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Evaluation of Striped Bass Introductions In Lake Cumberland

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by

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ABSTRACT

Striped bass were stocked in Lake Cumberland at rates approaching the recommended stocking rate of 10 fingerlings/acre in 1979 and 1981 after receiving only excess fingerling production from 1969-1978. Maintenance stockings were resumed in 1984 at a reduced rate of 5 fingerlings/acre since striped bass predominately utilized only the lower 50% of the lake surface acreage. The harvest objective was to establish a striped bass fishery which increased the sport fish yield by either a minimum of 10% or 1 lb/acre. This objective was achieved in the March 1987-February 1988 creel survey year following a 10-fold increase in striped bass fishing pressure from 1980; the striped bass harvest was 41,846 lb (1.7 lb/acre) or 41% of the total fish harvest. Fish from the previous 4 years of striped bass stockings (1979, 1981, 1984, and 1985) comprised 96% of the total striped bass fishery, with the average-size striped bass being 26.5 inches in length (7.4 lb). Available coolwater habitat during the critical summer period has increased the longevity of striped bass and developed a trophy fishery (>30 lb fish). A significant winter striped bass fishery has also developed due to shallower feeding activity during this period. Striped bass diet was composed principally of both gizzard and threadfin shad with a trend toward consuming larger gizzard shad by older striped bass. Decreases in numbers of intermediate-size gizzard shad were observed but not positively linked to striped bass predation. Average growth rates compared favorably to other studies with all year classes of striped bass attaining legal size (15 in) at age 2+. A significant improvement in growth rates for age 2 and 3 fish were observed for the 1984 and 1985 year classes following the reduction of the stocking rate. Annual striped bass stockings will be continued at 5 fingerlings/acre.

INTRODUCTION

Interest in striped bass has existed since 1879 when the first introduction was made outside its original range of the Atlantic coast and Gulf of Mexico into the San Francisco Bay (Talbot 1966). The first freshwater introduction in New Jersey (Surber 1957) was unsuccessful in the 1930's, but renewed interest was created in 1954 when it was discovered that striped bass had spawned in the Santee-Cooper reservoir system (Stevens 1957). Bailey (1974) adequately described the successes and failures of fry, fingerling, and adult stocking of striped bass in a wide range of reservoir types and his survey found more than 30 inland fisheries had been established in 1973. An updated survey in 1981 determined striped bass fisheries have been established in 100 of 173 lakes (58%) that had received this species (Axon and Whitehurst 1985).

Striped bass introductions began in Kentucky in 1957 with the stocking of 12 adult fish in Lake Cumberland. A series of miscellaneous stockings of adult and fry striped bass occurred in Kentucky until 1969 when the first fingerlings were introduced in both Herrington Lake and Lake Cumberland. A series of lakes in Kentucky were stocked in the 1970's with inconsistent numbers of fingerlings/acre from 1976-1978 and a fishery failed to develop. A report by the Striped Bass Committee of the Southern Division of the American Fisheries Society (Bayless 1975) indicated that a stocking rate of 10 fingerlings/acre was sufficient if other factors were favorable to create a population density comparable to Santee Cooper and Kerr reservoirs. Herrington Lake was consistently stocked at about 20 fingerlings/acre and evaluated during 1973-1978, but a fishery failed to develop (Axon 1979). Axon identified the lack of fishing interest for striped bass and a high natural mortality period for adult striped bass in late summer as limiting factors preventing the development of a fishery in Herrington Lake.

Lake Cumberland was the recipient of excess fingerling striped bass from 1969-1978, yet the stocking rate never approached the recommended 10 fingerlings/acre. In 1978, a new state record striped bass weighing 45.5 lb was caught in Lake Cumberland and continual reports were being received from anglers that many trophy-size striped bass were being harvested. New information on thermal preferences of striped bass (Coutant and Carroll 1980) indicated that Lake Cumberland would be the best candidate lake for establishing a striped bass fishery since it was deep and contained a cool, oxygenated hypolimnion. A decision was made in 1978 to stock Lake Cumberland for 3 successive years at the recommended stocking rate of 10 fingerlings/acre with the objective of establishing a striped bass fishery that increases the total sport fish harvest by either a minimum of 10% or 1 lb/acre. A federally-funded investigation study began in 1980 as part of D-J Project F-40 to evaluate the success of these stockings.

DESCRIPTION OF THE AREA

Lake Cumberland is a 50,250-acre (summer pool) multi-purpose impoundment built on the upper Cumberland River in 1950 by the U.S. Army Corps of Engineers. The lake is also operated for hydroelectric power production and is equipped with six 45,000 KW electric power generators. Lake volumes between elevations 723-675 (msl) are allocated to power production, thus contributing to the annual 50-foot fluctuation. The average depth of 80- feet is the deepest-average depth of all lakes in the state and accounts for the relatively high hydraulic residence time of approximately 215 days.

Lake Cumberland is a warm, monomictic lake which is stratified between April and November, but contains a well-oxygenated hypolimnion. Kentucky Division of Water (1984) rates Lake Cumberland in the upper end of the oligotrophic state using the Carlson Trophic State Index for chlorophyll-a. A water quality report by the U.S. Corps of Engineers (1976) found Lake Cumberland to have high water quality but to be phosphorus limited in regard to productivity.

The lower lake primarily lies in the Highland Rim physiographic region which is characterized by rolling hills, rough, precipitous terrain with wide bottoms bordering streams, while the upper lake enters the Cumberland plateau or Eastern Coal Field physiographic region which is characterized by dissected hills and low mountains. The lower lake contains large embayment-type habitat with considerably greater shoreline development than the upper lake, which is more riverine in appearance with very little inundated floodplain. Most of the watershed use is publically-owned forested land (55%) as opposed to only 21% that is in agricultural use.

MATERIALS AND METHODS

Three cove-rotenone studies were conducted annually from 1980-1985 with total acreage ranging from 8.3-9.7 acres. Sites were distributed throughout the lake in an attempt to sample at least 1 area in the upper-, mid-, and lower-lake sections (Figure 1). Cove sites in the extreme upper lake were non-existent; the Fishing Creek arm was utilized as the upper station. Locations of the two cove sites in the lower and mid-lake areas were unaltered beginning in 1981; the Fishing Creek site was moved downstream 4 miles in 1982 to a better location. Criteria for cove sites included: approximately 3 acres in surface area, maximum depth of 40 feet (depth of block net), presence of shoreline habitat, and mouth of 3-acre cove site adjacent to open water. This last criterion was difficult to obtain due to variable summer pool levels; often, 3-acre sites adjacent to open water would exceed the maximum depth requirement.

Cove-rotenone procedures were similar throughout the study. The cove was blocked prior to 0800 hours on the first day with a 0.5 in block net, and emulsified rotenone (2.5 or 5%) was dispersed via a boat venturi to obtain a rate of 1 ppm. Surfacing fish were dipped for 3 successive days and sorted to both species and inch-groups with weights of fish gathered on the first day only. Data from the three studies were combined each year and presented as per acre values.

Gill netting was conducted from 1980-1987 with a variety of gear. Four experimental gill nets, 450-ft long by 8-ft deep and containing three 150-ft panels of 0.75, 1.25, and 1.75-in mesh, were fished at standard locations in October beginning in 1982-1986. These experimental nets were the standard gear used in other striped bass and hybrid striped bass evaluations in Herrington Lake; in Herrington Lake these nets were literally fished the entire width of the channel. Lake Cumberland is a much wider lake with more varied habitat types and this gear was deemed inappropriate following 2-3 years of sampling. These experimental nets were also fished in 1980 (three nets) and 1981 in attempt to locate good sampling locations. In 1985, the 150-ft section of 0.75-in mesh was removed from these experimental nets, leaving 300-ft of two panels of mesh. The standard procedure was to set four nets for 3 nights in the lower lake; during the following week the procedure was duplicated in the mid-lake sections or vice versa (Figure 1). Experimental nets were floated 4-ft from the surface and ran each morning.

In the fall of 1980, a series of gill nets, 300-ft long by 8-ft deep with uniform mesh of either 3.0 or 3.5-in, were utilized to collect adult striped bass for food habit studies. In the spring of 1981 and 1982, four gill nets 300-ft long by 15 ft deep with uniform mesh of either 3.0 (2 nets) or 3.5-in (2 nets) were systematically set beginning in the lower lake and moving upstream to determine distribution of striped bass. Small mesh (1.5 and 2.0-inch) gill nets measuring 75 ft long by 8 ft deep were set in the headwater of Beaver Creek in the spring of 1983 and the headwaters of Beaver and Otter creeks in April 1987. These small mesh nets were used to increase the sample size of juvenile striped bass while they were concentrated in the embayment headwaters.

Fish from all gill nets were collected daily from a morning run of the nets. Non-target species were inch-grouped and weighed by inch group, while striped bass were sexed, individually measured to the nearest 0.10 in and weighed to the nearest 0.01 lb. Stomach contents were examined from randomly selected striped bass of each size range when large samples were obtained; otherwise, all stomachs were examined. Contents were field identified when possible and enumerated. Scale samples from striped bass were removed from an area below the lateral line near the posterior edge of the pectoral fin. Scales were later viewed on an Eberbach scale projector and appropriate measurements were obtained to determine back-calculated growth rates using the direct proportion method. Condition factors were calculated utilizing the relative condition factor (Kn) (Anderson and Gutreuter 1983).

Striped bass were also examined at striped bass tournaments in 1983, 1985, and 1987 to gather the aforementioned information.

A non-uniform probability creel survey (Pfeiffer 1966) was conducted on the entire lake (1980-1983), lower lake (1986), and during the winter in the Beaver and Otter creek embayments (1983). The lake was divided in 1980 into 10 areas of approximately 5,000 acres each and probabilities were assigned based on 1979 aerial pressure counts by project personnel. The creel survey was also utilized for a walleye evaluation study; therefore, area probabilities were adjusted in the spring to reflect a greater percentage of fishing effort in the headwater areas of the lake. The number of areas was increased to 11 in 1981 and 1982, then reduced back to 10 areas in 1983. A description of the areas and their respective probabilities are presented in Table 1. A winter creel survey conducted from 30 October 1983 through 31 March 1984 was only in one area, the Beaver and Otter creeks arms. In 1986, only the lower half of Lake Cumberland, encompassing four zones, was surveyed from 2 March 1986 through 28 February 1987.

Each survey week was stratified into 14 half-day periods with the length of day figured monthly and the mid-day adjusted accordingly. A hired creel clerk sampled the lake on 5 of the possible 14 half-day periods each week, except for the winter survey in 1983 when only 4 days were surveyed. An instantaneous count of anglers was made during a randomly selected 2-hour period during each half-day survey period; anglers were interviewed during the remaining portion of the period. The winter survey again deviated from the aforementioned by only sampling 3-hour post sunrise and pre-sunset periods, the principal fishing times for striped bass. Half-day probabilities used on the total lake survey were also assigned during the winter survey. Instantaneous counts and interviews were conducted simultaneously during the winter survey.

Prior to data expansion, daily creel information in 1980-1984 had to be summarized on a weekly basis to accommodate an existing Fortran IV computer program. Probabilities for each daily time period were multiplied by the survey area probability to arrive at a total daily probability. Daily probabilities were summed for a total weekly probability that was later utilized by the computer program to expand for monthly and yearly totals. Daily instantaneous pressure counts were averaged for a mean instantaneous count for the week. In 1986, a new statistical analysis system (SAS) program was developed that eliminated any hand calculations with a minor change in data expansion. Pressure values (man-hours) were derived by dividing the product of the instantaneous count and hours in the period by the product of time and area probabilities. Since our time probabilities expand to a weekly pressure value and the survey was conducted 5 days per week, five daily pressure values were then averaged to obtain a weekly pressure count. Weekly catch rates were then applied to this pressure value to generate the various catch and harvest figures.

A statewide voluntary mail-in survey was also used to monitor the relative contribution of annual striped bass stockings to the Lake Cumberland striped bass fishery. Boat docks, bait shops, country stores, and other establishments along with creel clerks and conservation officers were provided with self-addressed, postage-paid coin envelopes containing a questionnaire. Participating anglers who completed the questionnaire concerning the size, location of catch, method of fishing, etc., and who enclosed a scale sample from a harvested striped bass were mailed a clutch-back pin resembling a striped bass and a certificate (first fish only). A sub-sample of all striped bass scales were read annually to assign a year class, and both average length and weight were calculated per year class. Back-calculated lengths were not used due to variability among anglers in measuring their catch.

RESULTS

Stockings

Striped bass stockings began in Lake Cumberland in 1957 (Table 2). The focus of this study was to evaluate stockings of approximately 10 fingerlings/acre from 1979-1981. The 1980 stocking was missed due to opposition of the striped bass program; therefore, only two year classes were available to track. Stockings were resumed in 1984 at a lesser rate (5 fingerlings/acre) following a 2-year lapse. Stocking sites were dispersed among public access sites in areas in the mid and lower lake. Stocking priority was given to the Beaver, Otter, Lily, and Wolf Creek arms due to their better productivity and/or previous striped bass fishing success in those areas.

Age and Growth

A total of 503 striped bass was used to calculate the length-weight formula, $\log_e = -7.851 + 3.026 (\log_e)$ (Figure 2). Data for striped bass ranging from 4-47 inches in length were used in this calculation. The r^2 value of 0.98 indicated a good fit of the regression; however, sample sizes for striped bass $\geq$37 inches in length were small. These small sample sizes and significant differences in weight for fish of the same length resulted in predicted weights for larger fish that varied from 1-8 lb from empirical averages. Sexes were also combined in this regression analysis to avoid biases associated with seasonal differences of gonadal development. Average weights for age 1-9 striped bass are also portrayed on Figure 2.

Most striped bass were collected during the fall but some striped bass were captured in the spring from gill netting and/or tournaments during 1983 and 1986. All male striped bass were sexually mature and "flowing" at age 2, while female striped bass >age 4 were sexually mature. Only one age 3+ female striped bass (27.6 inches - 7.78 lb) was found to be sexually mature.

A total of 459 striped bass was utilized in the average back-calculated lengths by age (Table 3). Twelve year classes were represented, with the majority (83%) being from four year classes (1979, 1981,1984, and 1985). Good survival of the 1976 year class was evident by the presence of 27 fish in the sample. Three year classes (1971, 1973, and 1974) are represented in the table that do not correspond to stocking years. The 1971 and 1973 year classes are probably the result of errors in scale reading; thus, they do not likely represent natural reproduction. The 1974 year class was stocked in February 1975 as 5.0-8.0 inch fish and has produced the last two state record striped bass.

Mean lengths for ages 1-5 were 7.7, 16.5, 22.6, 26.1, and 29.7 in, respectively. Most year classes attained the legal minimum-size limit of 15 inches by age 2+. Comparisons of individual year class growth rates indicate a significant difference in growth rates for ages 1-2 of the 1984 year class and a significant difference for ages 1-3 of the 1984 year class. The oldest striped bass collected was in 1983 at age 11; the sampling gear was size specific for smaller and younger striped bass. Trophy-size striped bass ($\geq$30 lb) were common in the mail-in survey in which scale samples were submitted by participating anglers; however, back-calculated lengths from these fish were not included in these results due to angler error in total length measurements. The last 4 state record striped bass were from Lake Cumberland and were representatives of these older year classes. The current state record striped bass was set in 1985 at 58.25 lb.

Data was insufficient to compare condition factors for specific sizes and for age groups on an annual basis. However, condition factors were pooled for striped bass collected from 1982-1987. Pooled samples were stratified to examine the condition factors (Kn) for striped bass size groups stocked at 5 fingerlings/acre (1984-1987) versus 10 fingerlings/acre (1979 and 1981). Striped bass ranging in length from 15.5 to 21.4 in were used in this analysis, since sample sizes for these size fish were best due to gill net selectivity. This size range of striped bass also corresponds to the length range in which a significant increase for back-calculated linear growth was observed. Mean Kn factor (1.06) for striped bass stocked at 5 fingerlings/acre compared favorably to the mean Kn factor (1.04) for striped bass stocked at 10 fingerlings per acre and a t-test revealed no significant difference at the 0.05 level.

Deformed striped bass were omitted from age-growth, length-weight, and condition factor analysis. Deformities, including pugheadedness and cross-bite, were found within the 1975-1977, 1981, and 1984 year classes. The largest number of deformities (10) was seen during a striper tournament in May 1987 in which 143 striped bass were examined, of which 7% were deformed. The extent of the deformity was difficult to quantify but some fish seem to be unaffected, i.e., normal linear growth and weight; however, some fish were 3-4 years behind normal growth rates. The largest deformed striped bass examined was 31.4 in long (12-24 lb) and the smallest was 15.6 in long (1.88 lb). Deformities in striped bass have been reported from several lakes and best discussed by Hickey and Young (1984).

Food Habits

A total of 412 striped bass stomachs were examined for contents; 249 (60%) of these stomachs were empty. The principal food item by percent frequency of occurrence for all age striped bass was fish (34%); 24.5% of these fish were positively identified as gizzard or threadfin shad. Unidentifiable fish remains in 10% of the stomachs were deemed to be shad due to the lack of any spines in the dorsal fins. Only two incidents of a spinous-dorsal fin fish were found in striped bass stomachs; one was a walleye and the other fish could not be identified. Fish other than shad in the stomachs of striped bass were brook silversides, emerald shiners, and a darter. Two separate incidences of salamanders (5 and 9 in long) were also recorded in the stomachs of striped bass. Not included in these results were the occurrence of a 9-in trout in the stomach of a striped bass checked during a spring tournament. This one trout and the walleye were the only game fish identified in the stomaches.

Stomach contents by age group of striped bass indicated a trend toward consuming larger gizzard shad by older striped bass (Figure 3). All age group striped bass consumed 2-3 in shad with a shift toward larger gizzard shad beginning with age 2+ striped bass. Most 2-3 in shad were identified as threadfin shad or were presumed to be threadfin shad due to their smaller total length during the fall food habit collections. The highest percent frequency of occurrence (64.3%) for threadfin shad was for age 0 striped bass; the lowest percent (2.9%) was for age 5-8 striped bass. Gizzard shad up to 11 inches in length were consumed by older (age 5-8) striped bass.

Fish Population Studies

The total fish standing crop at Lake Cumberland ranged from 100 to 275 lb/acre (Table 4); the mean standing crop was 181 lb/acre. Forage fish standing crop values ranged from 30-68% (40-128 lb/acre) of the total standing crop; therefore, change in forage fish populations primarily influenced the annual fluctuations in total standing crop. Forage species in Lake Cumberland were primarily gizzard and threadfin shad, with threadfin shad biomass comprising a maximum of 30 lb/acre (1981) and a minimum of 0.8 lb/acre (1984).

Cove-rotenone studies were relatively ineffective in sampling the fish population in Lake Cumberland since it is a very deep, clear lake. Adequate cove sites in which the block net could be set at or near the mouth of the cove were non-existent due to maximum depths generally exceeding 50 feet. Sonar-graph recording indicated that most of the forage fish were suspended near points at the mouths of coves - outside of the study sites. Therefore, the forage fish biomass estimates are not felt to be very reliable trend data. Schools of fish, i.e., white crappie and paddlefish (1980) and white bass (1985), also biased the total standing crop values for those years.

Black basses were comprised of largemouth, spotted, and smallmouth bass (Table 5). Smallmouth bass numbers and biomass were low since only 1 of 3 coves was located in the lower lake where smallmouth bass habitat is more abundant. Good spawns of both largemouth and spotted bass were evident each year and six-year averages were similar, 104 and 115 fingerlings/acre; respectively. There was no discernible relationship between young-of-year production and numbers of intermediate-size spotted or largemouth bass the following year. Although largemouth bass is the dominant black bass species, intermediate-size spotted bass numbers generally surpassed numbers of intermediate-size largemouth bass. This same phenomenon was seen in the 1986 creel survey in which a disproportionately large number of intermediate-size spotted bass compared to largemouth bass were caught and released below the size limit (12 in). Generally one or less harvestable-size spotted bass per acre was sampled in the cove-rotenone studies. Average percent of the total black bass biomass for each species were as follows: largemouth bass (54.1%); spotted bass (35.7%), and smallmouth bass (10.1%).

Other principal game fishes collected in cove-rotenone studies were white bass, both black and white crappie, and walleye. Striped bass were seldom sampled in the coves except for an occasional fingerling- or intermediate-size fish. Cove-rotenone sampling was also relatively ineffective in sampling these species, and these studies were only continued primarily to determine reproductive success of walleye for another study.

The available prey-predator (AP/P) model (Jenkins and Morias 1977) was utilized to analyze cove-rotenone data for deficiencies in prey. Data were adjusted for open water based on the Douglas Lake rotenone study (Hayne et al 1967). Plots of the yearly data are presented in Figure 4. The straight diagonal line in the graph is the theoretical desirable ratio of 1:1 in which there is sufficient available prey for every inch group of predators; therefore, all points lying above this line imply there is sufficient prey available for a given size predator.

Declines in the available prey, as indicated by the plots near or below the desirable diagonal line in 1983-1985, were primarily influenced by declines in numbers of intermediate-size gizzard shad. Numbers of intermediate-size gizzard shad are naturally influenced by spawning success the previous year. Therefore, a plot of yearling gizzard shad numbers versus reservoir inflow values for May has been reported (Figure 5). These values had a high correlation coefficient (r=0.95) if 1981 data was omitted (r=0.32 with 1981 data) indicating spring water levels influenced the prey spawning success. Reasons for the non-conformity of the 1981 data cannot be explained except that averaging of monthly inflows possibly masked conditions during the peak spawning period. Low numbers of intermediate-size gizzard shad in 1983 can be explained by the low water conditions and poor spawn in 1982. An adequate gizzard shad spawn was observed in 1983; however, their survival was possibly influenced by the record duration of sub-freezing temperature and a partial freeze of Lake Cumberland in the winter of 1983-1984. Contrarily in 1985, there was a good spawn of gizzard shad in 1984 and a mild winter in 1984-1985 dismissing environmental factors as possible explanations for depressed numbers of intermediate-size gizzard shad.

Gill Netting

Gill netting with experimental gill nets was most effective at capturing gizzard shad (60% by number), white bass (11%), longnose gar (7%), spotted bass (5%), striped bass (4%), and walleye (4%). Yearly catch by species are summarized in Table 6. Sampling was divided between lower and mid-lake; the lower lake sampling stations consistently caught more striped bass. Netting efficiency for striped bass was also influenced by the time of the year. Netting was generally confined to October, but during hot, dry years (1983 and 1984), the lake water temperatures were often still too warm in mid-October to effectively net. Best sampling locations were long, extended points or flats (<40 ft deep), which are uncommon in Lake Cumberland.

A total of 226 striped bass was collected in the experimental nets from 1980-1986 (Table 7). These nets were selective for age 0-2 striped bass; however, data were deemed insufficient to calculate survival rates. Older striped bass (year classes 1975-77) collected in these nets were usually caught by mouth parts and their catch rates were not indicative of their relative abundance. The best yearly catch rates were in 1982 (2.3 striped bass/net day) and 1983 (2.74 striped bass/net day) which were influenced by the strong 1981 year class. The 1981 year class exhibited the best overall CPUE (5.53) which corresponded to the annual stocking rate of 10 fingerlings/acre. In 1979, striped bass were stocked at 8 fingerlings/acre; however, the CPUE was only 0.85. Only 5 striped bass fingerlings/acre were stocked in 1984-1986. The 1984 year class CPUE was 1.88. The CPUE for the 1985 and 1986 year classes are not comparable since netting ended before these fish reached age 2+ and age 1+, respectively. Experimental gill netting in 1986 indicated the previous 5 stocked year classes were well represented in the striped bass population.

Harvest

The estimated total fish harvest when the entire lake was surveyed in 1980-1983 varied from 734,395 fish (17 fish/acre) and 380,414 lb (8.9 lb/acre) in 1980 to 228,095 fish (5.1 fish/acre) and 105,655 lb (2.4 lb/acre) in 1981. The mean annual catch rate was 0.79 fish/h and ranged from 0.69 fish/h (1983) to 0.92 fish/h (1981). Groups of fish dominating the harvest by weight were crappie (45.6%), black bass (18.9%), white bass (15.5%), catfish (5.4%), and sunfish (5.3%) (Table 8). There was some shifting by some species in the relative contribution to the creel; however, crappie were consistently the dominant fish group by weight in the harvest throughout the study. Striped bass and walleye represented an average 1.9% and 3.9%, respectively, of the total yield during the total lake surveys.

Harvest of crappie and black bass annually fluctuated dependent upon fishing pressure. Spring pressure and harvest generally dictated the yearly success for these two groups of fish; spring success rates seemed to be influenced upon spring lake levels.

Estimates of striped bass harvest during the total lake surveys (1980-1983) were deemed low due to only one creel clerk surveying the entire lake. During these years the walleye fishery was also being surveyed and the spring walleye fishery principally occurred in the headwater of the lake (>60 miles from the dam). The striped bass yield ranged from 855 lb (1981) to 9,093 lb (1980) while the best year for number of striped bass harvested was in 1982 (1,076 fish). The 1980 harvest was influenced by the 1976 year class that averaged 13.8 lb and 32 inches in length. The 1981 striped bass fishery declined as did the total fishery; only 98 striped bass (855 lb) were estimated creeled. Striped bass harvest (numbers) increased in 1982 (1,076 fish); however, the average-size fish decreased to 19.9 inches in length (4.51 lb) due to the recruitment of the 1979 year class into the fishery. Both the 1979 and 1981 year classes were available to the striped bass fishery in 1983, yet total numbers (735) striped bass harvested decreased from 1982. The average-size fish remained similar at 22.8 inches in length (5.65 lb).

An intensive winter creel survey in the Beaver and Otter creek arms was initiated in 1983-1984, since the mail-in survey indicated a major winter striped bass fishery had developed in this area. Striped bass was the dominant species in the harvest (34%) by weight with an estimated 161 striped bass (1,244 lb) were creeled that were 26.5 inches in mean length (7.7 lb). Results from other winters were unavailable for comparison, but the winter fishery in 1983-1984 was deemed low due to the extreme cold temperatures and record durations of sub-freezing weather in December and January. Many boat access areas were frozen that prevented anglers access to the lake.

In 1986, the creel survey was modified to only survey the lower lake where the principal striped bass fishery occurs. This survey was conducted for a 12 month period (2 March 1986 - 28 February 1987); therefore, these results are not comparable to the eight-month surveys conducted in 1980-1983. However, these striped bass harvest results were deemed indicative of the total striped bass fishery for the entire lake, while results for other major species, i.e. black bass, crappie, and walleye were not.

An estimated 6,534 striped bass were caught in the March 1986-February 1987 survey, with 5,406 of this total being harvested. Ninety-one percent of the 1,129 released striped bass were <21 inches in length. The total weight of the striped bass harvest was 41,846 lb (1.7 lb/acre) which represented 40.8% of the total fish harvest. Multi-year classes of striped bass were represented in the fishery, with the 1981 (35%) and 1984 (38%) year classes being dominant (Table 9). The previous 4 years of striped bass stockings in 1979, 1981, 1984, and 1985 comprised 96% of the total striped bass fishery. There were no striped bass stocked in 1982 or 1983, which likely depressed the total striped bass harvest and the average-size fish in the creel. Figure 6 displays the length-frequency of the striped bass harvest with the average-size striped bass being 26.5 inches in length (7.38 lb). The best fishing months (Table 10) were May (963), February (900), and December (868); the largest fish (average size = 33.6 in) were caught in July by trolling.

Mail-In Survey

Striped bass harvest could not be quantified through the mail-in survey but many trends regarding the striped bass harvest could be tracked. The best fishing months based on voluntary returns were April (20.5%), March (14.4%), and December (13.2%) (Table 11). Returns were also summarized by lake area for a 3-year period (1984-1986) (Table 12). The Beaver and Otter creek arms consistently were the best fishing areas; an increase in main lake catches occurred, principally due to improved knowledge of striped bass movement patterns by anglers. Despite angler error in measuring length and weight, the mail-in survey provided useful information on growth rates and relative contribution of stockings to the fishery (Table 13). Year class strength results compared favorably to 1986 creel survey data in which the 1976, 1979, and 1981 year classes were dominant in the fishery. The relative importance of the 1981, 1984, and 1985 year classes were masked by the yearly subsampling procedures in aging mail-in survey returns and the reluctance of anglers to mail in scales from smaller striped bass (<5 lb) caught in 1985 and 1986. The 1976 year class dominated the fishery from 1978-1980. In 1981, the 1979 year class recruited into the fishery and co-equalled the 1976 in importance. The trophy status of the striped bass fishery is in good standing as evident by the average weight of striped bass (>30 lb) from several older year classes that still contribute to the fishery.

Movements and Habitat Selection

Data on movements and habitat selection were not specifically collected, but have been included since much was learned through a variety of sampling techniques, i.e., gill netting, mail-in survey, and interviews with fishermen. Striped bass were stocked throughout the lake from Burnside downstream to the dam (see Figure 1); however, the principal striped bass fishery was confined to the lower lake. There was never any indication of an upstream spawning run into the major headwater rivers, the Big South Fork of the Cumberland River and the Cumberland River. Annual netting and/or electrofishing during the walleye spawning run failed to locate any striped bass in the headwater reaches; however, the Tennessee Valley Authority netted one 25 lb gravid striped bass in 1980 while collecting paddlefish broodstock in the headwaters of the Big South Fork. Only an occasional striped bass was collected during intensive headwater gill netting for paddlefish (Hoyt 1985). Renown white bass runs occur in both these tributaries and, since white bass fishing techniques are similar to striped bass fishing techniques, a spawning population of striped bass would not have gone undetected. In the summer of 1984, a large number of striped bass were located in the Laurel River arm of Lake Cumberland. This tributary basically only consists of approximately 1.5 miles of backwater, but water temperatures are influenced by the cold water releases from Laurel River Lake (6-7 mi upstream). These striped bass probably traveled upstream during the winter months and failed to travel downstream, since they were harvested throughout the summer. Striped bass often concentrated in the winter near a warmwater effluent from an electric power plant in the Cumberland River near Burnside Island.

Large mesh gill nets were utilized in May 1982 and June 1983 in an attempt to locate the upstream limit of adult striped bass movements. Striped bass were located in the Conley Bottom area in 1982 and a single striped bass was netted in the Waitsboro area in 1983. No striped bass were located in the Fishing Creek arm; however, a dissolved oxygen-temperature profile (not shown) of Fishing Creek revealed sufficient coolwater habitat for adult striped bass. Very few striped bass have ever been reported from this major arm of the lake.

In winter-late spring, striped bass frequently were located in the headwaters of the major embayments in the mid-lower lake section. Forage fishes, i.e., gizzard shad and threadfin shad, were associated with warmer water temperatures produced by solar radiation of shallower aquatic zones or warm rains. As previously mentioned, no spawning run was detected; but in 1983, a large concentration of gravid male and female striped bass were located by fishermen in a small cove along the main lake. These fish seemed to be staged for a possible in-lake spawning attempt; however, no progency (non-stocking year) was located during subsequent studies.

In the late summer, striped bass moved to the deeper zones of the lake and were confined to the lower lake and the mouths of major embayments. Sonar graph recordings located large fish, presumably striped bass, suspended in 35-50 feet of water. Fishermen utilizing down-riggers substantiated striped bass were located in these zones. Dissolved oxygen-temperature profiles were taken periodically, with two representative summer profiles shown for 1980 (Figure 7) and 1986 (Figure 8). The top of the thermocline was 33 feet and 30 feet deep, respectively, and dissolved oxygen levels exceeded 4.5 ppm to depths of 80 feet where water temperatures were 50°F. This immense coolwater hypolimnion also supports a rainbow trout put-grow-take fishery.

DISCUSSION

Striped bass introductions began in Lake Cumberland in 1957-1962 with adult stockings; however, no measurable population was created until large numbers of fingerlings were stocked beginning in 1975-1978. Stockings at the recommended rate of 10 fingerlings/acre in 1979 and 1981 were the impetus for creating a highly desirable sport fishery. Missing year classes in 1982 and 1983 affected the harvest, yet the fast growth rate of the 1984 and 1985 year classes (stocked at 5 fingerlings/acre) ameliorated this loss.

Catch rates for striped bass in gill nets were low, precluding the computation of survival. The 1981 year class, followed by the 1984 year class, exhibited the best overall catch rate in gill nets; both year classes were equally important during the 1986 creel survey. The strength of the 1979 year class was not evident during the 1986 creel survey. The strength of the 1979 year class was not evident during gill netting or the creel survey but co-equaled the 1976 year class in abundance during the 1981 mail-in survey. The relative strength of these year classes was related to stocking densities, but not directly proportional. Although not presented in the results, years of strong striped bass year classes in the gill nets and/or 1986 creel survey received a significant proportion of larger striped bass (number/lb) from the hatchery. Mixed stockings, both large and small fingerlings, within the same year make it difficult to interpret, but the trend indicates the larger average-size fingerlings (number/lb) may contribute to better total survival. It is also felt that the location of these stockings, i.e. an arm of the lake, is another unknown variable since the productivity of some arms exceeds that of others.

The AP/P model was deemed inadequate to assess the availability of forage in Lake Cumberland; therefore, forage levels could not be related to strong year classes of striped bass. The model was based on cove-rotenone data and these were not felt to be reliable for the major forage species, gizzard and threadfin shad, and most of the major predator species, e.g. striped bass and white bass, were conspicuously absent in the coves. The strong year classes of striped bass produced in 1981 and 1984 occurred simultaneously with good gizzard and threadfin shad spawns in those years; however, cove rotenone data was not available to relate to the strength of the 1979 year class. Ney and Orth (1986) investigated matching predator stocking programs to prey abundance in Smith Mountain Lake, Virginia, and determined that young-of-year cohorts of forage species, gizzard shad and alewives, were not wholly available to same age striped bass. Asynchrony between same age prey and predator growth and survival creates sharing by stocked piscivores of future forage fish year classes and sharing among other resident piscivores as well as preceding and later cohort of their own species. They found, in effect, the abundance of forage fish, at the time of their stocking, is irrelevant and stocked piscivores must depend for success on the production of future forage fish generations. However, poor year classes of striped bass were produced in 1977 and 1978 (based on mail-in survey returns) following severe yearling winter mortality of both gizzard and threadfin shad. The fact that Lake Cumberland contains threadfin shad which are capable of multiple spawns (Heidinger and Imboden 1974) increases the chances of matching stocked predators with available forage. Threadfin shad are consistently underestimated in cove-rotenone studies (Siler 1986); therefore, a new sampling method is necessary to index their abundance. Knowledge of predator-prey relationships is definitely inferior to make a system specific analysis, and a better understanding of these relationships could modify stocking strategies and ultimately improve harvest in a put-grow-take striped bass fishery.

Average growth rates of striped bass compared favorably to other studies (Table 14), with back-calculated growth at age 3 generally exceeding other reported studies. All year classes reached legal size (15 inches) by age 2+. Striped bass growth rates for a previous study lake in Kentucky, Herrington Lake (Axon 1979), exceeded Lake Cumberland growth rates; however, Herrington Lake is a eutrophic lake with a higher standing crop of forage species, including threadfin shad. Lengths at age 2 were inversely related to the annual stocking rate and the average length for the 1984 year class at age 3 exceeded the lengths at age 3 for previous stockings. This same phenomenon for age 1 and 2 striped bass was observed in Watts Bar Lake, Tennessee where high stocking densities were accompanied by low average sizes of introduced fingerlings (Van den Avyle and Higginbotham 1979). These investigators believed that the size of stocking versus density-dependent mechanisms were responsible for the observed relationship.

Condition factors for striped bass (primarily age 2-3) were significantly similar among pooled samples despite differences in the AP/P ratios in some years. Years of lower AP/P ratios were the result of lower numbers of intermediate-size shad; however, this size range of shad represented only 8.5-10.4% in frequency of occurrence in the stomachs of the same age striped bass. Striped bass food habits were primarily fall data but Combs (1979) found insignificant differences in seasonal striped bass stomach contents and gizzard shad remained dominant year-round in Keystone Reservoir. Morris and Follis (1979) found reduced growth and condition factors coincided with depletion of intermediate-size shad. In theory, a decrease in numbers of intermediate-size forage should translate to a greater predatory pressure on the fingerling-size prey, but growth rates for Lake Cumberland striped bass (age 1-3) increased during this time frame. Density-dependent mechanisms were felt to be related to increased growth rates of age 1-3 striped bass in 1985 and 1986, since they were stocked at essentially 50% of the rate in 1979 and 1981. Reduced levels of intermediate-size shad cannot be explained with existing data and our lack of knowledge concerning striped bass density in Lake Cumberland, but the possiblity of striped bass predation cannot be dismissed as an explanation for depressed intermediate-size shad numbers.

Changes reported in the literature of endemic reservoir populations following striped bass introductions have been consistent in that no negative impact could be determined. Food habit results were similar to other studies (Combs 1979), (Ware 1978), (Filipek and Tommy 1984), in which shad, either gizzard and/or threadfin, were conclusively found to be the principal diet item of striped bass with a general trend toward consuming larger shad with an increase in mean length of the striped bass. Other species of fish and invertebrates were of minor importance, yet Stevens (1957) found an increase in use of mayfly nymphs in the spring. Notable changes in the clupeid standing crop have been found in Florida (Ware 1974) and Virginia (Hart 1978), following striped bass introductions, and Texas (Crandall 1978), following high density hybrid striped bass introductions. Initial rationale for stocking striped bass in 1960-1970's was to control clupeid populations by impacting the large biomass of adult gizzard shad and improve their length-frequency distribution by consistent annual spawns. Case histories of notable changes in clupeid standing crops following striped bass introductions have been associated with strong winter kills of gizzard or threadfin shad or an excessive stocking of striped bass. Stocking rationale has now changed from controlling to better utilization of clupeid populations.

Impacts on other sport fishes, e.g. white bass, crappie, and black basses, were difficult to quantify due to the cursory level of sampling. Crappie and white bass numbers and biomass were poorly sampled during cove-rotenone studies; however, their numbers in the creel surveys (1980-1984) fluctuated seemingly independent of striped bass stockings in 1979 and 1981. The largest number of white bass were collected in gill nets in 1984, with 93% of these fish ≥12 inches in length. Lake Cumberland still maintains one of the best white bass fisheries in the state with 1.0-2.5 lb fish common in the popular night fishery and the spring headwater spawning runs. Harvestable-size black bass numbers varied considerably in both the cove-rotenone studies and creel surveys, with the highest biomass years occurring in 1984 and 1983, respectively. Numbers of intermediate-size largemouth and spotted bass were highest in 1984, again following our large striped bass stockings in 1979 and 1981. Anglers are quick to associate poor fishing, regardless of the species, with striped bass introductions in Lake Cumberland. Other environmental and physical factors such as the amount of shoreline habitat associated with the lake level, water clarity, and water level fluctuation increases the variability associated with fishing success in this clear, hydropower lake. Harper and Namminga (1986) similarly found fluctuations in black bass populations in Lake Texoma following 11 years of striped bass stockings; black bass numbers generally increased coincident with the expansion of striped bass. The overall impact of striped bass in Lake Texoma was beneficial and changes in abundance of several species appeared to be the result of periodic strong year classes rather than an outcome of competition with, or predation by, striped bass. Combs (1980) supported the premise that striped bass introductions have failed to produce declines in other sport fisheries.

Conflicts between striped bass and rainbow trout (stocking began in 1982 following a 7-year cessation) in Lake Cumberland potentially exist. Trout are a soft-rayed fish and are stocked during the winter when heavy foraging activities are characteristic of striped bass. Only one spring stomach sample produced evidence of predation of rainbow trout by striped bass but these fish are spatially segregated during the time of fall stomach collections. Trout stocking crews have witnessed heavy predation by striped bass upon rainbow trout when released during the winter. Deppert and Mense (1979) reported trout in 40% of the striped bass stomachs below Tenkiller Reservoir, Oklahoma. Declines in trout abundance in Lake Mead (Persons and Dreyer 1987) and Lake McConaughy (Daryl Ellison, Nebraska Game and Parks, personal communication) were related to expanding striped bass populations. Trout population numbers are unknown yet the trout fishery failed to develop to its expected potential; therefore, the possibility of late winter predation by striped bass cannot be dismissed.

Lake Cumberland striped bass exhibited some of the characteristic habitat selections as seen in other lakes. Movement patterns resembled those reported from telemetry studies (Cheek 1983) in which spring and winter movements were similar and much less movement in the summer and fall. Vast volumes of cold-hypolimnetic-water (<75°F) in Lake Cumberland provided the coolwater habitat necessary to sustain trophy-size striped bass versus the "thermal squeeze" (Coutant 1985) witnessed by many other investigators (Waddle et al 1980), (Combs and Peltz 1982), (Schaich and Coutant 1980). Striped bass selected for mid-lower lake areas despite coolwater habitat available in upstream sections; a habit not completely understood. Other studies have found summer concentration in the lower lake, yet these areas were the only zone containing cooler water. The lower portions of Lake Cumberland lie within a different physiographic region which produce a broader floodplain and a better shore development factor. This logically produces better areas for striped bass feeding activities than the more riverine sections of the upper lake.

There was no evidence of a spring spawning run by Lake Cumberland striped bass despite headwater tributaries where excellent white bass "runs" occur. The excellent tributaries probably possess the flow requirements for striped bass natural reproduction. Natural reproduction by striped bass has been reported from several systems including Santee Cooper Reservoir, South Carolina; Kerr Reservoir, Virginia/North Carolina; Millerton Lake, California (Goodson 1966); Keystone Reservoir, Oklahoma (Mensinger 1970); Texoma Reservoir, Texas/Oklahoma (Combs 1979), and others. In-lake spawning has now been documented in Lake Powell (Gustaveson and Pettengill 1984) presumably due to the steep, perpendicular shoreline, clear water, and high dissolved oxygen levels at the substrate level. These same reservoir characteristics exist in many portions of Lake Cumberland, although no natural reproduction has been detected. Sexually mature striped bass staged in 1983 in the lower lake during the spawning temperature range; therefore, the possibility of in-lake spawning potentially exists.

The striped bass fishery continues to develop in Lake Cumberland with the creation of more year classes by the latter stockings of 5 fingerlings/acre. Achievement of the objective of increasing the total fish harvest by striped bass introductions by at least 1 lb/acre or 10% of the total fish yield was not met during 1980-1983 creel surveys, but the harvest of striped bass in the lower lake only (1986 survey) represented 1.7 lb/acre or 41% of the total fish harvest. Total lake harvest was not enumerated; therefore, the relative contribution of striped bass to the total lake fishery remains unknown. A nationwide survey by Axon and Whitehurst (1985) determined at least 279 lakes in 34 states had established striped bass, hybrid striped bass, or both. The mean annual harvest for striped bass was 1 lb/acre where fisheries had been developed; therefore, the Lake Cumberland harvest resembles the national average.

Interest in the Lake Cumberland striped bass fishery has heightened as witnessed by a 10-fold increase in striped bass pressure (0.21 man-hours/acre in 1980 - 2.3 man-hours/acre in 1986). Mean annual harvest rates have remained similar through time (0.05-0.08 fish/acre), yet harvest has increased due to the increased fishing pressure. The best overall monthly harvest rate in 1987 was 0.28 striped bass while, in 9 of the 12 remaining months, the rates were $\leq$0.10 striped bass/h. Summer monthly harvest numbers and catch rates were considered low since a significant night-time fishery was not surveyed.

Other positive values of this fishery include the creation of a trophy fishery in which striped bass >30 lb are not uncommon. Also, a significant winter-time fishery has developed in many of the major creek arms. A fishing guide service has developed in the last 5 years increasing the numbers of non-resident as well as resident fishermen traveling to the lake seeking a trophy striped bass. As fishing knowledge improve about deep-water trolling methods and night-time fishing increases, the harvest of striped bass is expected to improve by the addition of new fishermen to the fishery.

CONCLUSION

Striped bass introduction into Lake Cumberland has proven to be a good fishery management technique to better utilize the immense open-water habitat; older striped bass also prey upon the larger-size gizzard shad in Lake Cumberland. The result of striped bass stockings in Lake Cumberland has been rated a success based upon the original harvest objective and good growth rates. The fishery is still growing as multi-year classes recruit into the fishery and striped bass knowledge and fishing techniques by anglers improve, increasing the chance of catching a striped bass. Other positive features are the significant winter fishery and the development of a trophy fishery due to longevity of striped bass and the coolwater habitat available during the critical summer period. Fluctuations in populations of other major species were seemingly independent of striped bass introductions and related to periodic strong year classes and environmental and physical factors affecting the lake. Environmental and physical factors, i.e., winter clarity due to rainfall, water level fluctuations, and pool level strongly influenced the harvest of all species including striped bass. Reduced forage levels were felt to be partially due to cove-rotenone sampling error, since no decrease in striped bass growth rates was observed. Based on the AP/P ratio, there was ample prey available for larger predators. A buildup through successive stockings of larger-size, long-lived, efficient predators such as striped bass could conceivably impact the prey base in a nutrient-limiting lake such as Lake Cumberland. Stocking rates have been lowered to 5 fingerlings/acre since striped bass only utilize approximately 50% of the lake.

RECOMMENDATIONS

Future striped bass sampling in Lake Cumberland should be with experimental gill nets, 225 ft long X 10 ft deep, containing 3 panels (75 ft long) of the same mesh size (0.75-, 1.25-, 1.75-in) as used in this study. Gill netting should be confined to areas below Camp Earl Wallace on points and/or flats.

Future gill netting should only be conducted following lake de-stratification in the late fall.

Continue annual striped bass stockings at 5 fingerlings/acre due to the increased growth rates observed at this level. The hatchery should continue to strive for larger-size fingerlings (>1.5 in) within a similar stocking time frame, since there is some indication that strong year classes coincided with years receiving a significant proportion of larger fingerlings. Stocking sites should be in the headwater areas of the lake and in the headwaters of major embayments where principal shad spawning occurs. Suggested stocking sites are Cave Creek access site in the Cumberland River, Waitsboro access site, Twyford Point in Beaver Creek, road bed off Highway 90 in the headwater of Otter Creek, and the old road in the headwater of Lily Creek.

Reduce the striped bass daily creel limit to 3 fish/day. Although our objective did not include a trophy striped bass fishery, a significant trophy fishery has developed. A reduction in harvest by increasing the minimum legal size is not the proper approach to maintaining this trophy fishery since large striped bass are not expected to survive catch and release especially during summer water temperatures. The only other management option we have is a reduction in the creel limit, which is presently 5 fish/day. Creel limits are generally set too high to function as an exploitation control since few anglers attain the daily creel limit. Therefore, creel limits actually serve as a pyschological goal and a best attempt to disperse the catch among anglers. The 1986-1987 creel survey indicated 94% of the anglers had 1 or less striped bass in their daily creel, yet this was based on incomplete trip data. The popularity of the Lake Cumberland striped bass fishery has grown exponentially in the previous 5 years based mainly on the trophy status of this fishery. A "mini" attitude survey of Lake Cumberland striped bass fishermen conducted during the 1988 creel survey revealed 88% of the striped bass anglers are satisfied with the 5 fish/day limit, but 93% of the striped bass anglers felt that 3 fish/day is also an appropriate reduction to the limit. It has become socially unacceptable for anglers to harvest 5 trophy-size striped bass/day.

Monitor for striped bass natural reproduction in Lake Cumberland. Mass markings of striped bass fingerlings via hatchery feed (oxytetracycline) on an alternate-year basis is a possible means of monitoring for natural reproduction.

Consider the possibility of discontinuing rainbow trout stockings in Lake Cumberland if the fishery is not at a sufficient level to justify stocking.

Develop an open-water forage sampling technique to closely monitor yearly population trends of both gizzard and threadfin shad.

Conduct a habitat improvement project in the littoral zone of Lake Cumberland to improve available habitat for black basses, crappie, and other panfishes.

Explore methods of modeling the predator-prey relationships in Lake Cumberland without the use of cove-rotenone data.

Consider a long term monitoring program of Lake Cumberland striped bass by utilizing selected angler diaries in lieu of expensive creel surveys. Trend data on catch and harvest rates, size and age distribution, and growth rates can be readily obtained in this manner.

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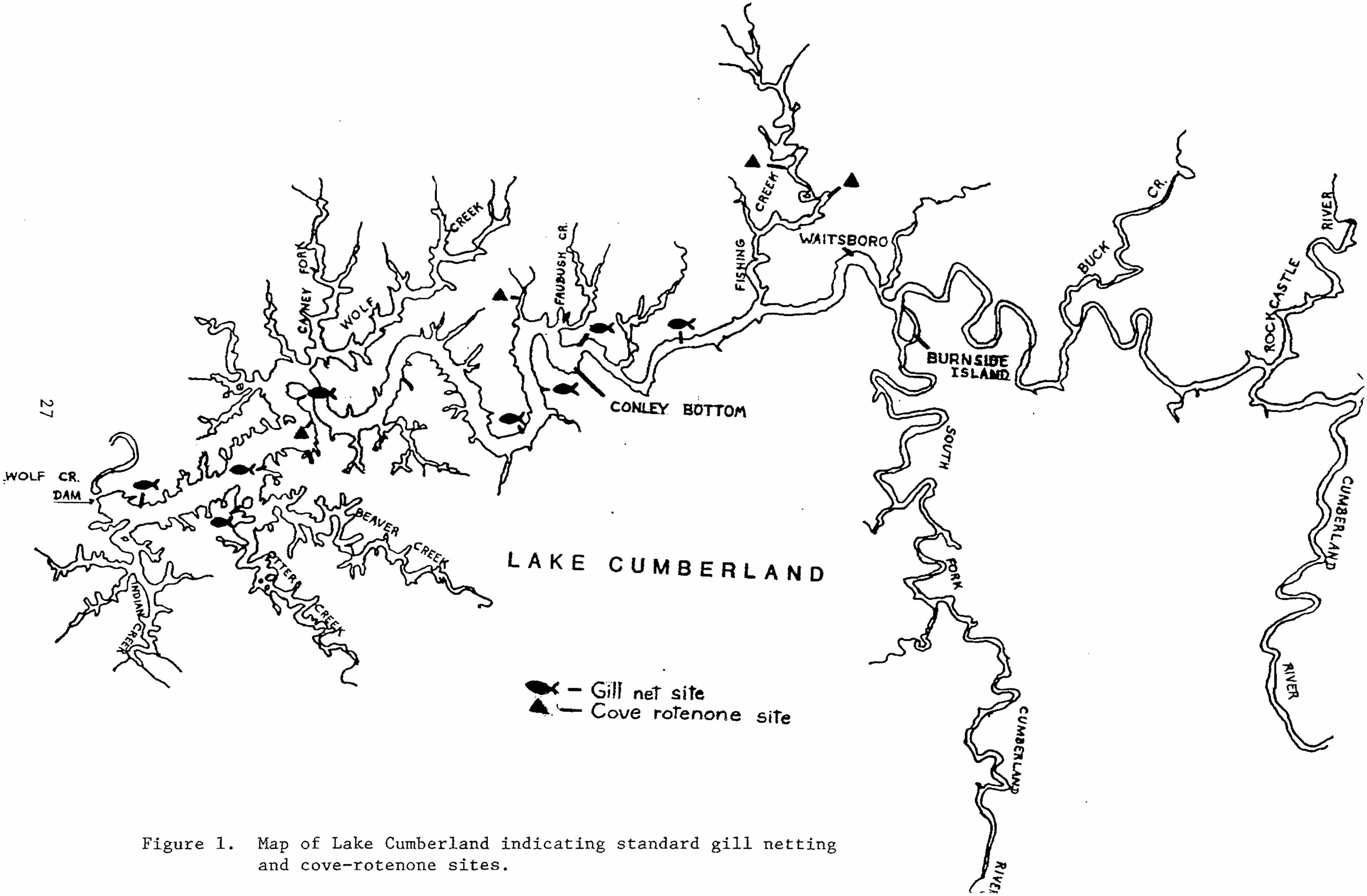
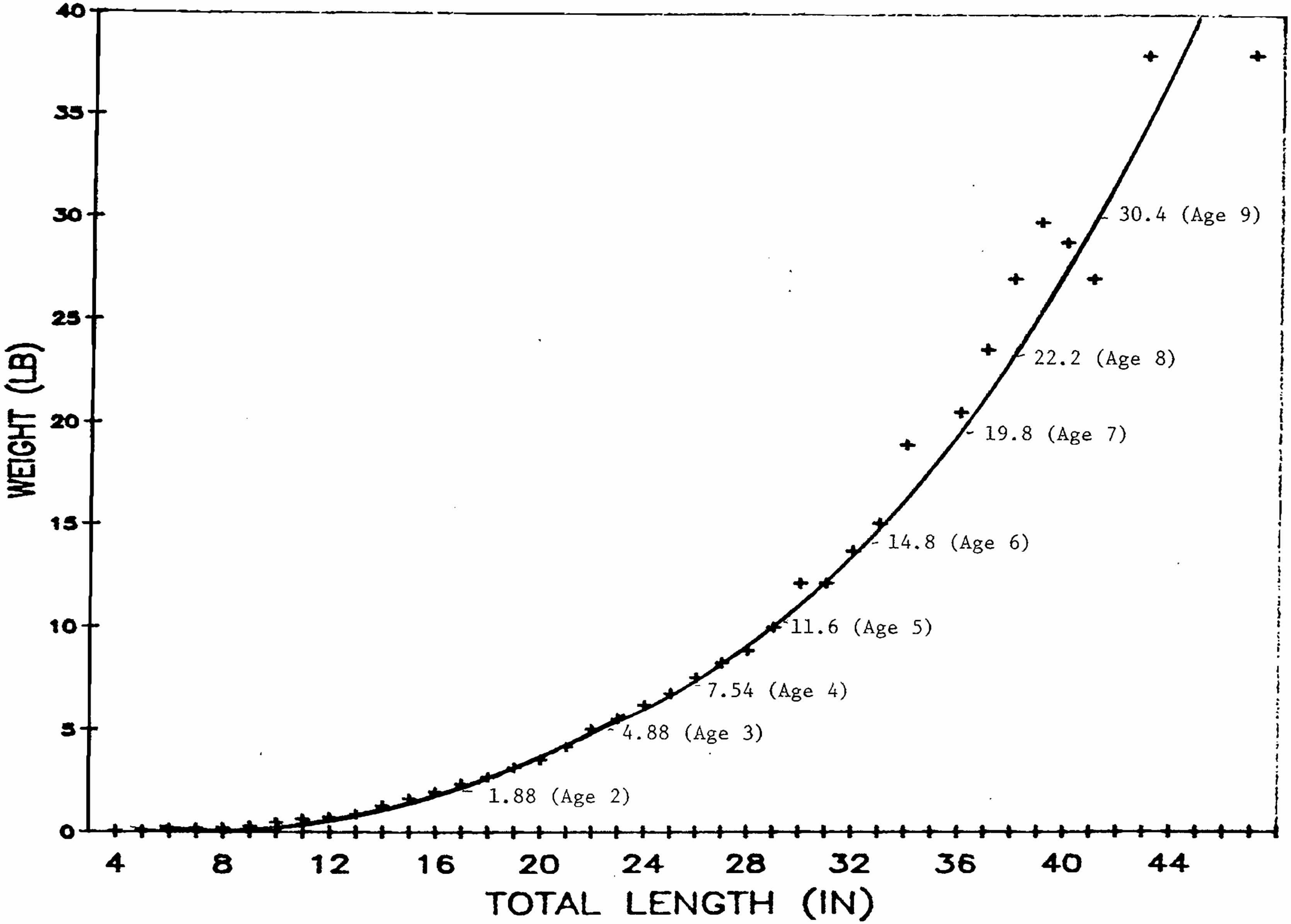


Figure 1. Map of Lake Cumberland indicating standard gill netting and cove-rotenone sites.

Figure 2. Length-weight relationship for striped bass in Lake Cumberland, 1980-1987.



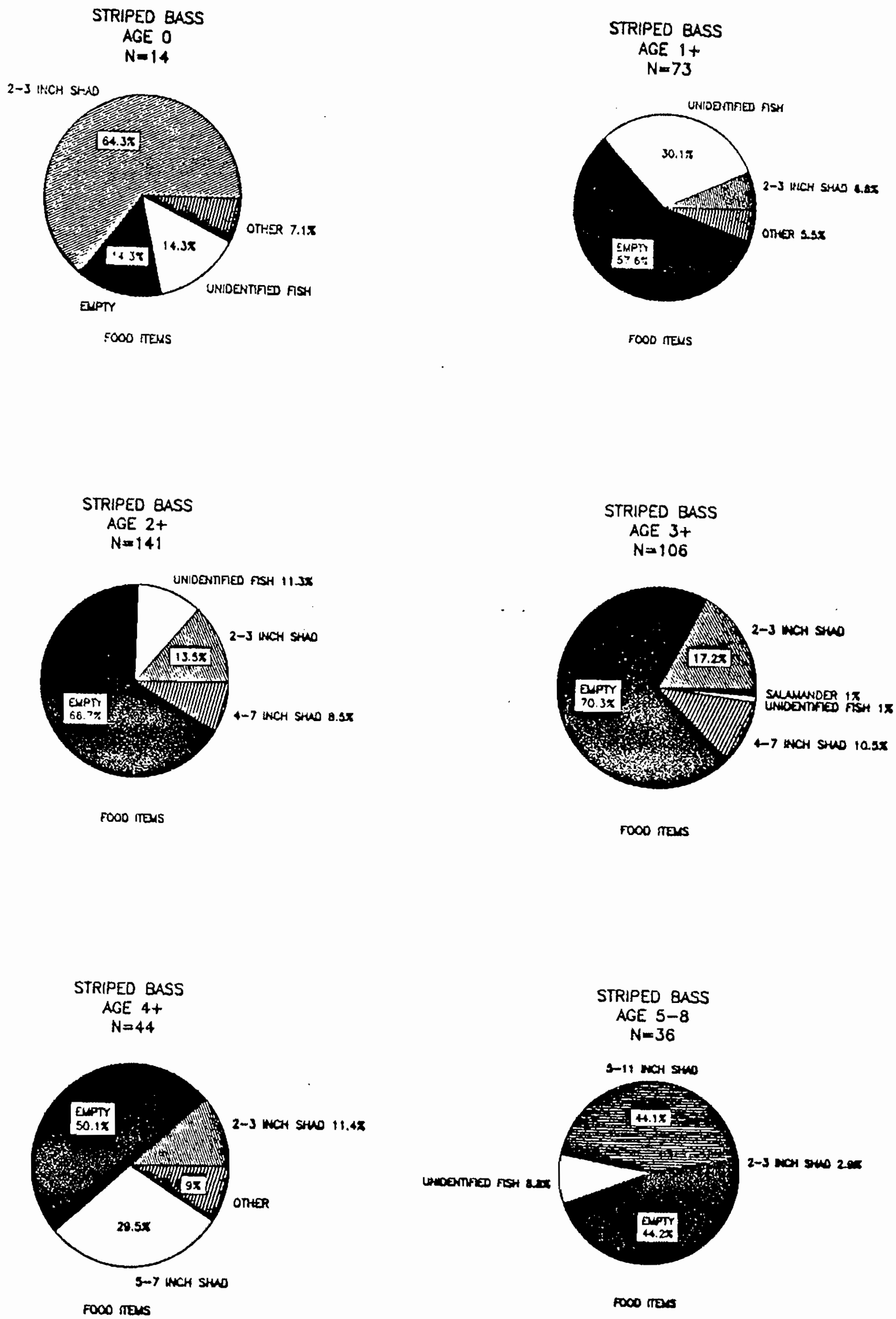


Figure 3. Percent frequency of occurrence of food items in stomachs of striped bass from Lake Cumberland.

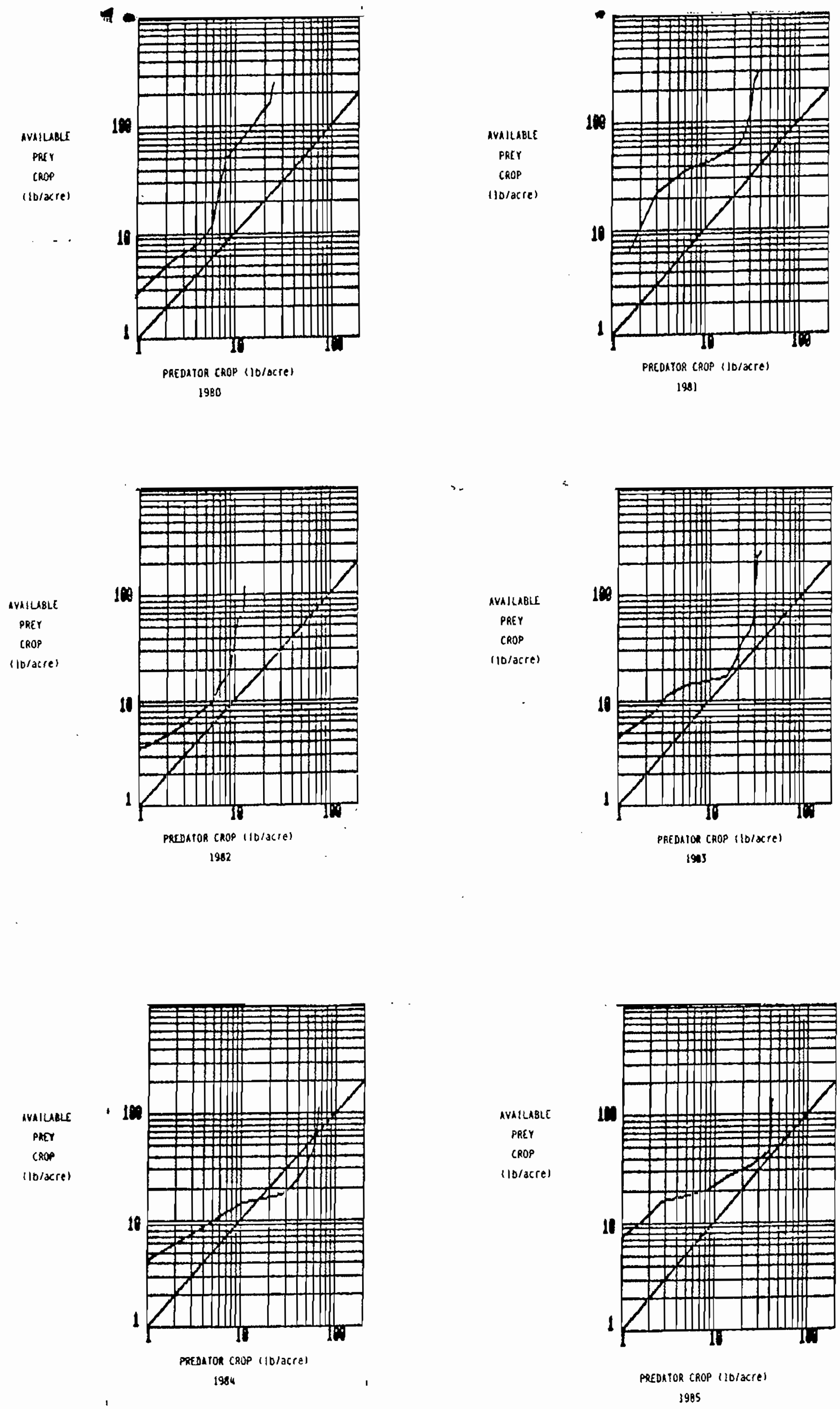


Figure 4. Available prey/predator (AP/P) plots by year of cove-rotenone studies conducted in Lake Cumberland (1980-1985).

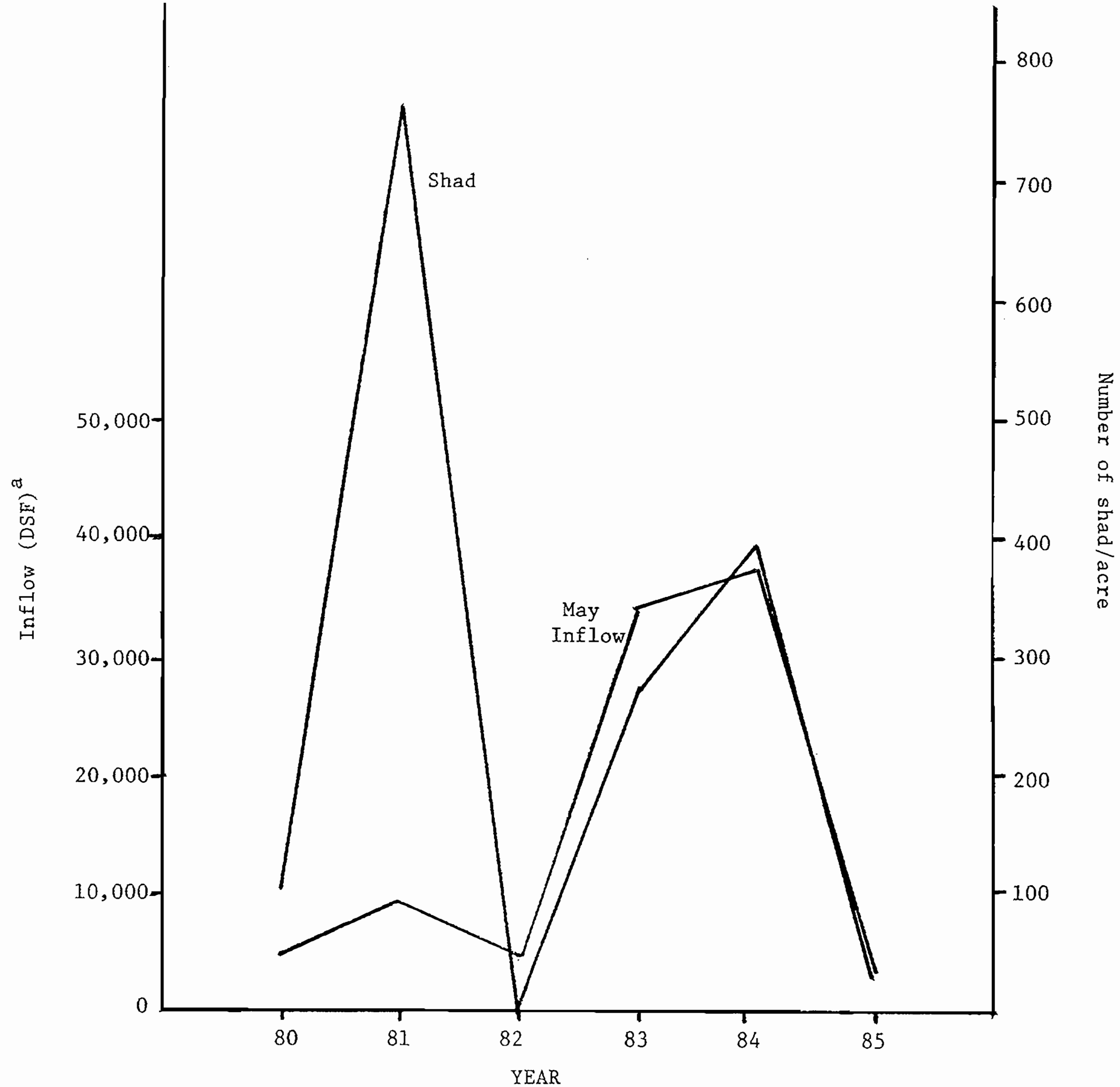
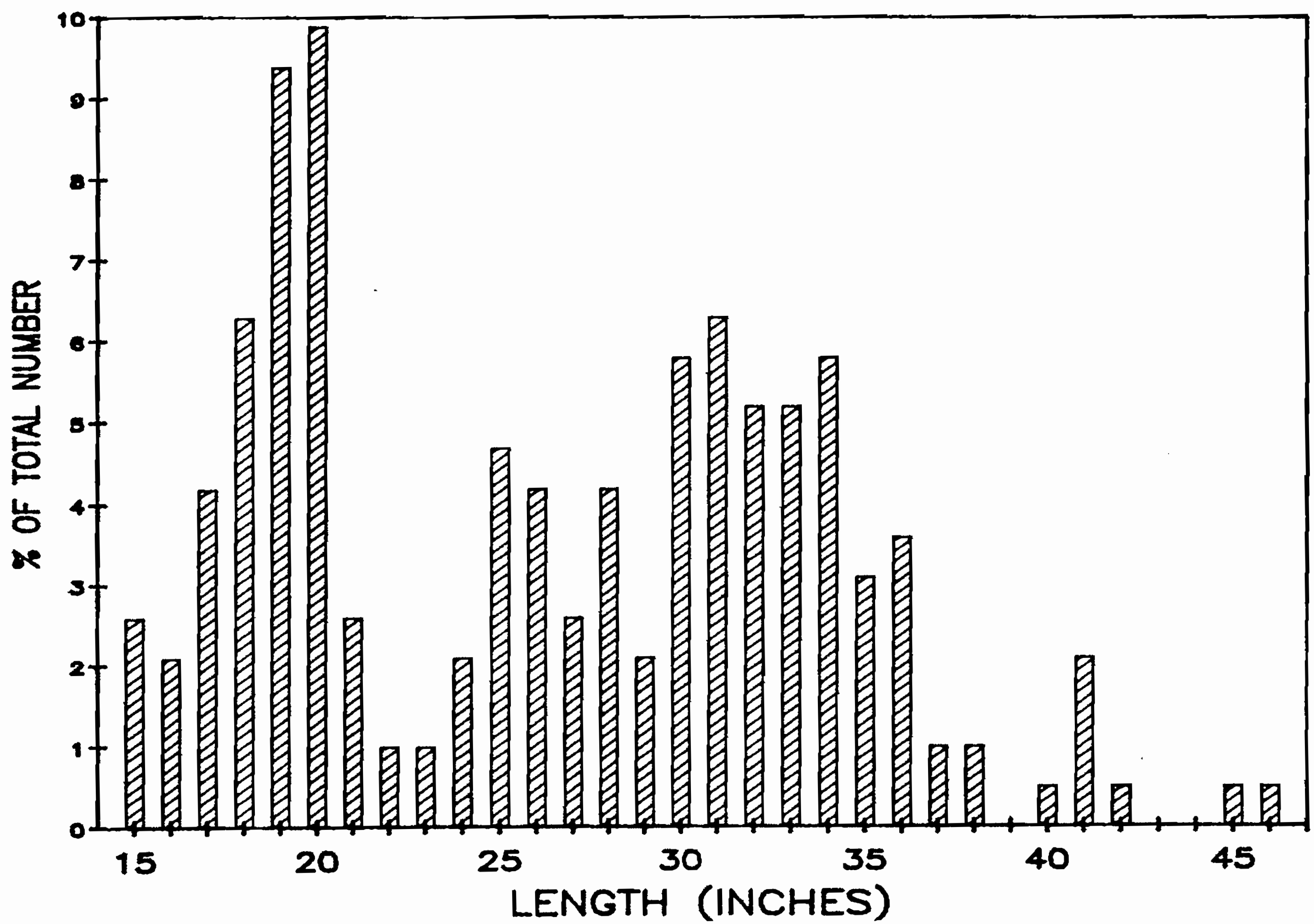


Figure 5. Relationship between May lake inflow and young-of-year gizzard shad. [a]DSF= day second feet

Figure 6. Length frequency of striped bass on Lake Cumberland creel survey conducted 2 March 1986 through 28 February 1987.



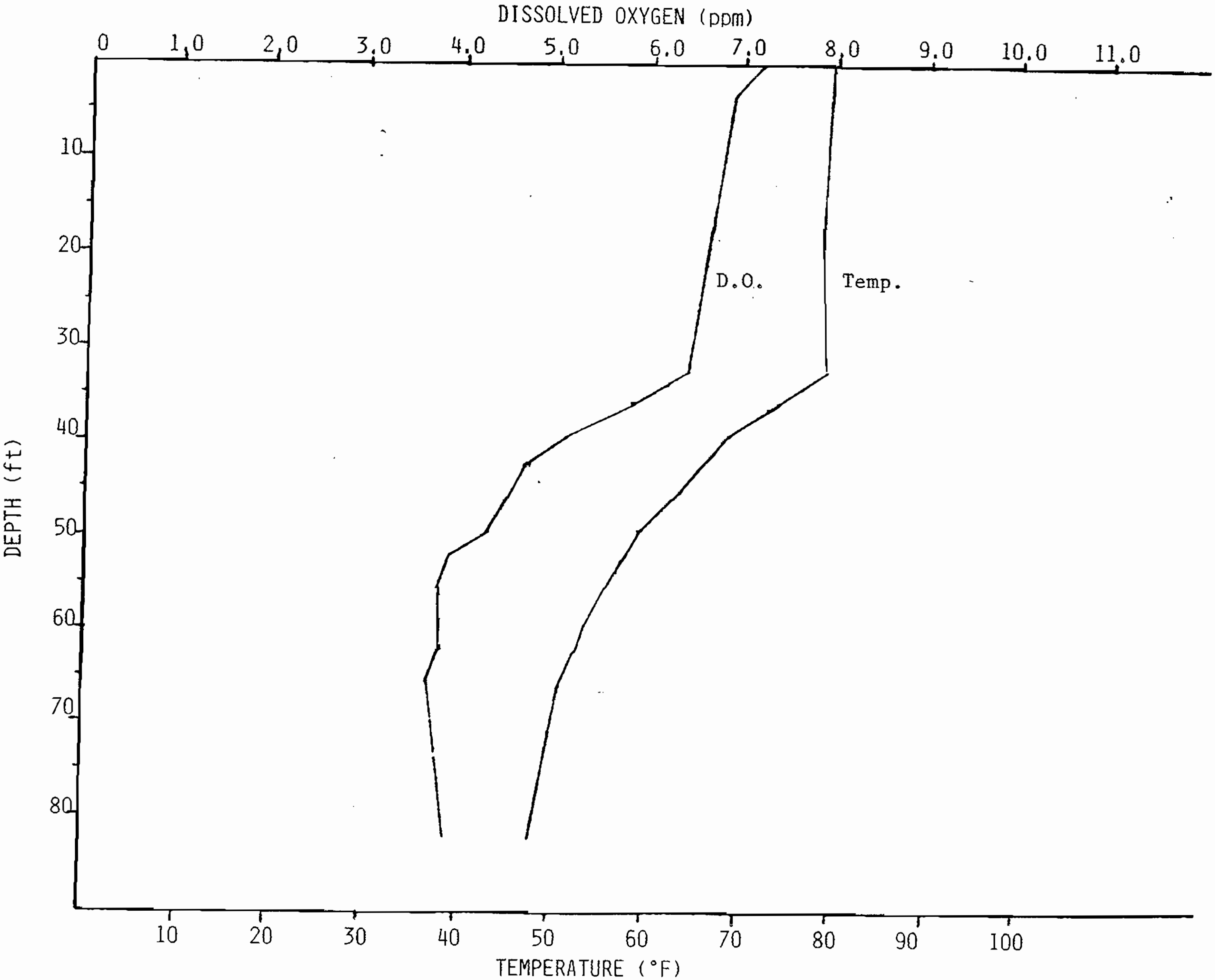


Figure 7. Temperature-dissolved oxygen profile taken at the mouth of Beaver and Otter Creek embayments of Lake Cumberland in September 1980.

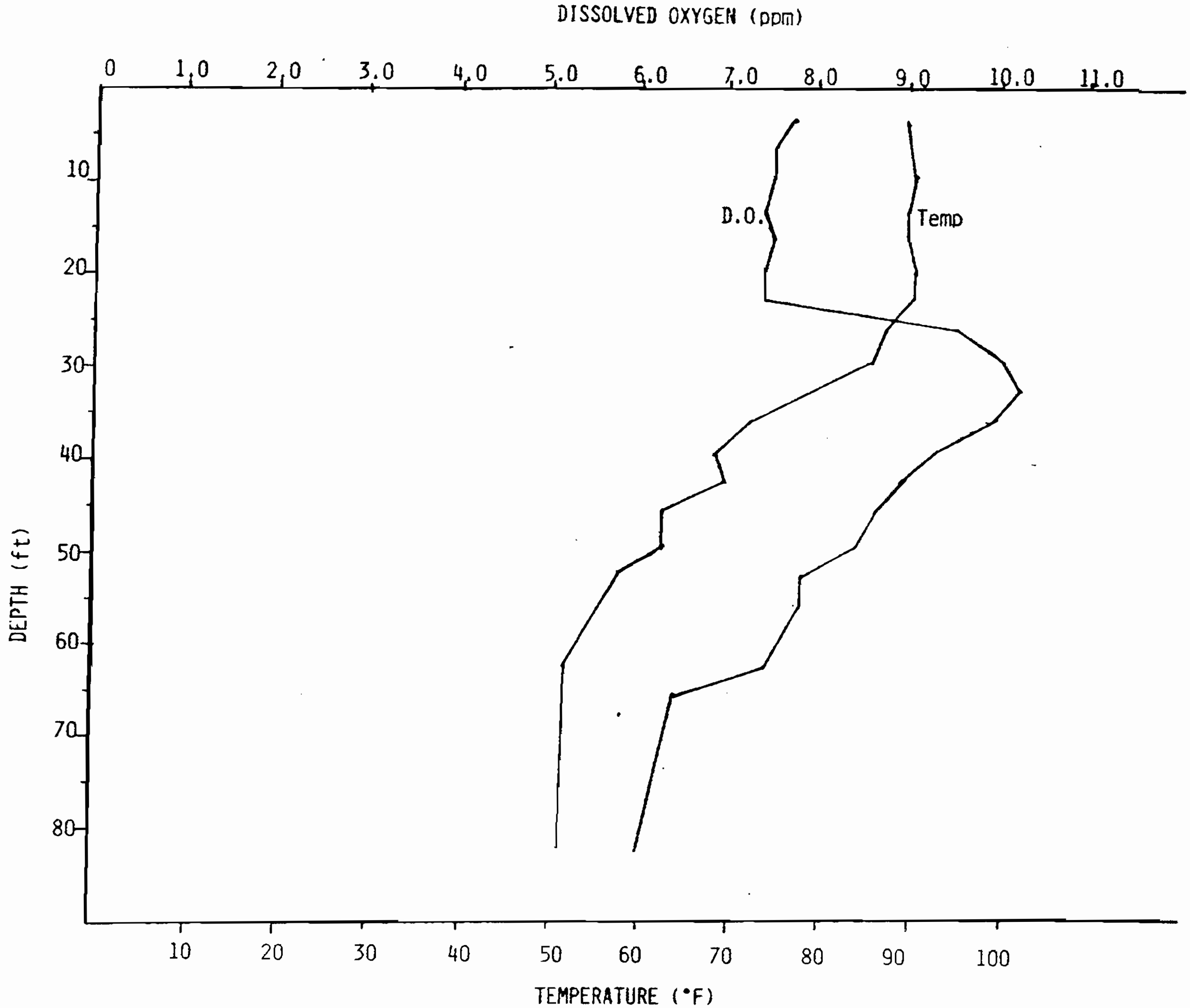


Figure 8. Temperature-dissolved oxygen profile taken in Otter Creek embayment of Lake Cumberland in August 1986.

Table 1. Location of areas and probabilities used during creel surveys conducted on Lake Cumberland (1980-1986).

Area	Description	1980 (44,629 a) Apr	1980 May-Oct	1981 (44,431 a) Apr	1981 May-Oct	1982 (46,352 a) Mar-Apr	1982 May-Oct	1983 (45,136 a) Mar-Apr	1983 May-Jun 15	1983 Jun 15-Oct	1986 (25,014 a) Mar 86 - Feb 87
1	Dam to mouth of Otter Creek, including Indian Creek	0.08	0.14	0.06	0.07	0.06	0.04	0.07	0.10	0.14	0.25
2	Otter and Beaver creeks	0.14	0.14	0.13	0.08	0.13	0.11	0.15	0.15	0.15	0.40
3	Mouth of Otter and Beaver creeks to Harmon Creek, including Lily and Greasy Creek										0.17
	Mouth of Otter and Beaver creeks to mouth of Wolf Creek	0.08	0.10	0.05	0.12	0.05	0.10	0.07	0.10	0.14	
4	Wolf and Caney creeks and tributaries	0.08	0.14	0.07	0.15	0.07	0.21	0.07	0.10	0.14	0.18
5	Mouth of Wolf Creek to below Camp Earl Wallace at Thomas Branch	0.05	0.06	0.05	0.07	0.05	0.05				
	Mouth of Wolf Creek to 4-H Camp							0.07	0.10	0.06	
6	Thomas Branch to bend below Conley Bottom	0.05	0.06	0.05	0.13	0.05	0.14				
	4-H Camp to mouth of Fishing Creek							0.07	0.12	0.14	
7	Conley Bottom to mouth of Fishing Creek, including Fishing Creek	0.08	0.14	0.07	0.13	0.07	0.13				
	Fishing Creek to Pitman Creek, inclusive							0.07	0.12	0.14	
8	Mouth of Fishing Creek to confluence of Buck Creek, including Buck Creek	0.08	0.10								
	Mouth of Fishing Creek to confluence of Buck Creek			0.04	0.05	0.04	0.04				
	Mouth of Pitman Creek to Buck creek, including Buck Creek							0.13	0.07	0.03	
9	Confluence of Buck Creek upstream in Cumberland River to first riffle	0.18	0.06								
	Cumberland River above Pitman Creek to first riffle			0.18	0.08	0.18	0.07	0.15	0.07	0.03	
10	South Fork Cumberland River to confluence of Little South Fork or first riffle, including area of Burnside Island	0.18	0.06	0.18	0.07	0.18	0.07	0.15	0.07	0.03	
11	Big Bend in Cumberland River to confluence of Buck Creek, including Buck Creek			0.12	0.05	0.12	0.04				

Table 2. Striped bass stockings in Lake Cumberland (50,250).

Year	Number	Number/acre	Size(in)	Number/lb	Source
1957	12		10-13		
1958	24		9-13		
1959	50		9-13		
1960	169		9-13		
1961	446		9-13		
1962	433		9-13		
1965	540,000		fry		
1969	42,350	0.8	3.0		Frankfort
1970	9,080	0.2	2.0	230/lb	Frankfort NFH, KY
1972	7,947	0.2	1.5-2.0		Frankfort NFH, KY
1975	49,797	1.0	4.0-8.0	73-14/lb	Edenton NFH, NC
1976	137,127	2.7	1.0-2.0	300-1608/lb	Minor Clark Fish Hatchery
1977	69,000	1.4	1.5-2.0	682/lb	Edenton NFH, NC
1978	226,457	4.5	1.0	2282/lb	Minor Clark Fish Hatchery
1979	408,281	10.0	1.1-1.4	1126-1874/lb	Minor Clark Fish Hatchery
1981	531,365	10.6	1.0-2.0	442-1774/lb	Minor Clark Fish Hatchery
1984	254,114	5.1	1.8-2.0	362-420/lb	Minor Clark Fish Hatchery
1985	253,525	5.0	1.3-1.8	558-1587/lb	Minor Clark Fish Hatchery
1986	250,539	5.0	1.6-2.7	309-544/lb	Minor Clark Fish Hatchery
1987	258,025	5.1	1.5-1.6	662-785	Minor Clark Fish Hatchery

Table 3. Back-calculated growth in length (in) of the various year classes of striped bass in Lake Cumberland.

Year	No.	Age 1	2	3	4	5	6	7	8	9	10	11
1985	62	8.1	18.2									
1984	98	8.3	18.4	24.7								
1981	194	7.4	15.5	20.5	24.3	28.0	30.8					
1979	58	6.8	14.9	21.6	26.1	27.0	30.8	32.4	34.7			
1978	2	6.9	14.7	17.8								
1977	7	8.3	16.1	21.8	26.1	31.3	32.4					
1976	27	8.7	17.0	22.5	26.7	30.2	33.2	36.6	37.6	39.4		
1975	5	8.7	17.5	23.3	27.9	31.6	35.4	37.3				
1974	3	6.3	16.4	23.5	28.3	33.0	36.2	36.6	38.3			
1973	1	10.2	17.3	24.1	27.7	33.2	35.8	37.0				
1972	1	10.0	19.6	25.4	29.9	33.6	37.0	40.3	42.3	44.5	45.8	47.0
1971	1	9.5	18.4	24.4	28.4	30.9	32.5	37.7	38.9	40.1		
Mean		7.7	16.5	22.6	26.1	29.7	32.6	35.9	37.3	41.4	45.8	47.0
Number		459	319	153	92	40	34	14	7	3	1	1
Smallest		3.1	10.7	16.1	19.9	24.2	26.5	29.9	33.0	39.4	45.8	47.0
Largest		14.5	21.5	26.6	30.2	34.4	37.9	40.3	42.3	44.5	45.8	47.0
Std error		0.09	0.13	0.19	0.27	0.45	0.50	0.79	1.21	1.58		
95% ConLo		7.6	16.3	22.2	25.6	28.8	31.6	34.2	34.5	36.3		
95% ConHi		7.9	16.8	22.9	26.6	30.6	33.6	37.6	40.2	46.4		

Table 4. Standing crop values (lb/acre) derived from cove rotenone samples collected in Lake Cumberland from 1980-1985.

	1980	1981	1982	1983	1984	1985
GAME FISHES						
White bass	2.05	4.23	0.79	1.31	2.49	12.39
Striped bass	0.45	0.18	0.04		0.12	0.01
Sauger		0.04	0.08	0.24	0.73	
Walleye	0.84	1.41	0.46	0.10	0.53	0.63
Largemouth bass	3.06	4.70	2.62	2.31	8.31	1.71
Smallmouth bass	0.34	1.68	1.09	0.57	0.39	0.24
Spotted bass	2.10	4.95	1.39	1.97	2.34	1.86
Black crappie	0.28	0.09	0.01	0.55	0.10	0.39
White crappie	34.88	6.74	1.55	11.95	12.51	7.21
Total	44.00	24.02	8.02	19.00	27.91	24.44
FOOD FISHES						
Blue catfish				0.03		0.02
Channel catfish	4.21	1.80	1.60	3.25	6.52	1.29
Flathead catfish	1.29	2.14	4.82	6.91	1.80	4.61
Total	5.49	3.94	6.42	10.19	8.32	5.92
PREDATORY FISHES						
Mooneye	0.30	2.34	0.81	0.47	0.89	4.66
Longnose gar	0.96	0.03	0.01	2.55	1.03	0.85
Total	1.26	2.37	0.82	3.03	1.93	5.50
PISCIVOROUS TOTAL	50.75	30.33	15.26	32.22	38.16	35.86
PANFISHES						
Bluegill	10.18	12.57	6.33	11.02	10.21	4.66
Hybrid sunfish		0.01				
Longear sunfish	6.02	6.76	4.94	6.83	6.46	4.89
Green sunfish			t	0.11	0.04	0.01
Warmouth	0.19	0.38	0.30	0.83	1.20	0.28
Rock bass			t		t	
Total	16.39	19.72	11.57	18.78	17.91	9.84
COMMERCIAL FISHES						
Paddlefish	50.84					
Carpsuckers	2.86				0.13	0.14
Hogsuckers	0.30	0.11	0.03	0.22	0.04	0.17
Redhorses	12.31	7.40	3.25	11.89	11.08	3.81
Carp	4.59	8.41	2.04	4.14	14.12	2.53
Buffalofishes		0.54		3.96	0.16	0.95
Bullhead		0.03		0.01		
Drum	9.64	7.71	4.50	11.67	11.61	10.72
White sucker	0.02					
Total	80.55	24.21	9.82	31.89	37.13	18.32
FORAGE FISHES						
Gizzard shad	125.07	127.39	61.80	130.24	36.73	49.39
Threadfin shad	1.53	30.17	1.61	8.00	0.84	11.19
Shiners	0.06	0.01	0.01	0.03	1.57	3.16
Misc. cyprinids	0.12	0.02	t	0.22	0.22	0.22
Madtom	0.01	0.02	0.04	0.01	0.01	0.01
Topminnows		0.01			t	0.01
Darters	0.77	0.41	0.20	0.37	0.42	0.47
Brook silverside	0.03	0.03	t	0.01	0.01	0.04
Total	127.58	158.05	63.66	138.88	39.80	64.49
NON-PISCIVOROUS TOTAL	224.52	201.97	85.05	189.55	94.85	92.65
GRAND TOTAL	275.28	232.30	100.32	221.77	133.01	128.51

Table 5. Number and pounds per acre by size group derived from cove-rotenone studies of the three species of black bass in Lake Cumberland.

		Year													
		1980		1981		1982		1983		1984		1985		$\bar{x}$	
Species	Size group[a]	No.	Lb(%)	No.	Lb(%)	No.	Lb(%)	No.	Lb(%)	No.	Lb(%)	No.	Lb(%)	No.	Lb(%)
Largemouth bass	Fingerling	84	0.35	342	1.98	78	0.30	51	0.57	41	0.32	29	0.17	104	0.62
	Intermediate	6	0.89	6	0.93	6	1.49	3	0.85	15	5.19	2	0.69	6	1.67
	Harvestable	2	1.82	1	1.78	1	0.83	1	0.89	2	2.80	1	0.85	1	1.50
	Total	92	3.06	349	4.70	85	2.62	55	2.31	58	8.31	32	1.71	111	3.79
			(55.6)		(41.2)		(51.4)		(47.7)		(72.3)		(44.9)		(54.1)
Spotted bass	Fingerling	55	0.48	193	1.12	127	0.44	93	0.51	80	0.59	142	0.46	115	0.60
	Intermediate	8	1.13	10	2.94	4	0.65	7	1.06	11	2.15	9	1.22	8	1.52
	Harvestable	1	0.50	1	0.88	t	0.29	0	0.41	t	0.10	t	0.18	t	0.38
	Total	64	2.11	204	4.95	131	1.39	100	1.97	91	2.84	151	1.86	123	2.50
			(38.4)		(43.7)		(27.3)		(40.7)		(24.7)		(48.8)		(35.7)
Smallmouth bass	Fingerling	4	0.03	17	0.34	8	0.05	8	0.08	t	t	18	0.11	9	0.10
	Intermediate	1	0.15	2	0.82	3	0.50	2	0.40	1	0.25	t	0.06	2	0.36
	Harvestable	t	0.15	t	0.52	1	0.54	t	0.08	t	0.13	t	0.07	t	0.25
	Total	5	0.33	19	1.68	12	1.09	10	0.56	1	0.38	18	0.24	11	0.71
			(6.10)		(13.0)		(21.4)		(11.6)		(3.3)		(1.8)		(10.1)

[a]Fingerling = 1-4 inch group, intermediate = 5-11 inch group, and harvestable $\geq$ 12 inch class.

Table 6. Summary of fish caught by experimental gillnetting for striped bass in Lake Cumberland from 1980-1986.

	1980		1981		1982		1983		1984		1985		1986*		Total	
Species	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
White bass	19	3	130	15	59	9	96	11	180	12	102	16			586	11
Striped bass	9	2	19	2	53	8	66	7	14	1	33	5	32		226	4
Walleye	55	10	57	7	27	4	26	3	34	2	13	2	19		231	4
Largemouth bass	2	t			3	t	1	t							6	t
Smallmouth bass			1	t	5	1	1	t	2	t					9	t
Spotted bass	14	3	38	4	70	10	89	10	6	t	27	4			244	5
White crappie	5	1	7	1	2	t	2	t	1	t					17	t
Black crappie							1	t			1	t			2	t
Sauger	2	t	2	t	3	t			1	t					8	t
Bluegill	1	t	4	t					1	t					6	t
Longear sunfish	2	t	5	1	1	t	1	t	1	t					10	t
Warmouth	1	t													1	t
Gizzard shad	385	70	428	50	324	48	482	53	1,109	74	418	64			3,146	60
Threadfin shad	2	t	1	t	11	2	54	6	68	5					136	3
Redhorse	2	t	3	1	2	t	6	1	6	t	5	1			24	t
Drum	4	t	3	t	6	1	1	t	4	t	4	1			22	t
Mooneye	1	t	9	1	2	t	2	t	1	t	1	t			16	t
Longnose gar	48	9	126	15	68	10	52	6	38	3	21	3			353	7
Channel catfish			26	3	32	5	21	2	36	2	27	4			142	3
Flathead catfish			3	1			1	t			1	t			5	t
Carp			1	t	1	t	1	t	1	t	1	t			5	t
Blue catfish							1	t	2	t	2	t			5	t
Quillback									1	t					1	t
Buffalofish											1	t			1	t
Hogsucker											1	t			1	t

*Only striped bass and walleye were enumerated during the 1986 gillnetting.

Table 7. Catch per net day[a] for each year class (total number in parentheses) of striped bass collected by experimental gill netting in the fall of 1980-1986 in Lake Cumberland.

Year netted	Year class 1975	1976	1977	1978	1979	1980	1981	1984	1985	1986	Total
1980	0.06 (1)	0.11 (2)	0.11 (2)		0.22 (4)						0.50 (9)
1981		0.08 (2)	0.04 (1)		0.17 (4)		0.50 (12)				0.79 (19)
1982		0.09 (2)	0.04 (1)		0.30 (7)		1.87 (43)				2.30 (53)
1983					0.08 (2)		2.66 (64)				2.74 (66)
1984					0.04 (1)		0.33 (8)	0.21 (5)			0.58 (14)
1985[b]							0.13 (3)	1.25 (30)			1.38 (33)
1986[b]					0.04 (1)		0.04 (1)	0.42 (10)	0.63 (15)	0.21 (5)	1.34 (32)
Total	0.06 (1)	0.28 (6)	0.19 (4)		0.85 (19)		5.53 (131)	1.88 (45)	0.63 (15)	0.21 (5)	9.63 (226)

[a]Net day is equivalent to one experimental net set for a 24-hour period.

[b]Experimental nets were modified by removing the small mesh panel.

Table 8. Sport fish harvest, and fishing pressure (man-h/acre) for principal species in Lake Cumberland from 1980-1984 and 1986 (values in parentheses are per acre values).

	Black bass	White bass	Striped bass	Walleye	Sauger	Crappie	Sunfish	Catfish	Drum	Carp	Trout	Total
1980												
No.	40,708	56,147	658	8,076	1,833	447,926	158,186	14,460	6,403			734,395
	(0.91)	(1.30)	(0.02)	(0.19)	(0.04)	(10.37)	(3.66)	(0.34)	(0.15)			(17.01)
%	5.5	7.6	t	1.1	0.2	60.9	21.5	2.0	0.9			
Lb	60,458	57,784	9,093	23,912	1,396	165,219	29,721	27,139	5,691			380,414
	(1.35)	(1.34)	(0.21)	(0.55)	(0.03)	(3.83)	(0.69)	(0.63)	(0.13)			(8.91)
%	15.9	15.2	2.4	6.3	0.4	43.4	7.8	7.1	1.5			
Pressure	4.78	1.24	0.21	1.01		11.38	1.18					20
1981												
No.	10,977	14,590	98	1,763	318	156,263	34,060	4,506	5,491	29		228,095
	(0.25)	(0.33)	(t)	(0.04)	(0.01)	(3.50)	(0.76)	(0.11)	(0.12)	(t)		(5.13)
%	4.8	6.4	t	0.7	0.1	68.5	14.9	2.0	2.4	t		
Lb	18,844	17,305	855	4,470	198	45,486	4,832	9,829	3,548	287		105,655
	(0.42)	(0.39)	(0.02)	(0.10)	(t)	(1.02)	(0.11)	(0.23)	(0.18)	(t)		(2.38)
%	17.8	16.4	0.8	4.2	0.2	43.1	4.6	9.3	3.4	0.3		
Pressure	1.61	0.52	0.11	0.35		2.8	0.09	0.05	0.02			5.6
1982												
No.	30,421	50,107	1,076	2,225	686	291,434	87,673	3,494	5,202	233	730	473,142
	(0.66)	(1.08)	(0.02)	(0.05)	(0.02)	(6.30)	(1.90)	(0.07)	(0.11)	(t)	(0.02)	(10.2)
%	6.4	10.6	0.2	0.5	0.1	61.7	18.5	0.7	1.1		0.2	
Lb	36,087	56,775	4,858	5,468	935	126,303	11,095	4,693	5,119	1,757	505	253,622
	(0.79)	(1.20)	(0.10)	(0.12)	(0.02)	(2.70)	(0.24)	(0.10)	(0.11)	(0.04)	(0.01)	(5.50)
%	14.2	22.4	1.9	2.2	0.4	49.8	4.4	1.9	2.0	0.7	0.2	
Pressure	3.1	1.0	0.2	0.4	t	3.0	0.2	t			t	14.1
1983												
No.	40,364	22,374	735	2,340	224	211,751	96,480	5,985	13,719		1,469	395,441
	(0.89)	(0.50)	(0.02)	(0.05)	(t)	(4.20)	(2.10)	(0.13)	(0.30)		(0.03)	(8.8)
%	10.2	5.7	0.2	0.6	t	53.5	24.4	1.5	3.5		0.4	
Lb	50,689	14,515	4,160	4,974	201	82,449	8,383	6,491	6,699		1,070	179,627
	(1.10)	(0.32)	(0.09)	(0.11)	(t)	(1.83)	(0.19)	(0.15)	(0.15)		(0.02)	(4.0)
%	28.0	8.0	2.3	2.8	0.1	45.9	4.7	3.6	3.8		0.6	
Pressure	3.9	0.4	0.4	0.6		3.6	0.6		0.06		0.06	12.7

4,199

Table 8 continued.

	Black bass	White bass	Striped bass	Walleye	Sauger	Crappie	Sunfish	Total catfish	Drum	Carp	Trout	Total
1984 (Beaver and Otter Creek)[a]												
No.	1,069	534	161	18		1,862	516	12	21			4,199
	(0.24)	(0.12)	(0.04)	(t)		(0.41)	(0.12)	(t)	(t)			(0.41)
%	25.7	12.8	3.8	0.4		44.7	12.4	0.3	0.5			
Lb	1,110	318	1,244	88		737	43	8	42			3,598
	(0.25)	(0.07)	(0.28)	(0.02)		(0.16)	(0.01)	(t)	(t)			(0.80)
%	30.8	8.8	34.0	2.4		20.5	1.2	0.2	1.2			
Pressure	0.82	0.08	0.76			0.40	0.13					2.3
1986 (lower lake only)												
No.	21,599	9,239	5,406	2,014		30,708	50,804	4,423	1,943	71	543	127,499
	(0.09)	(0.4)	(0.2)	(0.08)		(1.2)	(2.0)	(0.18)	(0.08)	(t)	(0.02)	(5.1)
%	16.9	7.2	4.2	1.6		24.1	39.8	3.5	1.5	0.1	0.4	
Lb	26,051	5,870	41,846	3,165		8,742	6,797	6,532	1,938	761	403	102,608
	(1.0)	(0.2)	(1.7)	(0.1)		(0.4)	(0.3)	(0.3)	(0.08)	(t)	(t)	(4.1)
%	25.4	5.7	40.8	3.1		8.5	6.6	6.4	1.9	0.7	0.4	
Pressure	5.9	0.4	2.3	0.5		1.8	1.3	0.6	0.02	t	0.08	13.8

[a]1984 - This survey was conducted on the Beaver Creek and Otter Creek arms of Lake Cumberland from 30 October 1983 through 31 March 1984. This survey was designed to estimate the winter harvest and pressure for striped bass in this section of the lake.

Table 9. Monthly catch by year class of striped bass in Lake Cumberland derived from a creel survey conducted 2 March 1986 through 28 February 1987.

Year class	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Total no.[a]
1985						28	39	65	86	84	22	87	411
1984	209	432	348	52	39		39	161	130	224		232	1,866
1981	79	124	400	17	115	114	194	65	130	392	45	378	2,053
1979	26	93	134		77	28	39	32	86	168	68	87	838
1978			27										27
1977												58	58
1976			54		39							58	151
Total	314	649	963	69	270	170	311	323	432	868	135	900	5,404

[a]Totals do not exactly compare to Table 8 due to computer rounding of numbers.

Table 10. Monthly harvest of striped bass in Lake Cumberland during 2 March 1986 through 28 February 1987.

Month	No.	Lb	Harvest rate[a] No./hour	Average length (in)	Average weight (lb)
Mar	314	1,659	0.28	23.7	5.28
Apr	649	3,243	0.14	23.2	5.00
May	963	7,802	0.13	27.3	8.10
Jun	69	283	0.10	21.8	4.10
Jul	270	4,039	0.06	33.6	14.94
Aug	170	1,530	0.08	28.3	9.01
Sep	311	2,600	0.10	27.6	8.36
Oct	323	1,606	0.06	23.2	4.97
Nov	432	2,420	0.05	24.1	5.60
Dec	868	6,219	0.07	26.2	7.16
Jan	135	1,521	0.01	30.5	11.23
Feb	900	8,923	0.07	29.3	9.92
$\bar{x}$			0.08		

[a]Harvest rate includes only striped bass anglers and not all fishermen.

Table 11. Monthly striped bass returns derived from the voluntary mail-in survey returns from Lake Cumberland (1976-1986).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1976	1	1	2	2	2	2				2	4	2	18
1977		1	1	1	3	3					5	5	19
1978		26	91	1	1					2		1	122
1979			3	23						2	12	31	71
1980	6	13	12	22		1	1	4	3	1		21	84
1981	5	10	24	52	4	3	17	16	1	7	31	46	216
1982	1	7	50	73	6	61	44	19	3	40	62	90	456
1983	46	45	108	133	49	66	25	34	51	19	56	48	680
1984	8	12	122	100	26	8	22	28	36	15	27	69	473
1985	1	5	15	51	1	19	29	20	9	11	27	12	200
1986	2	7	45	33	102	27	25	70	35	77	27	50	500
Total	70	101	408	581	194	191	163	191	138	176	251	375	2,839
% of total	2.4	3.6	14.4	20.5	6.8	6.7	5.7	6.7	4.9	6.2	8.8	13.2	

Table 12. Summary of striped bass mail-in survey returns (% of total number) by location in Lake Cumberland 1984-1986.

Location	Year 1984	1985	1986
Fall Creek	0.3	1.4	
Caney Creek	0.9		1.1
Lily Creek	0.5		2.9
Laurel River arm	0.9		
Wolf Creek	1.4	2.3	0.9
Harmon Creek	1.4		0.2
Main lake (lower)	9.4	17.5	39.1
Otter Creek	2.9	19.3	14.4
Beaver Creek	74.9	53.7	35.6
Beaver and Otter Creeks (combined[a])	81.5	76.2	51.2
Greasy Creek		0.5	
Faubush Creek			0.2
White Oak Creek			0.4
Indian Creek			2.5
Unknown	3.3	2.3	1.9

[a]These creeks are also combined since some anglers failed to separate the 2 creeks.

Table 13. Age and average growth of striped bass from Lake Cumberland derived from mail-in survey returns from 1977-1986.

Year	Year class 1969	1970	1972	1973	1974	1975	1976	1977	1978	1979	1981	1984	1985	Total
1977														
No.	3		2	3	4	7								19
Ave. length	39.8		33.3	29.0	19.8	17.2								
Ave. weight	29.00		16.08	10.09	3.02	2.04								
1978														
No.	2			1	13	5	101							122
Ave. length	44.5			30.5	27.8	24.1	18.8							
Ave. weight	42.00			11.04	8.13	5.05	2.12							
1979														
No.	1		1	3	5	3	56	2						71
Ave. length	46.5		37.8	33.5	31.1	27.2	26.5	21.0						
Ave. weight	47.00		25.00	15.11	11.04	7.11	6.15	3.04						
1980														
No.	1		1		6	10	62	4						84
Ave. length	45.5		38.0		36.0	30.2	29.5	27.0						
Ave. weight	43.08		18.12		22.11	10.11	9.12	7.06						
1981														
No.		1	1		7	3	101	3	1	91				208
Ave. length		46.5	43.0		40.5	36.8	33.0	26.0	20.0	20.3				
Ave. weight		40.00	35.00		26.00	16.11	14.09	7.04	4.00	3.09				
1982[a]														
No.			1		6	5	65	12	2	185	14			290
Ave. length			48.0		42.0	39.4	34.6	31.6	28.8	23.4	17.4			
Ave. weight			39.00		31.01	22.02	18.01	14.05	9.12	5.04	2.02			
1983[a]														
No.			1	1		2	15	3	2	82	53			159
Ave. length			44.0	42.5		44.5	36.9	33.2	31.0	27.2	19.3			
Ave. weight			43.06	30.00		26.00	20.12	15.06	13.08	8.13	3.08			
1984[a]														
No.					4	3	3	3	1	16	33			63
Ave. length					47.4	42.0	42.1	37.3	33.0	30.8	22.8			
Ave. weight					44.14	38.08	28.13	18.07	13.00	12.11	5.07			
1985[a]														
No.					2	2	1	4		12	32	13		66
Ave. length					47.0	43.0	43.5	36.8		34.6	27.0	18.0		
Ave. weight					49.02	36.00	30.00	20.10		17.09	9.05	2.12		
1986[a]														
No.							6	2	1	9	21	16	4	63
Ave. length							44.2	38.0	44.0	35.3	29.7	20.5	16.3	
Ave. weight							34.15	24.00	32.00	19.12	12.04	4.04	2.04	
Total Number	7	1	7	8	49	42	410	33	7	395	153	29	4	1,145
% of total number	0.6	t	0.6	6.9	4.3	3.7	35.8	2.9	0.6	34.5	13.4	2.5	0.3	

[a]The number of fish per year class is based on a "subsample" of each inch class received in the survey. Striped bass scales from inch classes were subsampled at the following rates: 1982 - 25%, 1983 - 20%, 1984 - 10%, 1985 - 30%, and 1986 - 10%.

Table 14. Comparisons of striped bass lengths (in) at age with this study.

State		Age 1	2	3	4	5	6	7	8	9	10
Tennessee	Van Den Avyle 1979	7.1	14.2	21.3	27.1	31.2	35.7	39.0			
Oklahoma	Erickson, et al 1970	10.3	17.4	21.5	24.9	27.3					
Kansas	McClosky and Stevens	7.0	12.5	17.3	20.9						
Texas	Prentice and Durocher	15.5	19.4	23.4	26.3	28.7	29.3				
Missouri	Hanson and Dillard 1975	6.2	13.5	19.3	23.0	25.0					
Florida	Ware 1970	11.1	18.1								
South Carolina	Nash 1984	9.1	15.6	20.5							
Utah	Gustavenson et al 1984	8.9	16.9	21.9	25.0	26.4	27.6	28.4	32.1	38.1	37.2
This study		7.7	16.5	22.6	26.1	29.7	32.6	35.9	37.3	41.4	45.8