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Food habits of largemouth bass, Micropterus salmoides (Lacepede) and spotted bass, Micropterus punctulatus (Rafinesque), from Beech Fork Reservoir, a new impoundment in Wayne and Cabell Counties, West Virginia

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FOOD HABITS OF LARGEMOUTH BASS, *MICROPTERUS SALMOIDES* (LACEPEDE) AND SPOTTED BASS, *MICROPTERUS PUNCTULATUS* (RAFINESQUE), FROM BEECH FORK RESERVOIR, A NEW IMPOUNDMENT IN WAYNE AND CABELL COUNTIES, WEST VIRGINIA

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ABSTRACT

A study was undertaken to determine the food habits of two game fishes, the largemouth bass Micropterus salmoides (Lacepede) and the spotted bass M. punctulatus (Rafinesque), in Beech Fork Reservoir shortly after its impoundment. A total of 171 largemouth bass and 95 spotted bass were collected from July 1978, through June 1979, and their stomach contents analyzed.

Largemouth bass fed primarily on fishes, particularly young-of-the-year bluegill. Aquatic and terrestrial invertebrates were also important food items, especially during the spring and fall. The dominant aquatic forms were chironomid larvae and pupae while the dominant terrestrial forms were adult dipterans.

Spotted bass utilized aquatic and terrestrial invertebrates more than fishes as food. Chironomid larvae and pupae were the most important aquatic invertebrates consumed while adult dipterans and hymenopterans dominated the terrestrial food category. Entomostracans were eaten by some of the smaller spotted bass, but were not found in any of the largemouth bass. The majority of the forage fishes of spotted bass were unidentifiable. However, none of these fishes were soft-rayed, indicating that minnows were not an important food item. Soft-rayed fishes were also conspicuously absent from the diet of largemouth bass. Crayfish were consumed by both species of bass but, when compared with the other food groups, were of relatively minor importance.

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Chapter I

INTRODUCTION

Beech Fork Reservoir, a 720-acre multiple-purpose impoundment, was constructed by the United States Army Corps of Engineers under authority of the Flood Control Act of 1962. Construction of the dam began in February 1973, and the project was completed in November 1976, with impoundment in the spring of 1977. The project is located in CabelI and Wayne Counties, West Virginia, on Beech Fork of Twelvepole Creek, a tributary of the Ohio River, and is approximately 6 miles(9.6 km) south of Huntington, West Virginia. The summer or seasonal pool is maintained at 592.0 feet (180.5 m) (msl) from April through October and the winter pool is maintained at 583.5 feet (177.9 m) (msl) from November through March. The dam is a random rock filled structure with a flood control elevation of 614.5 feet (187.3 m) (msl) and an uncontrolled spillway located on the left abutment.

Following impoundment in the spring of 1977, the West Virginia Department of Natural Resources initiated a fish stocking program at Beech Fork Reservoir. Channel catfish fingerlings were introduced in the lake in the fall of 1977 and again in the spring of 1978 and 1979. Walleye frye were also introduced in the spring of 1978 and 1979. Black crappie were stocked in late summer of 1978, with some adult fish included among those released. Largemouth bass were also stocked in the summer of 1978, with

released fish ranging in length from 19 to 51 millimeters. The stocking of spotted bass was not necessary, since this species is among those native to the Beech Fork drainage. Other native fishes which may be found in Beech Fork Lake are white crappie, grass pickeral, bluegill, sunfish, black bullhead, yellow bullhead, spotted sucker, white sucker, carp, brook silversides, minnows, darters, and brindled madtoms (Woodrum, 1979).

The construction of a dam and operation of a 720-acre multiple-purpose lake and other facilities provides flood control for the area as well as recreation, fish and wildlife conservation, and incidental redevelopment benefits. From a conservation standpoint, food habit studies on the fishes that inhabit the reservoir are considered vital to the management of the lake's fisheries and provide some insight into the population dynamics of various plant and animal communities inhabiting the lake. The food habits of certain fishes found in the Beech Fork drainage have been studied to some degree during a pre-impoundment investigation (Olson, 1971) and a post-impoundment investigation (Borda, 1980) of the Beech Fork Lake project. The purpose of this investigation was to compare the food habits of two game fish in the lake, the largemouth bass, Micropterus salmoides (Lacepede), and the spotted bass, M. punctulatus (Rafinesque). The objectives of this project were to determine: (1) what food organisms are most important to each species, (2) whether or not food habits vary with season, (3) whether or not food habits change as bass increase in size and (4) whether or not there are

any major differences in the feeding habits between the two species. This and other information gathered in this study will hopefully be of some benefit in future conservation and management of the lake's fisheries.

Chapter II

REVIEW OF THE LITERATURE

The feeding activity of largemouth and spotted basses has been the subject of many limnological investigations in streams and lakes. However, little information is available on the feeding of the two basses during their initial period of growth in a reservoir. Also, few studies have focused on comparing the food habits of the two species in a sympatric location. This may be due to the fact that the spotted bass was only recently recognized as a distinct species (Hubbs, 1927).

West Virginia Investigations

The food habits of largemouth and spotted basses have been included in limnological investigations of the Twelvepole Creek drainage. These investigations were conducted by graduate students at Marshall University.

Olson (1971), in a pre-impoundment study of the Beech Fork basin, looked at stomach contents of 15 species of fish, including spotted bass. Borda (1980), in a post-impoundment investigation of the Beech Fork basin, analyzed the stomach contents of 17 species of fish, including spotted and largemouth bass. Bohn (1974) included both species of bass in a study of the food habits of certain fishes from East Lynn Reservoir on the East Fork of Twelvepole Creek.

Food habit investigations of basses in other West Virginia impoundments include a study on food selection of largemouth bass in Moncove Lake, Monroe County (Woodrum, 1975), and a study of the summer and fall foods of spotted bass in two U. S. Army Corps of Engineer impoundments, Bluestone Reservoir in Summers County and Sutton Reservoir in Braxton County (Lewis, 1976).

Largemouth Bass Studies

Generalized studies on the food habits of largemouth bass in United States reservoirs are numerous. This species was included in a study of the food of some Reelfoot Lake fishes (McCormick, 1940) and Norris Reservoir fishes (Dendy, 1946) in Tennessee. Seaburg and Moyle (1964) examined the summer feeding habits of some Minnesota warmwater fishes, including largemouth bass. Food habits of largemouth bass at Big Creek Lake, Iowa, were studied to determine the utilization of prey, temporal food habits, and size at which bass became piscivorous (Paramagian, 1978). Black basses were included in a study of the food and growth of centrarchids from Bull Shoals Reservoir in Arkansas (Applegate et al., 1966). The relationship between food habits and growth of largemouth bass in Lake Blackshear, Georgia, was the subject of an investigation by Pasch (1974). Stomach contents of largemouth bass from Crab Orchard Lake, an Illinois impoundment, were examined in order to determine the significance of a high percentage of empty bass stomachs previously observed in several different populations (Lewis et al., 1974).

The food of young largemouth bass has been the subject of numerous aquatic investigations. Mid-summer feeding of juvenile bass in Clear Lake, California was examined by Murphy (1949) and his conclusions were tested in a further study by McCammon et al. (1964). Food habits of young largemouth bass in a new and old reservoir were determined by Applegate and Mullen (1967). The feeding habits of age 0 black basses during the filling of Beaver Reservoir, Arkansas, was explored by Hodson and Strawn (1968). Food and growth of young-of-the-year largemouth bass near its northern limit were studied by Hamilton and Powles (1979). Other food habit studies of juvenile bass were conducted in some Ohio waters (Turner and Kraatz, 1920) and in a Mississippi Lake (Warden and Lorio, 1976).

Elliot (1976) and Zweiacker and Summerfelt (1974) investigated the diel activity and feeding of the largemouth bass. The vulnerability of forage organisms to this species was the subject of studies by Lewis and Helms (1964) and Lewis et al. (1961).

Spotted Bass Studies

The spotted bass, unlike its counterpart the largemouth bass, has been the subject of relatively few food habit investigations. This may be related to the fact that this bass was not recognized as a distinct species until recently.

Scalet (1977) compared the feeding habits of spotted and largemouth basses in a sympatric stream. Ryan et al. (1970) examined the food habits of spotted bass in the Tchefuncte River of Southeastern Louisiana in relation to size, sex, and season.

An analysis of the stomach contents of various sizes of spotted bass collected in the Wabash River drainage of Illinois was performed by Smith and Page (1969). This species was included in a study of the food of basses from Bull Shoals Reservoir (Applegate et al., 1966) and Beaver Reservoir (Hodson and Strawn, 1968), both in Arkansas. Stomach contents of spotted bass from Claytor Lake, Virginia, were examined by Rosebery (1951). Food habits and food availability were the subjects of studies on spotted black bass from a lotic environment in Louisiana (Carver, 1968) and a lentic environment in Oklahoma (Clemens, 1952).

Chapter III

DESCRIPTION OF THE STUDY AREA

General

The Beech Fork Lake project is located in northeastern Wayne County and includes two small parts of Cabell County, West Virginia. The dam is 3.7 miles (6.0 km) above the mouth of Beech Fork, 19.6 miles (31.6 km) above the mouth of Twelvepole Creek, and 2 miles (3.2 km) southeast of Lavalette, West Virginia. The earth embankment type structure has a top elevation of 640.0 feet (195.1 m) (msl) and rises 86 feet (26.2 m) above the old stream bed. The length at the crest is 1080 feet (329.2 m). The spillway is an uncontrolled type with a bottom width of 80 feet (24.4 m) and a crest elevation of 614.5 feet (187.3 m) (msl).

The reservoir itself is maintained at a seasonal or summer pool of 592.0 feet (180.5 m) (msl) and a minimum or winter pool of 583.5 feet (177.9 m) (msl). The summer pool covers an area of 720 acres (291.4 ha) and the winter drawdown effectively reduces the area to 450 acres (182.2 ha). The mean depth at summer pool is 12.75 feet (3.9 m) and the mean breadth is 713 feet (217.3 m). The length of the lake is 8.33 miles (13.4 km) and covers approximately 31 miles of shoreline.

Geology

The Beech Fork drainage basin lies within the maturely

dissected Kanawha section of the Appalachian Plateau physiographic province. Erosion of the plateau has resulted in a typically dendritic pattern of drainage. The terrain in the reservoir area is rugged, consisting of narrow, steep-walled valleys of irregular shape. Maximum relief is 460 feet (140.2 m) with most level land confined to the stream valley. The Beech Fork basin lies within sedimentary strata of Pennsylvanian age. The Monongahela and Conemaugh Groups comprise the formations at the lake site. The formations consist of clays, indurated clays, claystones, shales, siltstones, sandstones, and thin limestones and coals. The majority (70 to 75 %) of the rock at the site consists of indurated clay.

Collecting Stations

Collections were made at three stations on Beech Fork Reservoir, each covering approximately 0.5 miles (0.8 km) of shoreline (Figure 1). Due to the nature of the electrofishing equipment, collecting was limited to shallow water areas near the shore. Since the basses collected from three areas were taken to represent the entire lake, the author does not feel it necessary to provide detailed information concerning substrate composition, water depth, et.

Station 1 is located across from the Beech Fork Lake Marina, approximately 0.25 miles (0.4 km) from the dam.

Station 2 is located on Millers Fork below Childers Branch, approximately 1.0 miles (1.6 km) from the dam.

Station 3 is located on Beech Fork below William Hunter Branch, approximately 1.75 miles (2.8 km) from the dam.

Chapter IV

MATERIALS AND METHODS

The basses used in this study were collected by electrofishing at three stations on Beech Fork Reservoir. Collections were made semi-monthly between 2000 and 0200 hours from July 1978 through June 1979. Bad weather and water conditions did not permit collections in September and December of 1978, and January, February, and March of 1979. A Coffelt electrofishing boat was employed in the sampling. One member of the collecting team maneuvered the boat up and down the shoreline while the remaining members dip netted the stunned fish. All basses taken were placed in a live well until collecting ceased, then separated as to species. The specimens were fixed in 10 percent formalin, taken to the laboratory, sorted, and preserved in 70 percent ethanol.

Each fish collected was measured to the nearest millimeter and weighed to the nearest 0.01 gram on a Mettler P-1200 balance. The stomach and esophagus were removed with microdissecting scissors and stored in 70 percent ethanol. The remainder of the fish was discarded. Once the stomachs were removed from al. fish collected during a particular month, an analysis of the contents was made. Stomach contents were examined under a Bausch and Lomb binocular dissecting microscope, identified to the lowest possible taxon, and categorized as follows: fish, crayfish, aquatic invertebrates (other than crayfish), terrestrial

invertebrates, and miscellaneous. The food items were blotted dry on paper towels and weighed to the nearest 0.0001 gram on a Bosch S-2000 analytical balance.

Food habits were determined for both species of bass for the entire collecting period, as well as seasonally. Fishes were arbitrarily divided into six length classes (100 mm and less, 101-125 mm, 126-150 mm, 151-175 mm, 176-200 mm, and 201 mm and greater) and food preference determined for each class. The statistical analysis included: (1) percent of organisms in diet by weight, (2) percent of organisms in diet by numbers, (3) percent frequency of occurrence of each organism, and (4) percent of stomachs containing food. Fishes with empty stomachs were not used in calculating food habits. In the final analysis, the food habits of largemouth and spotted bass were examined from a comparative aspect.

Chapter V

RESULTS AND DISCUSSION

A total of 171 largemouth bass and 95 spotted bass stomachs were examined from Beech Fork Reservoir. One hundred thirty-nine (81.3%) of the largemouth bass and 72 (75.8%) of the spotted bass stomachs contained food. The number of largemouth bass stomachs with food was highest in July (90.6%) and lowest in August (70.6%). The highest occurrence of food for spotted bass was in October and April (86.4%) and lowest in June (50.0%). Judging from the number of stomachs with food, largemouth bass appeared to feed most intensively in the summer and spotted bass in the fall. A monthly summary of the percentage of stomachs with food is presented in Table 4, while monthly variations are illustrated in Figure 8.

Food of Largemouth Bass

Fishes were the primary food of largemouth bass, both by weight (88.3%) and frequency of occurrence (54.7%). They are compared with the other major food groups in importance by weight (Figure 2) and frequency of occurrence (Figure 4).

Bluegills, Lepomis machrochirus (Rafinesque), were the most common forage fishes and occurred in 20.1 percent of the stomachs with food. Other identifiable food fishes were walleye, Stizostedion vitreum (Mitchell), logperch, Percina caprodes (Rafinesque), and bullhead catfish, Ictalurus sp. Fishes digested beyond identification were found in 33.1 percent of the stomachs. However,

all of these fishes were spiny-rayed, indicating that no minnows were utilized as forage. The appearance of walleye in the bass stomachs is interesting but not surprizing, since their fry were abundant when the lake was initially stocked. There was no evidence of cannabilism. A list of forage fishes by numerical importance is included in Table 1A.

With few exceptions, fishes have been found to be the most important food item of largemouth bass (Bohn, 1974; McCormick, 1940; Dendy, 1946; Seaburg and Moyle, 1964; Applegate et al., 1966; and Scalet, 1977). Largemouth bass almost invariably prefer a particular species of fish as forage. When available, soft-rayed fishes such as shad are particularly vulnerable to predation (Dendy, 1946; Pasch, 1974; and Lewis et al., 1974).

Crayfish comprised the second highest weight of food of largemouth bass. However, they cannot be considered a major food item since they were only found in 3.6 percent of the stomachs. The importance of crayfish in the diet of largemouth bass has been shown to vary in other studies. Due to the piscivorous nature of this species, crayfish are more often than not a minor food item.

Studies of the largemouth bass in West Virginia reservoirs (Woodrum, 1975; and Bohn, 1974) have indicated that crayfish are used more extensively as food than what has been reported from other reservoirs. Scalet (1977) found that a lotic population of largemouth bass fed more on crayfish than what has been reported for bass from lentic environments. Hodson and Strawn (1968) reported that largemouth bass in a new reservoir fed sparingly on

crayfish, although they were common in largemouth bass from pre-impoundment waters.. They suggested that once a population of crayfish established itself in the lake, it would become a more important source of food for largemouth bass.

Aquatic invertebrates, other than crayfish, although comprising only 0.5 percent of the food biomass, were important numerically (22.7%) and occurred in 31.6 percent of the stomachs. All of the aquatic invertebrates found in largemouth bass stomachs were immature insects. Only two orders, Diptera and Ephemeroptera, were represented in the stomachs. Dipteran larvae and pupae comprised 21.3 percent of the total number of food organisms found in the largemouth bass. Among these dipterans were the families Chironomidae; Culicidae, and Tabanidae. Ephemeropteran naiads of Caenis occurred in 5.7 percent of the stomachs while comprising 1.0 percent of the total number of organisms. A list of aquatic invertebrates by numerical importance is included in Table 1A.

Generally, aquatic insects are important in the diets of juvenile bass (Murphy, 1949; McCammon et al., 1964; and Hodson and Strawn, 1968). Dipteran larvae and pupae have been found to make up a substantial part of the diet of young fish (Turner and Kraatz, 1920 and McCormick, 1940).

Terrestrial invertebrates, although constituting a minor portion of the food biomass, were found in 34.5 percent of the stomachs and represented 67.1 percent of the total number of food organisms. Such high numbers of terrestrial invertebrates are uncommon in most largemouth bass food habit studies. The use of terrestrial invertebrates by largemouth bass in Beech Fork Reservoir

may be compensation for a lack of other suitable forage. In newly impounded waters, benthic organisms such as crayfish and insects need time to expand and establish their populations.

The majority of the terrestrial forms were adult insects. The most important by numbers were Chironomidae (20.4%), Hymenoptera (17.1%), and Homoptera (5.9%). Terrestrial invertebrates of lesser importance included Orthoptera, Lepidoptera, Araneae, Isopoda, and Annelida. A list of terrestrial invertebrates by numerical importance is included in Table 1A.

Dendy (1946) reported that terrestrial insects were only a minor item in the diet of largemouth bass from a lentic environment. Paragamian (1978) found that terrestrial invertebrates represented no more than 8.6 percent of the number of food items found in any size group of bass. Scalet (1977) reported a 10.6 percent frequency of terrestrial invertebrates in bass from a lotic habitat.

Miscellaneous items, which included anything that could not be classified in any of the major food categories, were found in 16.5 percent of the stomachs and represented 6.1 percent of the food by weight. Plant detritus was found in 10.8 percent of the stomachs and was probably injested accidentally while bass fed on other organisms. Frogs occurred in 1.4 percent of the stomachs and were found in fish collected in early spring. They were identified as the spring peeper, Hyla crucifer Wied, and the chorus frog, Pseudacris sp.

Seasonal Food Habits

The food habits of largemouth bass from Beech Fork Reservoir varied with season. However, the variation in diet may not only

be influenced by the time of year, but also by the continual growth and changing food requirements of the bass. A complete list of food organisms found in largemouth bass by season is presented in Table 2A. Seasonal importance of the major food groups by weight is illustrated in Figure 3, while frequency of occurrence is illustrated in Figure 5.

Fishes were the dominant food item by weight throughout the year. Greatest utilization was in the summer, when they were found in 67.1 percent of the stomachs with food. The high consumption of fishes in the summer months is related to the availability of bluegill fry as forage subsequent to their spawning. Walleye fry, which were stocked early in the year, were utilized as food in the spring and summer, but were not found in the fall.

Applegate et al. (1966) found that largemouth bass over 4.0 inches (100 mm) in total length were primarily fish eaters throughout the year, but fish consumption by smaller bass tended to be seasonal. Pasch (1975) discovered a significant percentage of young-of-the-year bluegill in the stomachs of small bass in the summer months. Bohn (1974) found that fishes contributed the greatest food bulk in the summer.

Crayfish were utilized as food in the summer and fall, but in very small numbers. Bohn (1974) and Paragamian (1978) found that crayfish were eaten more in the spring than at other times of the year. The absence of crayfish in the spring samples of Beech Fork Reservoir bass contradicts these findings, however crayfish were found in such small numbers overall that an accurate

comparison cannot be made.

Aquatic invertebrates, other than crayfish, occurred in more stomachs during the fall than at any other time of year. Chironomid pupae were the dominant organisms, occurring in 55.2 percent of the stomachs. Applegate et al. (1966) found that midge pupae were the primary aquatic insects consumed by largemouth bass in the fall and winter.

Consumption of terrestrial invertebrates was equally high in the spring and fall. During both of these periods, this group comprised approximately three-fourths of the total number of food organisms and were found in nearly half of the stomachs examined. Chironomid adults were the most common terrestrial forms eaten during both spring and fall. More variation, however, was shown in the fall diet, when hymenopteran and homopteran adults as well as large numbers of unidentifiable insects were consumed. Spiders were found in fish during both seasons, but were more common in the fall. Terrestrial invertebrates were consumed in small numbers during the summer, when fish and other aquatic organisms dominated the diet.

Although terrestrial invertebrates have been reported as minor food items of largemouth bass, studies of the food of other centrarchids have shown terrestrial organisms to be important in both the spring (Applegate et al., 1966) and fall (Bohn, 1974).

Like many of the other foods of largemouth bass, consumption of miscellaneous items varied with season. Plant detritus was found only in the summer samples and was probably ingested

accidentally while bass fed on other organisms. Frogs were found only in the spring, probably because they were abundant as prey during the early breeding season.

Food Habits by Length Class

100 mm and less

Twenty (90.9%) of the 22 fish contained food. Fishes were the number one food item, both by weight (97.0%) and frequency of occurrence (70.0%). Aquatic invertebrates, other than crayfish, and terrestrial invertebrates were present in 30 and 20 percent of the stomachs respectively, although their total weights were negligable. The majority of the aquatic and terrestrial invertebrates consumed were insects. Somewhat surprisingly, microcrustaceans were not found in this or any of the other size groups of largemouth bass. The percent by weight and frequency of occurrence of the major food items of the various length classes of largemouth bass are summarized in Table 3A. Variations in percent weight are illustrated in Figure 6A, while variations in percent occurrence are illustrated in Figure 7.

101-125 mm

Thirty-five (81.4%) of the 43 fish contained food. Fishes were again the number one food item by weight (74.3%) and frequency of occurrence (51.4%). Crayfish first appeared in the diet of bass in this length class, comprising 6.5 percent of the total weight and occurring in 2.8 percent of the stomachs. Other aquatic invertebrates, mostly chironomid larvae and pupae, contributed only 1.4 percent of the total weight of food organisms but were present in 48.6 percent of the stomachs. Terrestrial

invertebrates ranked second in importance by weight (12.3%) and third in frequency of occurrence (31.4%). Adult dipterans and hymenopterans dominated this food category.

126-150 mm

Twenty-two (91.7%) of the 24 fish contained food. This was the only length group in which fishes were not the dominant food by weight. Miscellaneous items contributed the greatest weight (47.0%) with fishes ranking second (41.6%). Frogs were consumed by 5.9 percent of the bass in this length class and accounted for the disproportionate weight of miscellaneous items. Terrestrial invertebrates were found in the greatest number of stomachs (68.2%), followed by aquatic invertebrates other than crayfish (31.8%).

151-175 mm

Twenty-seven (90.0%) of the 35 fish contained food. Fishes were the dominant food by weight (86.7%) but occurred in only 33.3 percent of the stomachs. Both terrestrial invertebrates and aquatic invertebrates other than crayfish, had higher frequencies of occurrence, 55.5 and 40.7 percent, respectively. Dipterans were the prevalent aquatic and terrestrial forms. Crayfish represented the second highest percent by weight (5.8%) but were only found in 3.7 percent of the stomachs. Bass were predominately piscivorous by this length class.

176-200 mm

Eighteen (69.2%) of the 26 fish contained food. Fishes comprised the greatest weight (91.3%) and frequency of occurrence (72.2%). Crayfish and miscellaneous food items were each found

in 5.5 percent of the stomachs. Aquatic invertebrates, other than crayfish, and terrestrial invertebrates were both found in 16.7 percent of the stomachs. The dominant aquatic invertebrates were chironomid pupae and the dominant terrestrial forms were adult dipterans.

Greater than 200 mm

Seventeen (65.4%) of the 26 fish contained food. Fishes and crayfish were the only food items found in this length class. Fishes accounted for 97.0 percent of the total food weight and were found in 94.1 percent of the stomachs with food. Crayfish comprised 3.0 percent of the food by weight and occurred in 5.9 percent of the stomachs. Apparently, aquatic and terrestrial insects were eliminated from the diet once fish reached this size.

Many food studies of largemouth bass have revealed the following progression in diet: small fish feed primarily on microcrustaceans, then as they become larger, turn to insects and fish, and finally progress to fish and/or crayfish (Paragamian, 1978; Applegate, et al., 1966; Pasch, 1974; Murphy, 1949; Applegate and Mullan, 1967; Turner and Kraatz, 1920; and Warden and Lorio, 1976). Largemouth bass from Beech Fork Reservoir did not conform to this pattern of feeding. Microcrustaceans were not utilized as food, possibly because the bass were large enough to feed on other organisms when they were introduced in the lake. All of the fishes collected were greater than 74 mm in length, and they were already piscivorous by this size.

The time at which microcrustaceans dominate the diet of largemouth bass has been shown to vary. Applegate et al. (1966) found plankton to be important in fishes 20-48 mm total length. Turner and Kraatz (1920) found the greatest volume of entomostracans in fish less than 30 mm in length. Warden and Lorio (1976) reported high frequencies of zooplankton in fish up to 99 mm. Pasch (1974) reported significant amounts of plankton in fish as large as 120 mm. Woodrum (1975) noted a change from micro- to macrocrustaceans in bass 101-150 mm.

The use of crayfish by bass at Beech Fork was generally steady in fish over 100 mm in length. The consumption of other aquatic invertebrates was variable but declined considerably once bass reached 176 mm and was eliminated by the time bass were 201 mm. Consumption of terrestrial invertebrates generally declined in bass greater than 125 mm, and no terrestrial organisms were found in fishes greater than 200 mm.

The time at which largemouth bass from Beech Fork Reservoir became primarily piscivorous was difficult to determine. Fishes were equally important by weight to the smallest and largest groups of bass. They declined in importance initially until bass reached a length of 150 mm, then increased in importance thereafter. Although bass were piscivorous at lengths less than 100 mm, they did not become predominately fish eaters until 151 mm. If the disproportionate weight of frogs in the 126-150 mm size class is excluded, then largemouth bass at Beech Fork Reservoir became predominately piscivorous sometime before they reached 74 mm total length.

The time at which largemouth bass become predominately fish eaters has been shown to vary. Applegate and Mullan (1967) reported that fish succeeded midge larvae as the primary food of bass at a length of 40 mm. Hodson and Strawn (1968) reported a population of bass to be piscivorous by 90 mm one year and 50 mm the following year. Murphy (1949) found that the diet of bass changed from insects to fish at 70 mm fork length (73 mm total length). Turner and Kraatz (1920) noted that fish dominated the diet of bass 50-80 mm. Pasch (1974) found that bass became primarily piscivorous by 95 mm, and Applegate et al. 1966 reported similar findings in bass greater than 100 mm.

Food of Spotted Bass

The primary food of spotted bass by weight was fishes (70.3%), however they occurred in only 26.0 percent of the stomachs. The percent by weight of the major food groups is illustrated in Figure 2 and percent occurrence in Figure 4.

The majority of fishes found in spotted bass stomachs were unidentifiable, however all of these were spiny-rayed, indicating that minnows were not important forage. The identifiable fishes included two bullheads, Ictalurus sp., one green sunfish, Lepomis cyanellus Rafinesque, and one unknown cyprinid (Table 1B).

The importance of fishes in the diet of spotted bass has been shown to vary, although this species is generally more piscivorous in lakes than in streams. Dendy (1946) found that spotted bass in a lentic environment fed primarily on fish, including shad, crappie, and bluegill. Bohn (1974) reported that bass in

a reservoir were primarily piscivorous, with bullheads representing the greatest food volume. Rosebery (1951) found that bass in an impoundment fed primarily on bluegills. In contrast to these studies, fishes were found to be a secondary food item of spotted bass from lotic habitats (Scalet, 1977; Ryan et al., 1970; and Smith and Page, 1969).

Terrestrial invertebrates were the second most important food item by weight (11.6%) and occurred in the highest number of stomachs (58.9%). Insects were by and large the most numerous terrestrial food items. Arachnids and oligochaetes were of minor importance. The majority of the identifiable insects were dipterans. Chironomid adults were the most important of these and were found in 53.4 percent of the stomachs with food. A variety of other terrestrial insects were encountered, including hymenopterans (21.9%), homopterans (10.9%), and coleopterans (6.8%). A list of terrestrial invertebrates by numerical importance is presented in Table 1B.

Terrestrial invertebrates have been listed as an important food of spotted bass in other studies (Scalet, 1977 and Smith and Page, 1969), however the frequencies of occurrence recorded were not as high as those for Beech Fork spotted bass. Some of the more common terrestrial invertebrates encountered in other studies were dipterans, odonates, coleopterans, and lepidopterans.

Aquatic invertebrates, other than crayfish, were relatively unimportant by weight, however they were found in greater numbers than any other food item. Their frequency of occurrence (46.6%) was second only to terrestrial invertebrates. The most important

aquatic invertebrates by number were microcrustaceans (38.9%) followed by insects (20.5%). Although prevalent in numbers, microcrustaceans were found in only a small number of stomachs. Cladocerans, the dominant zooplankters, occurred in 6.8 percent of the stomachs. The use of copepods as food was evidenced by only one specimen being found in a 60 mm fish. Aquatic insects, although less important by numbers, were found in more stomachs. The dominant insects, chironomid pupae were found in 26.0 percent of the bass sampled. Other dipteran larvae and pupae were of lesser importance. Besides dipterans, immatures of the orders Ephemeroptera and Odonata were also found. A list of aquatic invertebrates by numerical importance is included in Table 1B.

The use of microcrustaceans as food by young spotted bass has been documented by many authors (Ryan et al., 1970; Smith and Page, 1969; and Applegate et al., 1966). The relationships between consumption of entomostracans and size of bass will be discussed in a later section. Aquatic insects have been listed as an important food item of spotted bass, particularly juveniles (Scalet, 1977; Smith and Page, 1969; Applegate et al., 1966). Some of the more commonly encountered insects in these studies were dipteran larvae and pupae, ephemeropteran naiads, and trichopteran larvae.

Crayfish, generally thought to be a staple food of spotted bass, were of minor importance in the diet of fish from Beech Fork Reservoir. The percentage weight (6.2) of crayfish in Beech Fork spotted bass is somewhat misleading, since only three specimens

were found out of 95 fish examined.

In contrast to fishes, crayfish are generally thought to be more important in the diet of bass inhabiting streams than those in lakes. In studies on lotic populations of spotted bass, Scalet (1977) and Carver (1968) found crayfish to be the most important food item. In a study of a lentic population of spotted bass, Bohn (1974) found that crayfish ranked second to fish in terms of total volume. Hodson and Strawn (1968) found no evidence of crayfish in bass during the filling of Beaver Reservoir, Arkansas, but suggested that crayfish may become a more important food item once their populations become established in the lake. This philosophy may well hold true for Beech Fork Reservoir.

Miscellaneous items comprised 8.6 percent of the food biomass and were found in 12.3 percent of the stomachs. The biomass of miscellaneous foods was enhanced by the consumption of amphibians (one frog and one salamander). Unidentifiable plant and animal material was present in 10.9 percent of the stomachs.

Seasonal Food Habits

Ths food habits of spotted bass from Beech Fork Reservoir varied considerably with season. A complete list of food items in terms of seasonal importance is presented in Table 2B. Seasonal fluctuation by weight of the major food groups is illustrated in Figure 3, while frequency of occurrence is illustrated in Figure 5.

Fishes were the dominant food item by weight throughout the year. They represented the highest portion of the food biomass

in the spring (74.9%), but were found in more stomachs in the summer (50.0%). Crayfish were found only in the summer months and accounted for 41.3 percent of the food weight while occurring in 13.6 percent of the stomachs.

There have been relatively few food habit studies of spotted bass documenting the seasonal use of fishes and crayfish. Ryan et al. (1970) reported the highest occurrence of fishes and crustaceans in spotted bass taken during the spring. Carver (1968) found that crayfish were equally important forage in all seasons, but fishes predominated in the spring. Bohn (1974) reported that fishes represented the greatest food volume in the summer and crayfish in the fall.

Aquatic invertebrates, other than crayfish, were most important by weight (9.9%) and frequency of occurrence (75.0%) in the fall. Their numbers were highest in the summer (95.4%), but this was due to a few small fish consuming large numbers of entomostracans. Entomostracans were not found in the spring or fall. Dipteran insects were utilized as food during all seasons, but comprised the largest numbers (45.1%) in the fall. Chironomid pupae were the most common dipterans and were found in 66.7 percent of the fall samples. Ephemeroptera and Odonata were the only other orders of insects represented, and occurred only in the fall.

Ryan et al. (1970) found that aquatic insects dominated the diet of spotted bass in the fall while microcrustaceans were most important in the spring. Carver (1968) noted that although aquatic

insects were of relatively minor importance in the diet of spotted bass, their highest occurrence was in the fall. Bohn (1974) found aquatic insects only in bass collected during the spring.

Terrestrial invertebrates were consumed in largest quantities in the spring and fall, occurring in 84.6 and 70.8 percent, respectively, of the stomachs. Adult chironomids were the most important, occurring in 50.0 percent of the fish sampled during both seasons. Adult insects found during both the spring and fall included hymenopterans, homopterans, coleopterans, and hemipterans.

Carver (1968) found that terrestrial insects comprised the greatest volume of spotted bass food in the fall, with caterpillars and moths (Lepidoptera) occurring in greatest numbers. Bohn (1974) found the highest volume of terrestrial invertebrates in the spring, among them hymenopterans, coleopterans, and Lumbricus.

The highest volume of miscellaneous food items occurred in the spring. Included among these were an unidentified frog and a plethodontid salamander.

Food Habits by Length Class

Less than 100 mm

Nineteen (70.4%) of the 27 fish contained food. Fishes were the dominant food item by weight (86.7%) and frequency of occurrence (52.6%). Excluding miscellaneous items, crayfish comprised the second largest weight (5.2%), however they were only found in one stomach. Aquatic invertebrates other than crayfish, and terrestrial invertebrates occurred in 42.1 and 15.7 percent, respectively, of the stomachs. Microcrustaceans were the most numerous aquatic

invertebrates, but were not found in fish greater than 62 mm. Adult insects represented the majority of terrestrial invertebrates. The percent by weight and frequency of occurrence of the major food items of the various length classes of spotted bass are summarized in Table 3B. Variations in percent weight are illustrated in Figure 6B, while variations in percent occurrence are illustrated in Figure 7.

101-125 mm

Eighteen (78.3%) of the 23 fish contained food. Fishes comprised the greatest weight (46.4%) and terrestrial invertebrates the greatest frequency (66.6%). Miscellaneous items (including one frog) ranked second by weight (26.4%) and aquatic invertebrates, other than crayfish, second in total frequency (33.3%). The most important aquatic invertebrates were chironomid pupae and the most numerous terrestrial forms were adult dipterans.

126-150 mm

Twenty-eight (93.3%) of the 30 fish contained food. Terrestrial invertebrates contributed the largest weight (36.7%), followed by crayfish (28.2%). Terrestrial invertebrates also occurred in the most stomachs (85.7%) followed by aquatic invertebrates other than crayfish (42.8%). Fishes ranked third in total weight (14.6%) while occurring in only 3.6 percent of the stomachs. Insects were the most important aquatic and terrestrial invertebrates consumed with dipteran larvae, pupae, and adults dominating the sample. Crayfish were not found in any of the larger size classes of bass.

151-175 mm

Six (46.1%) of the 13 fish contained food. Fishes represented the highest weight (88.5%) while occurring in 33.3 percent of the stomachs. Terrestrial invertebrates ranked second by weight (8.8%) and first in frequency of occurrence (66.6%). Aquatic invertebrates other than crayfish comprised a relatively small portion of the biomass (2.7%), but were found in 50.0 percent of the stomachs. Terrestrial invertebrates consumed included adult dipterans and odonates. Aquatic forms eaten were predominately dipteran pupae.

176-200 mm

No fish were collected in this length class.

Greater than 200 mm

Only two fish were collected in this length group, one of which contained food. The fish containing food was 307 mm in length and had two bullhead catfish in its stomach. No other food items were found.

Upon analyzing the food data of the different size classes, fishes appear to become the staple food of spotted bass at lengths greater than 150 mm. Fishes did not steadily increase in usage as bass increased in size. They were the principal food of the smallest group of bass, then decreased in importance as the bass grew to approximately 150 mm. At this time, terrestrial invertebrates and crayfish contributed the greatest weight. Once over 150 mm, bass were primarily fish eaters, and all other food groups diminished in importance.

Spotted bass have been shown in several studies to change food habits as they increase in size. Scalet (1977) found that

consumption of aquatic and terrestrial invertebrates tended to decrease with size of fish. The use of crayfish generally increased with size and was greatest in bass over 200 mm. Plankton was not found in this lotic study of spotted bass.

Smith and Page (1969) found that insects were the principal food of lotic spotted bass in all length groups, with highest occurrence in sub-adults (76-152 mm). Aquatic insect usage decreased with size while terrestrial insect usage increased. Frequencies of crayfish and fish also increased with the size of the bass. Plankton was not found in fish greater than 75 mm.

In a lentic study of spotted bass food habits, Applegate et al. (1966) found that fish less than 50 mm consumed primarily aquatic insects and entomostracans. Bass 50-100 mm utilized aquatic insects and fish while bass greater than 100 mm were mostly piscivorous.

Hodson and Strawn (1968) reported that during the filling of Beaver Reservoir in Arkansas, insects were the dominant food items of spotted bass in all size classes. Insects were supplimented by plankton in fish less than 70 mm. Crayfish were not utilized as food and fishes did not amount to more than 5.0 percent by weight in any size class.

Chapter VI

CONCLUSIONS

One can only speculate on the reasons for the differences in food habits between largemouth and spotted bass. Perhaps habitat choice may account for some of the differences in food selectivity. Largemouth bass have been reported to prefer shallow, vegetated, slack water areas with soft silty bottoms while spotted bass characteristically prefer deep water areas, sparsely vegetated, with hard rock and rubble substrate. Such habitat segregation was observed during electrofishing procedures at Beech Fork Reservoir, when largemouth bass were primarily found in shallow, soft bottom areas while spotted bass were more numerous along rock rip-rap areas near the dam.

Although fishes comprised the greatest weight of food items of both largemouth and spotted bass, there were differences in the kinds utilized. Bluegills were the primary forage of largemouth bass, but were not found in spotted bass. This is not surprising, since bluegills and largemouth bass are known to prefer a similar habitat. The importance of bluegills in the diet of largemouth bass has been shown to vary, although Lewis et al. (1964) stated that they were not a preferred food item. The use of bluegills by largemouth bass at Beech Fork Reservoir may be due to the availability of this species and not necessarily choice.

Aquatic and terrestrial invertebrates were consumed in higher frequencies by spotted bass than largemouth bass. However, the types of organisms preferred were quite similar. This suggests that there may be some competition for particular food items, especially among smaller bass. However, due to the differential habitat preference, the competition factor is probably not developed enough to effect the well being of either species. Competition may become important in the event that one species of bass outnumbers the other to the extent that habitat overlap is unavoidable.

Crayfish were not an important food item of bass at Beech Fork Reservoir, probably because they were not as abundant as other food organisms. Once crayfish have had time to expand and establish their population in the lake, they may become a more important food item, particularly of spotted bass.

Scalet (1977) listed feeding site as a criterion for evaluating differences in food habits between basses. He stated that spotted bass might be more benthic in their feeding habits and largemouth bass more nektonic. This idea has been emphasized by other researchers as well. However, bass at Beech Fork Reservoir do not conform to this expected pattern of feeding. Benthic organisms such as crayfish and immature insects were of almost equal importance to both spotted and largemouth bass. Terrestrial invertebrates, which had presumably fallen onto the surface of the water, were found in more spotted bass than largemouth bass stomachs. The differences in feeding habits between the two

species is probably more related to habitat segregation, food preference, and food vulnerability, than it is to feeding site.

The food habits of basses in Beech Fork Reservoir are likely to change as the lake ages, populations of fish become stabilized, and forage densities change. This study provides the groundwork for future studies of the food habits of basses in Beech Fork Reservoir. Hopefully, these studies will indicate what types of changes, if any, take place as the lake matures.

Chapter VII

SUMMARY

1. The food habits of largemouth bass, Micropterus salmoides, and spotted bass, M. punctulatus, from Beech Fork Reservoir, Wayne and Cabell Counties, West Virginia, were determined from July 1978 through June 1979.
2. Monthly percentages of stomachs with food indicated that largemouth bass fed most intensively in the summer and spotted bass in the fall.
3. Fishes were the most important food item of largemouth bass, both by weight and frequency of occurrence. They also comprised the greatest weight of spotted bass food, however both aquatic invertebrates (other than crayfish) and terrestrial invertebrates occurred in more stomachs.
4. The most important forage fishes of largemouth bass were bluegills, Lepomis macrochirus, while the majority of forage fishes of spotted bass were unidentifiable. Only one soft-rayed fish was found in 266 bass stomachs examined, indicating that minnows were not an important forage item. There was no evidence of cannibilism.
5. The overwhelming majority of aquatic and terrestrial invertebrates consumed by both species of bass were dipterans. Chironomid pupae were the dominant aquatic forms while chironomid adults were the number one terrestrial forms. Collectively, 11 orders of insects were found in the bass stomachs. There

was little variation between species of bass in the types of insects consumed.

6. Crayfish were of relatively minor importance in the diet of both species of bass.
7. The food habits of both species of bass tended to vary with season. Fishes were utilized more as food in the summer months. Aquatic invertebrate consumption peaked in the fall. Terrestrial invertebrates were important in the diet during both spring and fall. Entomostracans, a food item of spotted bass, were eaten only in the summer.
8. Both species of bass exhibited similar patterns of feeding as they grew. Fishes were the dominant food item of bass less than 100 mm in length, but diminished in importance as bass grew to 150 mm. At this point, spotted bass fed more on terrestrial invertebrates and crayfish while largemouth bass fed on terrestrial invertebrates and miscellaneous items (mostly frogs). In bass greater than 150 mm, fishes became the staple food while other food items diminished in importance.

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APPENDIX

Table 1A. Taxonomic checklist of food organisms consumed by largemouth bass from Beech Fork Reservoir, Wayne and Cabell Counties, West Virginia, July 1978-June 1979. N = total number of organisms, % number = percentage of all organisms combined, and % FO = percent frequency of occurrence of each organism.

Food Organism	N	% number	% FO
FISH	96	7.7	54.7
Unidentified	51	4.1	33.1
Centrarchidae			
Lepomis macrochirus	37	2.9	20.1
Percidae			
Stizostedion vitreum	6	0.5	4.3
Percina caprodes	1	0.1	0.7
Ictaluridae			
Ictalurus (bullhead)	1	0.1	0.7
CRAYFISH	5	0.4	3.6
Astacidae			
Orconectes sanbornii	5	0.4	3.6
*AQUATIC INVERTEBRATES	282	22.7	31.6
Insecta	277	22.3	---
Diptera	265	21.3	---
Chironomidae pupae	230	18.5	19.4
Unidentified pupae	21	1.6	5.0
Chironomidae larvae	12	1.0	5.0
Culicidae pupae	1	0.1	0.7
Tabanidae larvae	1	0.1	0.7
Ephemeroptera			
Caenis	12	1.0	5.7
TERRESTRIAL INVERTEBRATES	834	67.1	34.5
Insecta	815	65.6	---
Diptera	342	27.5	---
Chironomidae	253	20.4	17.2
Unidentified	80	6.4	12.2
Tipulidae	5	0.4	3.6
Culicidae	4	0.3	2.1

Table 1A concluded.

Food Organism	N	% number	% FO
Hymenoptera	213	17.1	4.3
Unidentified	173	13.9	7.2
Homoptera	73	5.9	1.4
Orthoptera	3	0.2	2.1
Lepidoptera	3	0.2	1.4
Odonata	2	0.2	1.4
Trichoptera			
Hydroptilidae	2	0.2	1.4
Coleoptera	2	0.2	1.4
Ephemeroptera	1	0.1	0.7
Hemiptera	1	0.1	0.7
Arachnida			
Araneae	17	1.3	2.1
Crustacea			
Isopoda	1	0.1	0.7
Oligochaeta			
Lumbricus terrestris	1	0.1	0.7
MISCELLANEOUS	26	2.1	16.5
Plant detritus	15	1.2	10.8
Amphibia			
Hylidae	5	0.4	1.4
Hyla crucifer	3	0.2	0.7
Pseudacris	2	0.2	0.7
Other (sand, tissue, etc.)	6	0.5	4.3

Number of food organisms.....1243
Number of stomachs with food... 139

*Other than crayfish

Table 1B. Taxonomic checklist of food organisms consumed by spotted bass from Beech Fork Reservoir, Wayne and Cabell Counties, West Virginia, July 1978-June 1979. N = total number of organisms, % number = percentage of all organisms combined, and % FO = percent frequency of occurrence of each organism.

Food Organism	N	% number	% FO
FISH	21	1.9	26.0
Unidentified	17	1.5	21.9
Ictaluridae			
Ictalurus (bullhead)	2	0.2	1.4
Centrarchidae			
Lepomis cyanellus	1	0.1	1.4
Cyprinidae	1	0.1	1.4
CRAYFISH	3	0.3	4.1
Astacidae			
Orconectes sanbornii	3	0.3	4.1
*AQUATIC INVERTEBRATES	672	59.8	46.6
Crustacea	437	38.9	6.8
Cladocera	436	38.8	6.8
Copepoda	1	0.1	1.4
Insecta	231	20.5	----
Diptera	223	19.8	----
Chironomidae pupae	200	17.8	26.0
Chironomidae larvae	11	1.0	5.5
Culicidae pupae	5	0.4	4.1
Unidentified pupae	5	0.4	2.7
Tabanidae larvae			
Chrysops	1	0.1	1.4
Tipulidae larvae	1	0.1	1.4
Ephemeroptera			
Caenis	5	0.4	2.7
Odonata	3	0.3	2.7
Coenagrionidae			
Argia	2	0.2	1.4
Libellulidae	1	0.1	1.4

Table 1B concluded.

Food Organism	N	% number	% FO
TERRESTRIAL INVERTEBRATES	416	37.1	58.9
Insecta	409	36.5	----
Diptera	241	24.6	----
Chironomidae	205	18.3	53.4
Unidentified	25	2.2	16.4
Culicidae	8	0.7	8.2
Tipulidae	3	0.3	2.7
Unidentifiable	86	7.7	13.7
Hymenoptera	51	4.5	21.9
Unidentified	35	3.1	20.5
Formicidae	16	1.4	1.4
Homoptera	13	1.2	10.9
Coleoptera	9	0.8	6.8
Hemiptera	5	0.4	5.5
Dermaptera	1	0.1	1.4
Trichoptera			
Hydroptilidae	1	0.1	1.4
Lepidoptera	1	0.1	1.4
Orthoptera	1	0.1	1.4
Arachnida			
Araneae	6	0.5	6.8
Oligochaeta	1	0.1	1.4
MISCELLANEOUS	10	0.9	12.3
Amphibia	2	0.2	2.7
Anura	1	0.1	1.4
Urodela			
Plethodontidae	1	0.1	1.4
Other (plant, tissue, etc.)	8	0.7	10.9

Number of food organisms.....1122
Number of stomachs with food. 72

*Other than crayfish

Table 2A. Seasonal variation in diet of largemouth bass from Peech Fork Reservoir, Wayne and Cabell Counties, West Virginia, July 1978-June 1979. N = total number of organisms, % number = percentage of all organisms combined, and % FO = percent frequency of occurrence of each organism. Spring = April and May, Summer = June, July, and August, and Fall = October and November.

	Spring			Summer			Fall		
Food Organism	N	% number	% FO	N	% number	% FO	N	% number	% FO
FISH	24	12.0	45.0	57	30.9	67.1	15	1.7	37.9
Unidentified	14	7.9	30.0	28	15.2	37.1	9	1.0	27.6
Centrarchidae									
Lepomis macrochirus	8	4.0	12.5	24	13.0	28.6	5	0.6	10.3
Percidae									
Stizostedion vitreum	1	0.5	2.5	5	2.7	7.1	---	---	---
Percina caprodes	---	---	---	---	---	---	1	0.1	3.4
Ictaluridae									
Ictalurus (bullhead)	1	0.5	2.5	---	---	---	---	---	---
CRAYFISH	---	---	---	3	1.6	4.3	2	0.2	6.9
Astacidae									
Orconectes sanbornii	---	---	---	3	1.6	4.3	2	0.2	6.9
*AQUATIC INVERTEBRATES	20	10.0	15.0	61	32.9	28.6	200	23.4	62.1
Insecta	19	9.5	---	61	32.9	---	196	22.9	---
Diptera	17	8.5	---	54	29.1	---	193	22.6	---

Table 2A continued.

Food Organism	Spring			Summer			Fall		
	N	% number	% FO	N	% number	% FO	N	% number	% FO
Chironomidae pupae	16	8.0	7.5	26	14.0	11.4	188	22.0	55.2
Unidentified pupae	---	---	---	20	10.8	8.6	---	---	---
Chironomidae larvae	1	0.5	2.5	7	3.8	7.1	4	0.5	6.9
Tabanidae larvae	---	---	---	---	---	---	1	0.1	3.4
Culicidae pupae	---	---	---	1	0.5	1.4	---	---	---
Ephemeroptera									
Caenis	2	1.0	5.0	7	3.8	4.3	3	0.3	6.9
Nematoda	1	0.5	2.5	---	---	---	4	0.5	10.3
TERRESTRIAL INVERTEBRATES	148	74.4	50.0	48	25.9	20.0	638	74.4	48.3
Insecta	147	73.9	---	46	24.9	---	622	72.5	---
Diptera	142	71.4	---	36	19.5	---	164	19.1	---
Chironomidae	122	61.4	35.0	7	3.8	1.4	124	14.4	31.0
Unidentified	11	5.5	5.0	29	15.7	5.7	40	4.7	10.3
Tipulidae	5	2.5	5.0	---	---	---	---	---	---
Culicidae	4	2.0	7.5	---	---	---	---	---	---
Hymenoptera	---	---	---	---	---	---	213	24.9	20.7
Unidentified	2	1.0	5.0	5	2.7	5.7	166	19.4	13.8
Homoptera	---	---	---	---	---	---	73	8.5	6.9
Orthoptera	---	---	---	1	0.5	1.4	2	0.2	6.9
Lepidoptera	1	0.5	2.5	---	---	---	2	0.2	6.9
Odonata	---	---	---	2	1.1	2.8	---	---	---

Table 2A concluded.

Food Organism	Spring			Summer			Fall		
	N	% number	% FO	N	% number	% FO	N	% number	% FO
Coleoptera	---	---	---	2	1.1	2.8	---	---	---
Trichoptera									
Hydroptilidae	1	0.5	2.5	---	---	---	1	0.1	3.4
Ephemeroptera	1	0.5	2.5	---	---	---	---	---	---
Hemiptera	---	---	---	---	---	---	1	0.1	3.4
Arachnida									
Araneae	1	0.5	2.5	---	---	---	16	1.9	6.9
Crustacea									
Isopoda	---	---	---	1	0.5	1.4	---	---	---
Oligochaeta									
Lumbricus terrestris	---	---	---	1	0.5	1.4	---	---	---
MISCELLANEOUS	7	3.6	10.0	16	8.7	22.8	3	0.3	10.0
Plant detritus	---	---	---	15	8.2	21.4	---	---	---
Amphibia									
Hylidae	5	2.6	5.0	---	---	---	---	---	---
Hyla crucifer	3	1.6	2.5	---	---	---	---	---	---
Pseudacris	2	1.0	2.5	---	---	---	---	---	---
Other (sand, tissue, etc.)	2	1.0	5.0	1	0.5	1.4	3	0.3	10.3
Number of food organisms		199			185			859	
Number of stomachs with food		40			70			29	

*Other than crayfish

Table 2B. Seasonal variation in diet of spotted bass in Beech Fork Reservoir, Wayne and Cabell Counties, West Virginia, July 1978-June 1979. N = total number of organisms, % number = percentage of all organisms combined, and % FO = percent frequency of occurrence of each organism. Spring = April and May, Summer = June, July, and August, and Fall = October and November.

	Spring			Summer			Fall		
Food Organism	N	% number	% FO	N	% number	% FO	N	% number	% FO
FISH	4	2.0	11.5	12	2.6	50.0	5	1.1	20.8
Unidentified	2	1.0	7.7	11	2.4	45.6	4	0.9	16.7
Ictaluridae *Ictalurus* (bullhead)	2	1.0	3.8	---	---	---	---	---	---
Centrarchidae *Lepomis cyanellus*	---	---	---	---	---	---	1	0.2	4.2
Cyprinidae	---	---	---	1	0.2	4.5	---	---	---
CRAYFISH	---	---	---	3	0.6	13.6	---	---	---
Astacidae *Orconectes sanbornii*	---	---	---	3	0.6	13.6	---	---	---
*AQUATIC INVERTEBRATES	10	5.2	27.0	443	95.4	40.9	219	46.9	75.0
Crustacea	---	---	---	437	94.0	22.7	---	---	---
Cladocera	---	---	---	436	93.8	22.7	---	---	---
Copepoda	---	---	---	1	0.2	4.5	---	---	---
Insecta	8	4.2	---	5	1.0	---	215	46.1	---
Diptera	8	4.2	---	5	1.0	---	210	45.1	---
Chironomidae pupae	6	3.2	11.5	---	---	---	194	41.6	66.7
Chironomidae larvae	---	---	---	---	---	---	11	2.5	16.7

Table 2B continued.

Food Organism	Spring N	Spring % number	Spring % FO	Summer N	Summer % number	Summer % FO	Fall N	Fall % number	Fall % FO
Culicidae pupae	2	1.0	7.7	3	0.6	4.5	---	---	---
Unidentified pupae	---	---	---	---	---	---	5	1.0	8.3
Tabanidae larvae									
Chrysops	---	---	---	1	0.2	4.5	---	---	---
Tipulidae larvae	---	---	---	1	0.2	4.5	---	---	---
Ephemeroptera									
Caenis	---	---	---	---	---	---	5	1.0	8.3
Odonata	---	---	---	---	---	---	3	0.6	8.3
Coenagrionidae									
Argia	---	---	---	---	---	---	2	0.4	4.2
Libellulidae	---	---	---	---	---	---	1	0.2	4.2
Nematoda	2	1.0	3.8	1	0.2	4.5	1	0.2	4.2
TERRESTRIAL INVERTEBRATES	170	89.6	84.6	6	1.2	18.2	240	51.4	70.8
Insecta	168	88.6	---	6	0.4	---	235	50.4	---
Diptera	110	58.0	---	2	0.4	4.5	129	27.7	---
Chironomidae	94	49.5	57.7	2	0.4	4.5	109	23.4	54.2
Unidentified	9	4.7	15.4	---	---	---	16	3.4	50.0
Culicidae	4	2.2	7.7	---	---	---	4	0.9	16.7
Tipulidae	3	1.6	7.7	---	---	---	---	---	---
Unidentified	37	19.5	19.2	3	0.6	13.6	46	9.9	8.3
Hymenoptera	7	3.7	15.4	---	---	---	44	9.4	45.8
Unidentified	7	3.7	15.4	---	---	---	28	6.0	41.6
Formicidae	---	---	---	---	---	---	16	3.4	4.2
Homoptera	3	1.6	7.7	---	---	---	10	2.2	25.0
Coleoptera	6	3.2	11.5	1	0.2	4.5	2	0.4	4.2

Table 2B concluded.

Food Organism	Spring			Summer			Fall		
	N	% number	% FO	N	% number	% FO	N	% number	% FO
Hemiptera	3	1.6	7.7	---	---	---	2	0.4	8.3
Dermaptera	1	0.5	3.8	---	---	---	---	---	---
Trichoptera Hydroptilidae	---	---	---	---	---	---	1	0.2	4.2
Lepidoptera	1	0.5	3.8	---	---	---	---	---	---
Orthoptera	---	---	---	---	---	---	1	0.2	4.2
Arachnida Araneae	1	0.5	3.8	---	---	---	5	1.0	16.7
Oligochaeta	1	0.5	3.8	---	---	---	---	---	---
MISCELLANEOUS	6	3.2	19.2	1	0.2	4.5	3	0.6	12.5
Amphibia	2	1.0	7.7	---	---	---	---	---	---
Anura	1	0.5	3.8	---	---	---	---	---	---
Urodela									
Plethodontidae	1	0.5	3.8	---	---	---	---	---	---
Other (plant, sand, etc.)	4	2.2	15.4	1	0.2	4.5	3	0.6	12.5
Number of food organisms		190			465			467	
Number of stomachs with food		26			22			24	

Table 3A. Percent weight and frequency of occurrence (FO) of major food items found in the stomachs of largemouth bass in various length classes from Beech Fork Reservoir, Wayne and Cabell Counties, W. Va., July 1978-June 1979.

Length class and no. stomachs w/food		Fish	Crayfish	* Aquatic Invertebrates	Terrestrial Invertebrates	Miscellaneous
100 mm and less	% weight	97.0	0.0	0.6	2.0	0.4
20 stomachs	% FO	70.0	0.0	30.0	20.0	10.0
101-125 mm	% weight	74.3	6.5	1.4	12.3	5.5
35 stomachs	% FO	51.4	2.8	48.6	31.4	31.4
126-150 mm	% weight	41.6	2.0	1.8	7.6	47.0
22 stomachs	% FO	22.7	4.5	31.8	68.2	5.9
151-175 mm	% weight	86.7	5.8	1.4	4.3	1.8
27 stomachs	% FO	33.3	3.7	40.7	55.5	16.7
176-200 mm	% weight	91.3	1.1	0.2	1.0	6.4
18 stomachs	% FO	72.2	5.5	16.7	16.7	5.5
201 mm and greater	% weight	97.0	3.0	0.0	0.0	0.0
17 stomachs	% FO	94.1	5.9	0.0	0.0	0.0

*Other than crayfish

Table 3B. Percent weight and frequency of occurrence (FO) of major food items found in the stomachs of spotted bass in various length classes from Beech Fork Reservoir, Wayne and Cabell Counties, W. Va., July 1978-June 1979.

Length class and no. stomachs w/food		Fish	Crayfish	* Aquatic Invertebrates	Terrestrial Invertebrates	Miscellaneous
100 mm and less	% weight	86.7	5.2	0.4	1.0	6.7
19 stomachs	% FO	52.6	5.3	42.1	15.7	5.3
101-125 mm	% weight	46.4	2.4	8.7	16.1	26.4
18 stomachs	% FO	27.7	5.5	33.3	66.6	16.6
126-150 mm	% weight	14.6	28.2	5.9	36.7	14.6
28 stomachs	% FO	3.6	3.6	42.8	85.7	17.8
151-175 mm	% weight	88.5	0.0	2.7	8.8	0.0
6 stomachs	% FO	33.3	0.0	50.0	66.6	0.0
176-200 mm no stomachs				NO FISH		
201 mm and greater	% weight	100.0	0.0	0.0	0.0	0.0
1 stomach	% FO	100.0	0.0	0.0	0.0	0.0

*Other than crayfish

Table 4. Percent of largemouth and spotted bass stomachs with food during various months, from Beech Fork Reservoir, Wayne and Cabell Counties, W. Va., July 1978-June 1979.

Month	Number of stomachs collected		Number of stomachs with food		% stomachs with food	
	*LMB	+SB	LMB	SB	LMB	SB
July	32	25	29	17	90.6	68.0
August	34	7	24	4	70.6	57.1
October	28	22	23	19	82.1	86.4
November	8	6	6	5	75.0	83.4
April	21	22	15	19	71.4	86.4
May	27	11	25	7	92.6	63.7
June	21	2	17	1	80.9	50.0
All months combined	171	95	139	72	81.3	75.8

*Largemouth Bass
+Spotted Bass

Figure 1. Map of Beech Fork Reservoir, Wayne and Cabell Counties, West Virginia, showing location of collecting stations.

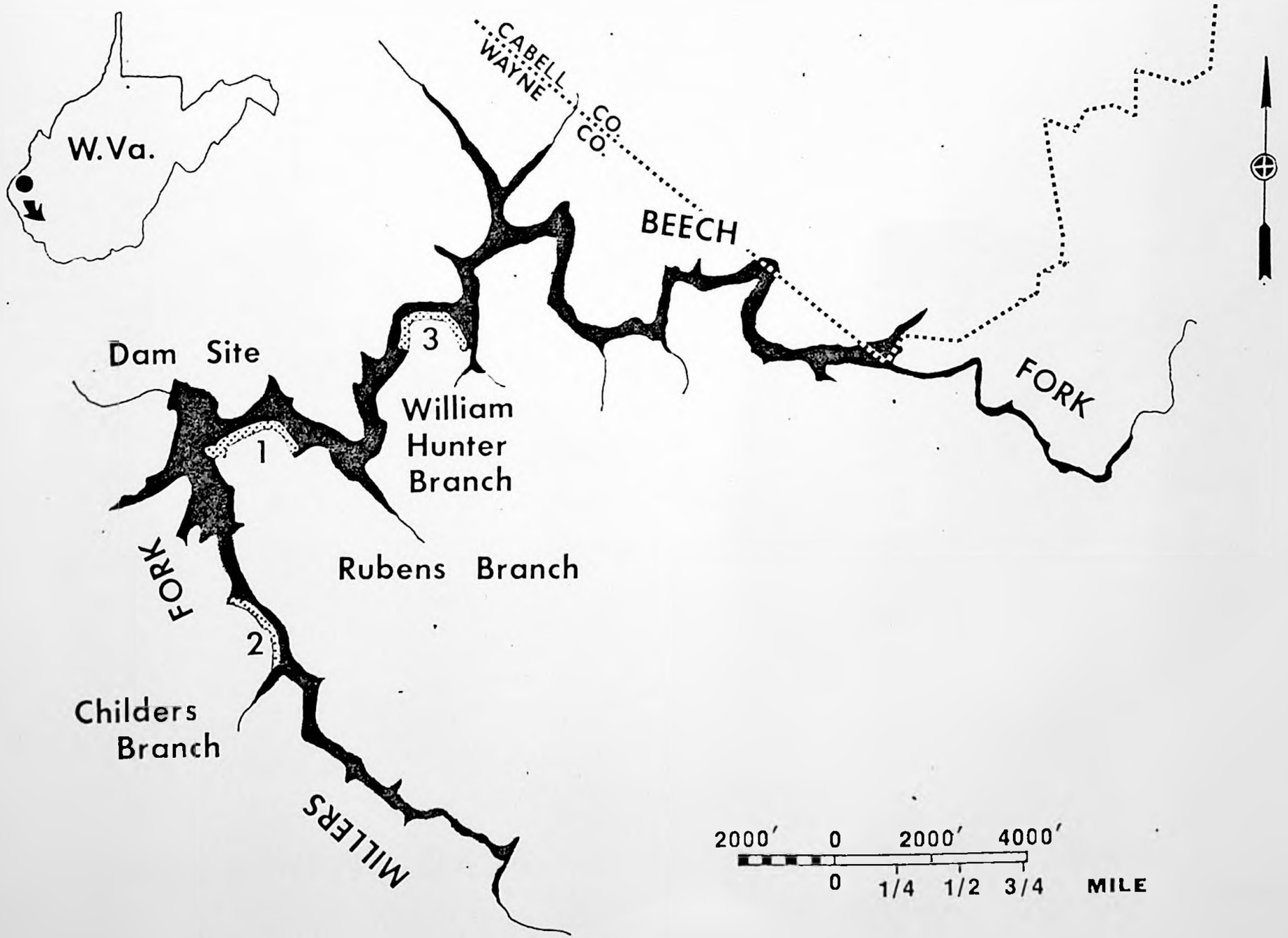
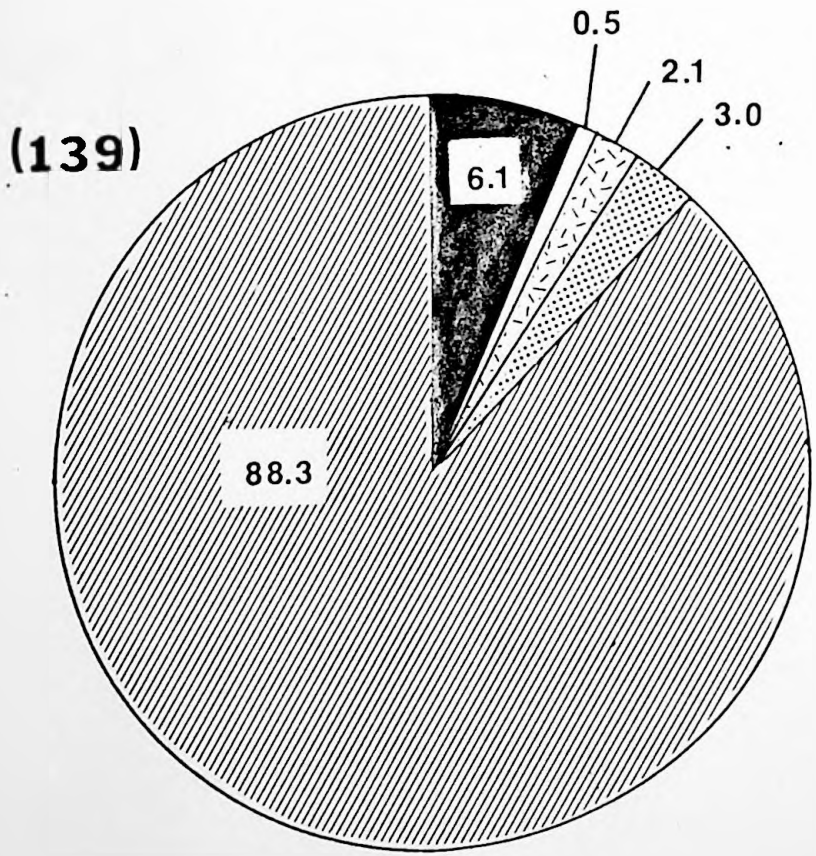
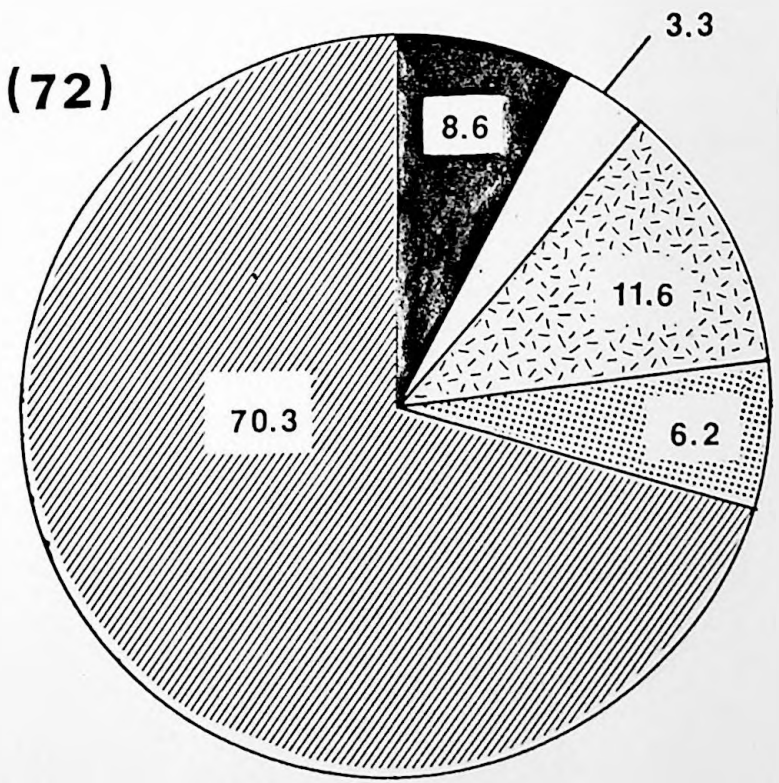

W.Va.
CABELL
WAYNE
CO.
CO.
BEECH
FORK
Dam Site
3
William
Hunter
Branch
1
Rubens Branch
FORK
2
Childers
Branch
MILLERS
2000′ 0 2000′ 4000′
0 1/4 1/2 3/4 MILE

Figure 2. Percent weight of major food items of largemouth and spotted bass from Beech Fork Reservoir, Wayne and Cabell Counties, West Virginia. Sample Size numbers are in parentheses.



LARGEMOUTH BASS



SPOTTED BASS

Figure 3. Seasonal variation in percent weight of major food items of largemouth and spotted bass from Beech Fork Reservoir, Wayne and Cabell Counties, West Virginia. Spring = April and May; Summer = June, July, and August; Fall = October and November. Sample size numbers are in parentheses.

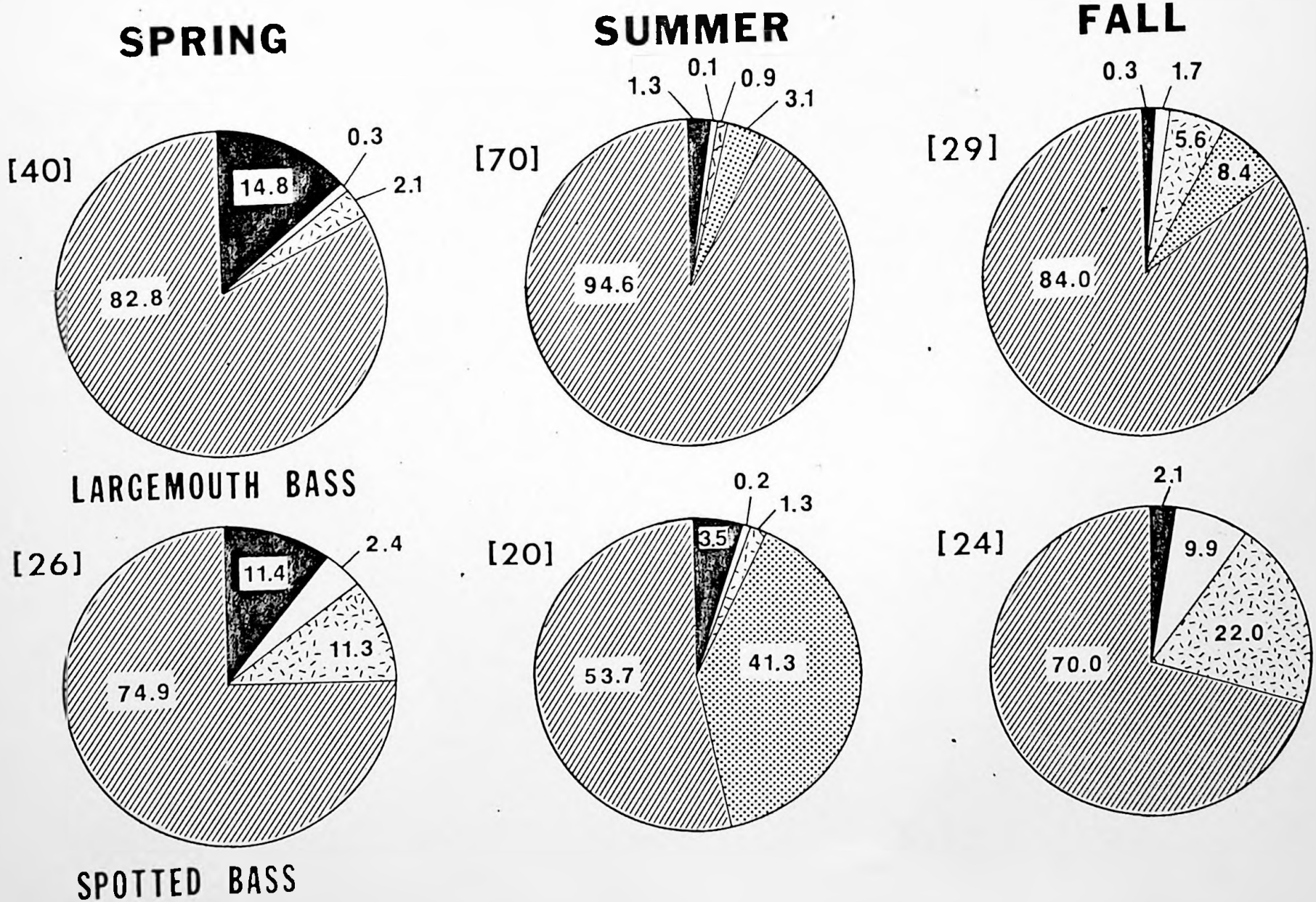

SPRING
SUMMER
FALL
[40]
14.8
0.3
2.1
82.8
[70]
1.3
0.1
0.9
3.1
94.6
[29]
0.3
1.7
5.6
8.4
84.0
LARGEMOUTH BASS
[26]
11.4
2.4
11.3
74.9
[20]
0.2
1.3
3.5
53.7
41.3
[24]
2.1
9.9
22.0
70.0
SPOTTED BASS

Figure 4. Histogram showing the percent occurrence of Fish (F), Crayfish (C), Aquatic Invertebrates, other than crayfish (A), Terrestrial Invertebrates (T), and Miscellaneous Items (M) in the stomachs of largemouth and spotted bass from Beech Fork Reservoir, Wayne and Cabell Counties, West Virginia. Sample size numbers are in parentheses.

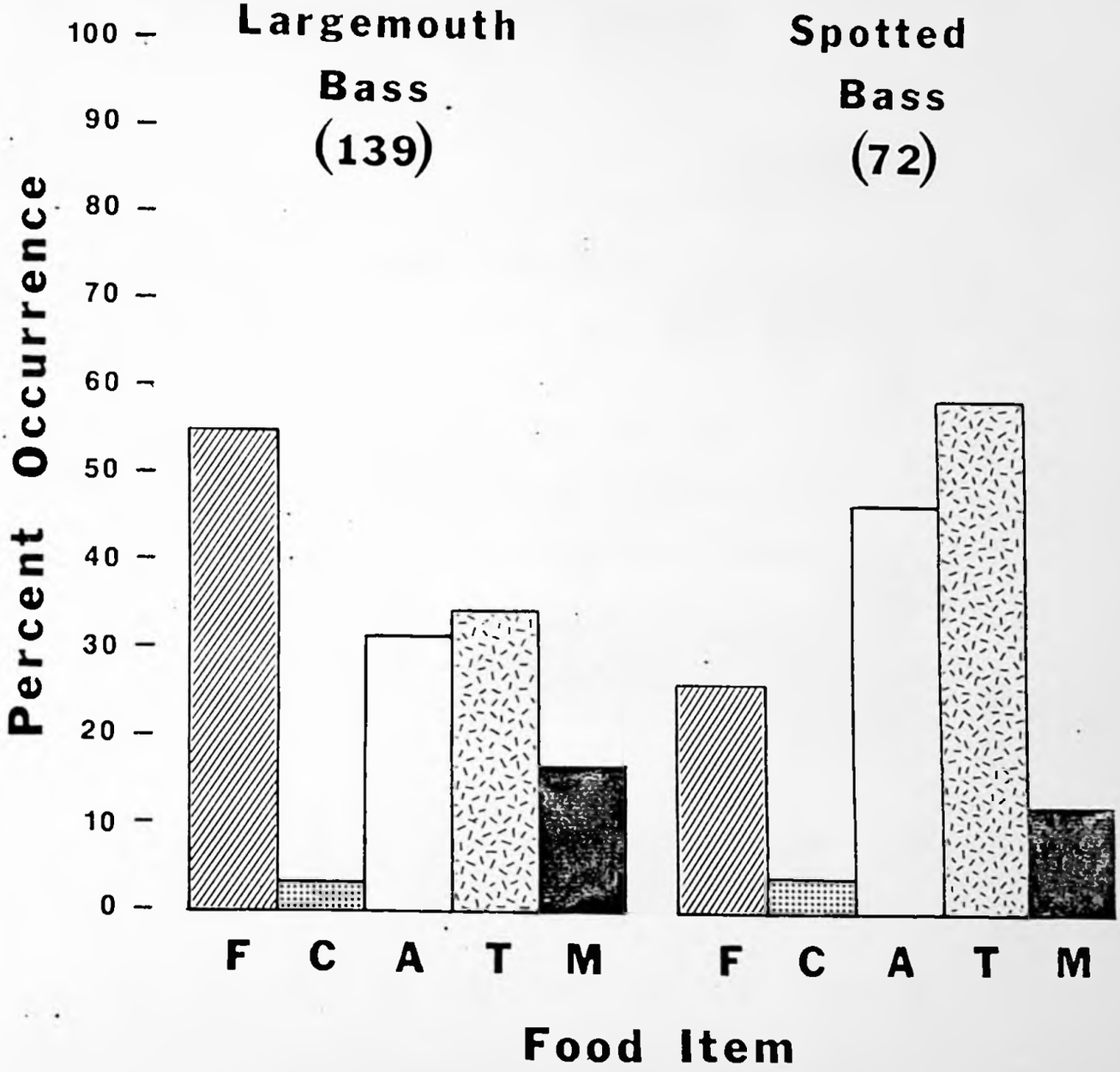

Largemouth Bass (139)
Spotted Bass (72)
Percent Occurrence
100
90
80
70
60
50
40
30
20
10
0
F C A T M
F C A T M
Food Item

Figure 5. Histogram showing the percent occurrence by season of Fish (F), Crayfish (C), Aquatic Invertebrates, other than crayfish (A), Terrestrial Invertebrates (T), and Miscellaneous Items (M), in the stomachs of largemouth and spotted bass from Beech Fork Reservoir, Wayne and Cabell Counties, West Virginia. Solid bar represents largemouth bass and open bar represents spotted bass. Spring = April and May; Summer = June, July, and August; and Fall = October and November.

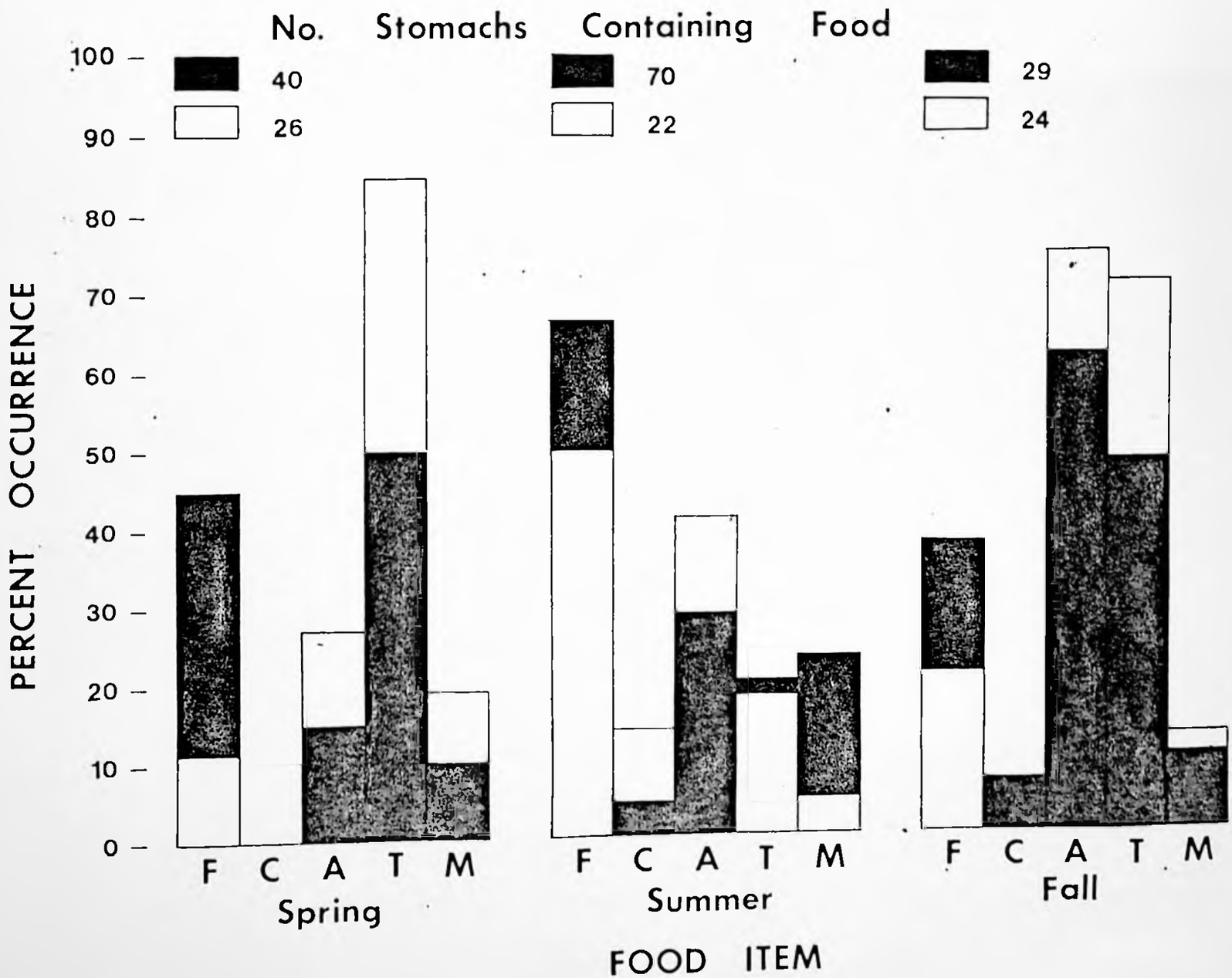

No. Stomachs Containing Food
40
26
70
22
29
24
PERCENT OCCURRENCE
100
90
80
70
60
50
40
30
20
10
0
F C A T M
Spring
F C A T M
Summer
F C A T M
Fall
FOOD ITEM

Figure 6A. Variation in percent weight of major food items in the various length of largemouth bass from Beech Fork Reservoir, Wayne and Cabell Counties, West Virginia. Food categories include Fish, Crayfish, Aquatic Invertebrates, other than crayfish (Aqu. Inv.), Terrestrial Invertebrates (Terr. Inv.), and Miscellaneous.

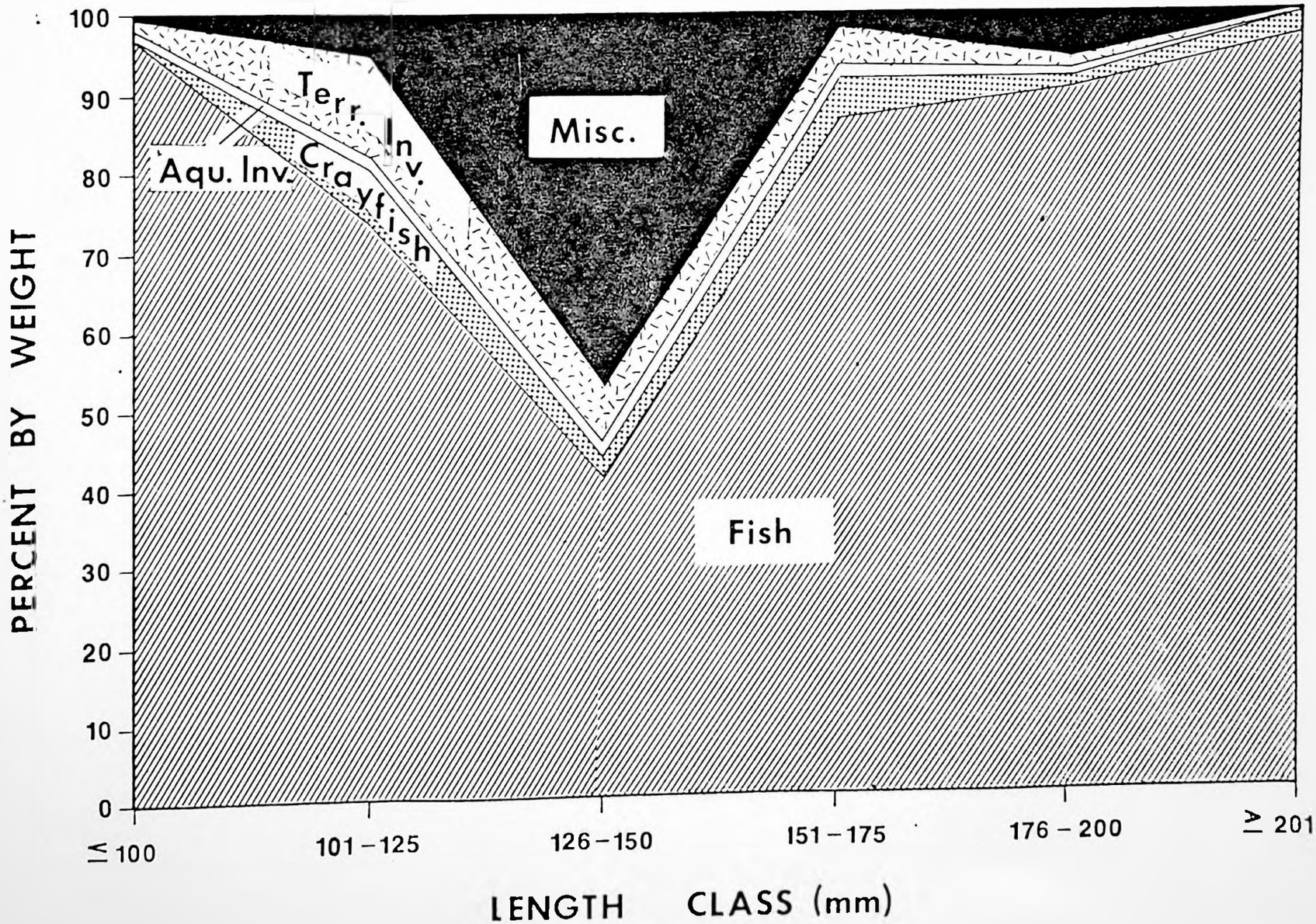

PERCENT BY WEIGHT
100
90
80
70
60
50
40
30
20
10
0
Terr. Inv.
Misc.
Aqu. Inv.
Crayfish
Fish
≤ 100
101 – 125
126 – 150
151 – 175
176 – 200
≥ 201
LENGTH CLASS (mm)

Figure 6B. Variation in percent weight of major food items in the various length classes of spotted bass from Beech Fork Reservoir, Wayne and Cabell Counties, West Virginia. Food categories include Fish, Crayfish, Aquatic Invertebrates (other than crayfish), Terrestrial Invertebrates, and Miscellaneous.

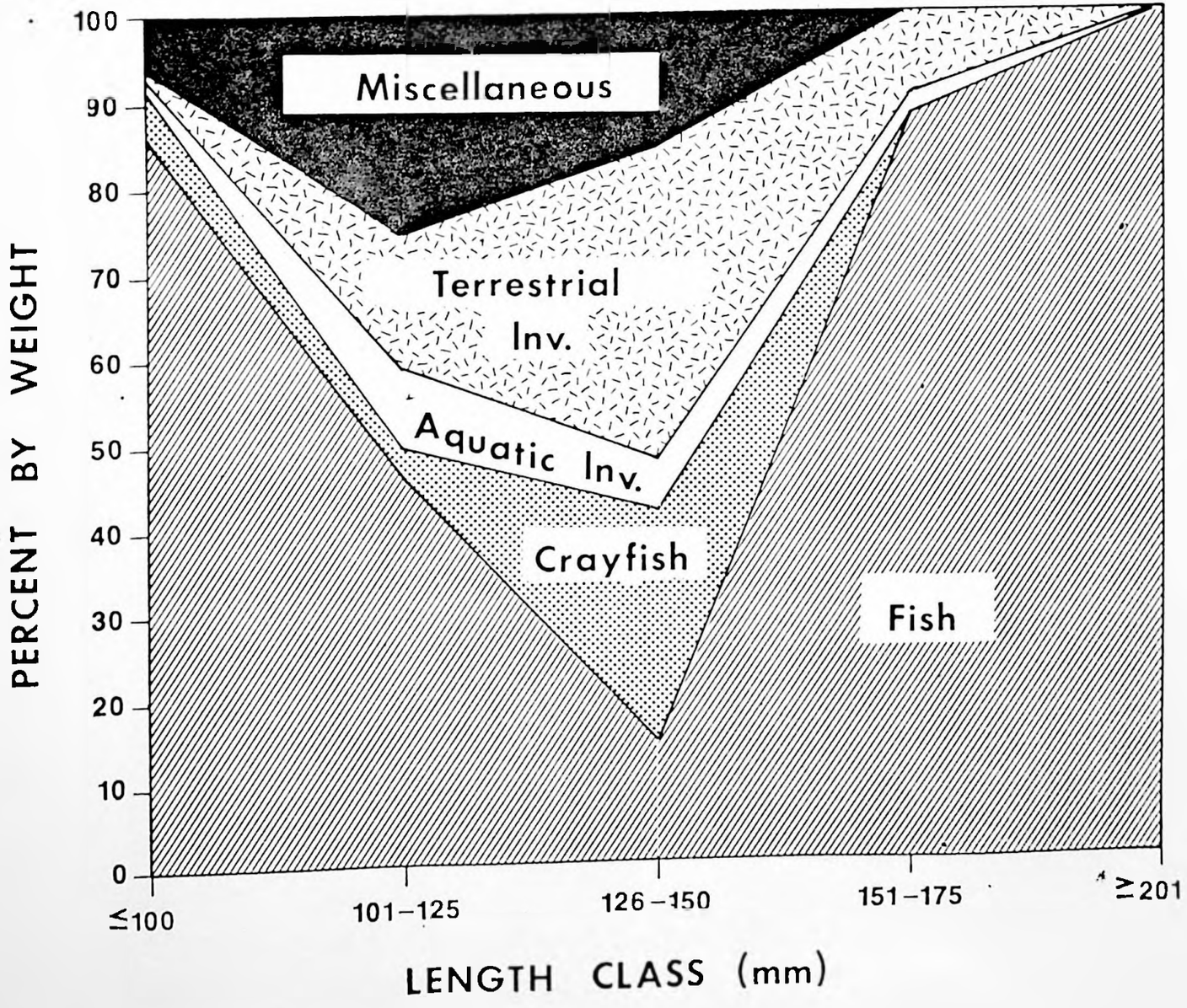

Miscellaneous
Terrestrial Inv.
Aquatic Inv.
Crayfish
Fish
PERCENT BY WEIGHT
100
90
80
70
60
50
40
30
20
10
0
≤100
101–125
126–150
151–175
≥201
LENGTH CLASS (mm)

Figure 7. Histogram showing the percent occurrence of Fish (F), Crayfish (C), Aquatic Invertebrates, other than crayfish (A), Terrestrial Invertebrates (T), and Miscellaneous Items (M) in various length classes of largemouth and spotted bass from Beech Fork Reservoir, Wayne and Cabell Counties, West Virginia. Solid bar represents largemouth bass, open bar represents spotted bass, and striped bar represents both species equal. Sample sizes are indicated above the graph. LMB = Largemouth Bass; SB = Spotted Bass.

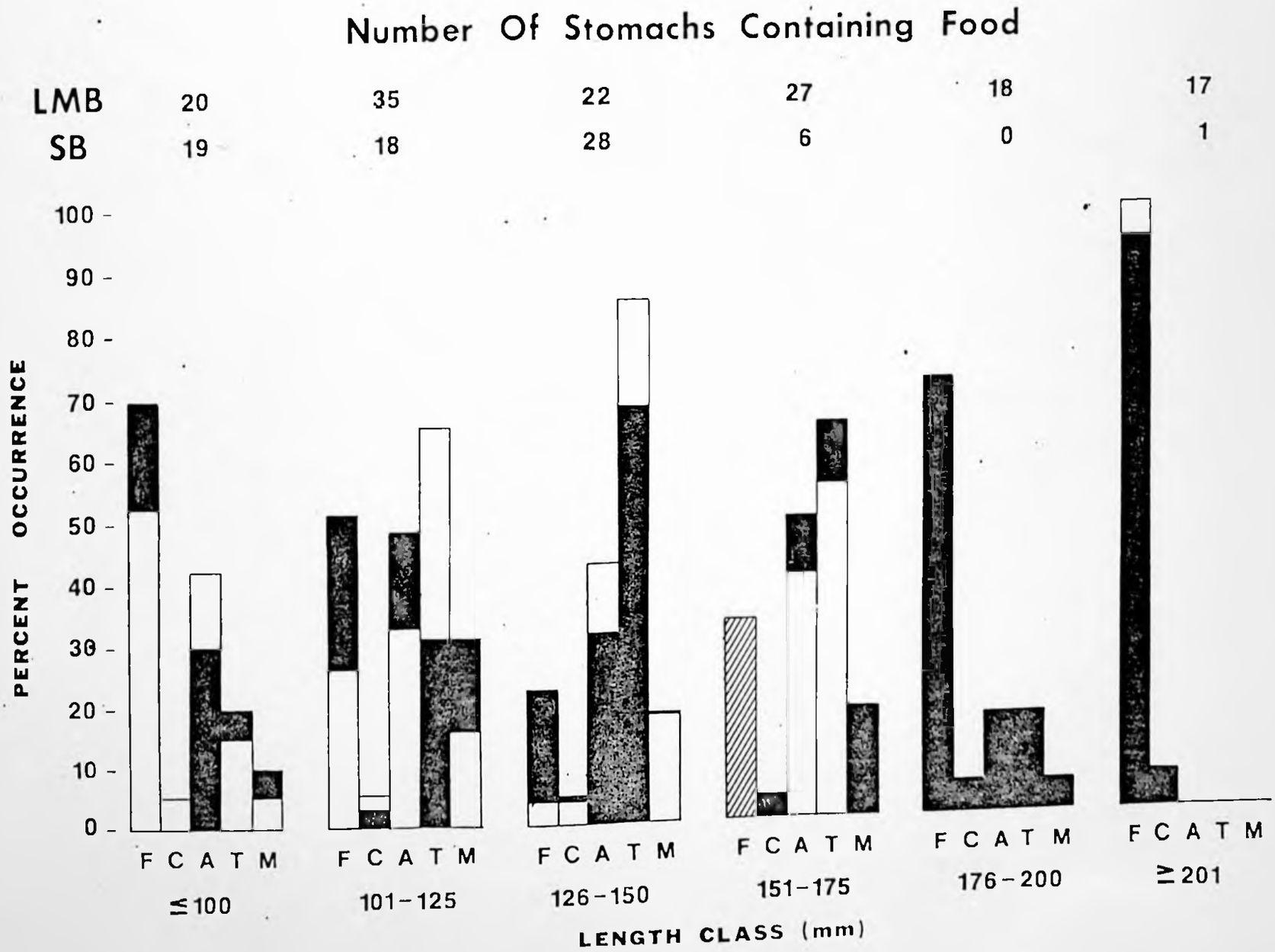
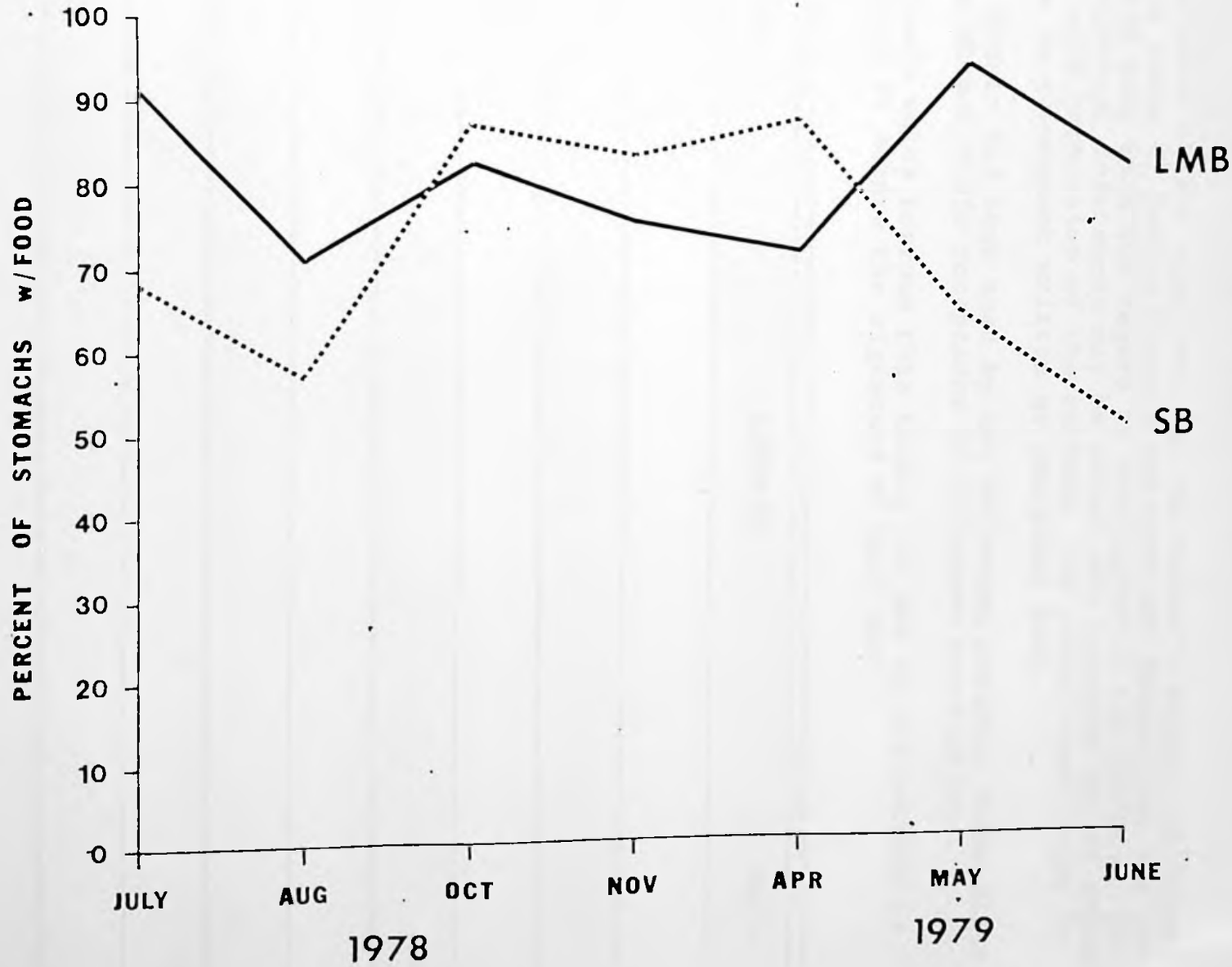

Number Of Stomachs Containing Food
LMB 20 35 22 27 18 17
SB 19 18 28 6 0 1
PERCENT OCCURRENCE
100
90
80
70
60
50
40
30
20
10
0
F C A T M
≤100
101–125
126–150
151–175
176–200
≥201
LENGTH CLASS (mm)

Figure 8. Monthly variation in percent of stomachs with food of largemouth and spotted bass from Beech Fork Reservoir, Wayne and Cabell Counties, West Virginia.


PERCENT OF STOMACHS w/FOOD
100
90
80
70
60
50
40
30
20
10
0
LMB
SB
JULY
AUG
OCT
NOV
APR
MAY
JUNE
1978
1979

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