeridae			20		2				10				5						5
Ephemeruptera[b]													18	1			8		
Chaoborus larvae				2					3					11					
Annelida														11					
Argulus sp.						3													2
Unidentified Crustacea				2												17			
Miscellaneous	15	31	40	5	14	13				15	22		4				2	20	12
Ceratopogonidae larvae					28	8	36				11								
Megaloptera	3				4														
Odonata																			
Hemiptera	3						9												
Hymenoptera																			

[a] Exclusive of Leptodora kindti.

[b] Exclusive of Ephemeridae.

VITA

John Michael Richardson was born May 6, 1953 in Nashville, Tennessee. He attended elementary school in Stevenson, Alabama, and junior and senior high school in Russellville, Kentucky, before graduating from Clarksville High School in Clarksville, Tennessee, in 1971. He received his Bachelor of Science degree from The University of Tennessee, Knoxville, in Wildlife and Fisheries Science in June 1977 after previously majoring in Nuclear Engineering. In March of 1982, he received his Master of Science degree in Wildlife and Fisheries Science, also from The University of Tennessee, Knoxville, Tennessee.

John was married to the former Patricia L. Lee of Clarksville, Tennessee, in December 1974. John and Patty have two children, Amelia Lee and John Clayton.