# SPAWNING BEHAVIOR AND AGE AND GROWTH OF WHITE BASS IN CENTER HILL RESERVOIR, TENNESSEE [1]

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## ABSTRACT

The spawning behavior, age and growth and food habits of white bass, *Roccus chrysops* (Rafinesque), were studied in Center Hill Reservoir, Tennessee, from October, 1965 until March, 1967. White bass began to move toward the headwaters in late February and early March when water temperatures rose above 45° F. Spawning started in mid-March at a water temperature of 53° F. and appeared to stop if water temperature dropped below 53° F. The duration of the spawning season was one and one-half to two months. The growth rate of white bass was more rapid than in other waters. The maximum age of white bass in Center Hill Reservoir is eight years. The primary forage species for adult white bass were shad, *Dorosoma spp.*

## INTRODUCTION

The Caney Fork River was impounded in 1949 to form Center Hill Reservoir. Prior to this time and for several years thereafter no white bass, *Roccus chrysops* (Rafinesque), were reported from this impounded section of the river (Netsch and Turner, 1964), although this river is within the range reported for this species (Hubbs and Lagler, 1958; Kuhne, 1939). In November, 1954, white bass were stocked in Great Falls Reservoir near the headwaters of Center Hill Reservoir (Fetterolf, 1957). White bass apparently passed Great Falls Dam and were first noted in Center Hill Reservoir during spring 1955. In 1956, approximately 100 yearlings were caught (Fetterolf, 1957). A very significant fishery for this species now exists in the headwaters of Center Hill Lake, especially during the spring months.

This study on white bass began in Ocotber, 1965 at Center Hill Reservoir, Tennessee, and continued through the spring of 1967. The major emphasis of this research was focused on spawning behavior. However, other aspects of the life history of the white bass such as food habits and age and growth also were investigated.

## DESCRIPTION OF THE STUDY AREA

Center Hill Reservoir was impounded in 1949 by the U. S. Army Corps of Engineers at mile 26.6 on the Caney Fork River near Smithville, Tennessee. Caney Fork River (total length — 150 miles) is a tributary of the Cumberland River, and it becomes confluent with the Cumberland River at mile 309 near Carthage, Tennessee. Most of the reservoir lies within Dekalb County, but part of the lake is bordered by Putnam, Warren, and White counties. Flood control, power, and recreation are the main functions of Center Hill Dam and Reservoir.

Center Hill Reservoir is 64 miles long and drains an area of 2,195 square miles. At elevation 685 the shoreline is 415 miles long, and there are 23,060 surface acres of water.

Center Hill is a storage reservoir and sometimes fluctuations occur rapidly. Within a period of one week in February, 1966, the water level rose 14 feet. Usually the highest water levels occur in April. Progressively lower levels occur during the summer.

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[1] This paper is based on a thesis submitted to the Graduate Faculty of Tennessee Technological University, June, 1967. This research was supported in part by a grant from the Tennessee Game and Fish Commission.

Falling Water River, controlled by Burgess Falls Dam, flows into the lake from the east and is a major branch of Center Hill Reservoir. Burgess Falls, a 90-foot waterfall at the headwaters of Center Hill Reservoir, prohibits fish movement to the Burgess Falls Dam tailwaters.

Center Hill Reservoir has many coves and small tributaries, but in the upper 25-mile section the lake lies between steep cliffs which rise over 100 feet from the edge of the water. At the extreme headwaters there is the Great Falls Hydro Plant, a series of rapids, and a 35-foot waterfall. One-half mile upstream from the waterfall is Great Falls Dam, located at mile 91.1 on the Caney Fork River. Stream flow in the gorge below Great Falls Dam varies from approximately five to an estimated 210,000 cubic feet per second. The maximum known flood occurred in March, 1929 (Netsch and Turner, 1964).

Depth of the reservoir increases rapidly from the shoreline. Because of the steep shore and fluctuating water levels, rooted aquatic vegetation is rare. The maximum depth is approximately 210 feet at flood control pool. Center Hill Reservoir is best described as being an oliogotrophic lake (Gnilka, Arnold. 1967. Unpublished M.S. thesis. Tennessee Technological University).

The major study area was in the headwater area between Webb's Camp Boat Dock and Great Falls Hydro Plant because large concentrations of white bass had been reported there during spring.

## MATERIALS AND METHODS

White bass were captured primarily with one-and-one-half-inch-bar-mesh trammel nets fished perpendicular to the shoreline at night. Infrequently, one- to two-and-one-half-inch-bar-mesh gill nets were used. Nets varied from 66 to 300 feet long by six feet deep. Hoop nets were fished but did not effectively capture white bass.

In shallow water, white bass were collected with a portable electrofishing device powered by a three phase, 230 volt A.C., 180 cycle generator. The aluminum boat was used as the negative electrode (Stubbs, 1966).

The sex, total length in millimeters, and weight in grams of each fish were recorded on standard scale envelopes which contained scales from the fish. These scales were obtained from the area between the lateral line and the anterior region of the spiny dorsal fin. The stomach of each specimen was examined and food items were preserved in a collecting bottle.

The number of fish caught per 100 feet of net per hour was computed to obtain an index of relative abundance or movement into the study area. The sex ratio in the spawning area and the extent of movement into the area were determined by the use of trammel nets and the electrofishing unit.

Specific spawning acts were observed during the day and at night by sitting motionless on the shore or by quietly rowing a boat around the general spawning area. Proof that spawning had occurred during periods when it was not possible to be present for personal observations was obtained by placing egg nets in the current to collect eggs as they floated downstream.

The stomach contents which had been preserved at the time of capture were later analyzed to find out what white bass were eating during the sampling periods. The numbers of each forage species were tabulated to determine which forage items occurred most frequently. Volumetric analyses of food items were not attempted.

Scale measurements made in the anterior field from the focus to successive annuli were used to age the fish and for back calculating total lengths of the fish at previous annuli by the direct proportion formula (Rounsefell and Everhart, 1953). A computer program was used to obtain the mean lengths attained at successive annuli for each age class of each sex (Ager, Lothian. 1967. Fish age-growth, regression, and back calculation. Unpublished M.S. thesis. Tennessee Technological University). Total body length and scale measurements were punched on IBM data cards and used as the input data for the IBM 1710 computer. Sigler (1949) found that white bass were completely scaled at a total length of 29 mm. This length was used as a correction factor in the computer program.

Length and weight data were transferred to IBM cards for computing a regression of weight as a function of length as described by Swingle (1964). A computer program developed by Kerr[1] was used to print out the length-weight regression line by an IBM 1620 Autoplotter[2]. The machines used for these programs were an IBM 1620, Model 1 and an IBM Document Writing System with a modified 866 Typewriter for curve plotting. Regression analyses were made for 235 female and 419 male white bass taken from Center Hill Reservoir between October, 1965 and June, 1966. Regression analyses were also made for the combined sexes and included 18 immature specimens of undetermined sex.

## RESULTS AND DISCUSSION

### *Spawning Behavior*

Specific spawning requirements for white bass were unknown to most fishery biologists as recently as 1945 (Howell, 1945), although many fishery biologists have known for over 60 years that white bass normally migrate to spawn each spring in tributaries or in shoal areas in lakes which lack tributaries (Bonn, 1953; Horrall, 1961; Riggs, 1953, 1955). Most writers indicate that white bass spawn from April to July when water temperatures range from 58° F. to 75° F. Actual spawning activity lasts about two weeks at any one locale (Riggs, 1953). Male white bass generally migrate to the spawning area a month prior to the females when water temperatures are from 55-60° F. (Riggs, 1953). Spawning occurs both during the day and night over gravelly or rocky bottoms and usually in shallow water.

### *Spawning Migration*

In 1966 forty days elapsed from the time migration started until spawning was first observed. Only 27 white bass were collected from November, 1965 through February 11, 1966. On the night of February 11, seventeen white bass were caught. Their numbers increased rapidly and they spawned first on March 19. Prior to February 11 water temperatures were in the low 40's. Between February 11 and 18, the surface temperatures rose from 42° F. to 50° F. The rapid increase in water temperatures was caused by more than two inches of rain on February 11 and 13. As a result the lake level rose from elevation 625 to 639. Surface water temperatures in the headwaters remained at 50° F. for a month following the rains and the water level fluctuation was insignificant.

Age classes within all the samples taken from February 11 to March 14 is illustrated in Figure 1. Age classes IV, V, and VI were not represented in the samples until the latter part of the period.

Males outnumbered the females during the early part of the spawning run (Figure 1); however, the number of females was approximately equal to that of the males at the end of the period.

Many more white bass were caught near the shore in shallow water (less than 10 feet deep) than were caught off shore or in deep water. White bass rarely were caught in water deeper than 25 feet during spawning migration.

From October 21, 1966 until February 25, 1967, only 14 white bass were captured. In late February the surface water temperature in the headwaters was 43° F. On March 5 the water temperature was 46° F. Heavy rains on March 5 and 6 caused the water level to rise over 10 feet. Water temperatures increased to 52° F. in the headwaters by March 12. Sampling on the night of March 12, fifty-six male and 26 female white bass were captured. On the following night 84 males and 17 females were captured.

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[1] Kerr, Hugh B. 1620 Data Conversion Program for the Autoplotter. The D. W. Mattson Computer Center. Tennessee Technological University, Cookeville. Tennessee.

[2] Autoplotter for the IBM 1620, IBM program number 1620-CX-01X, August, 1964.

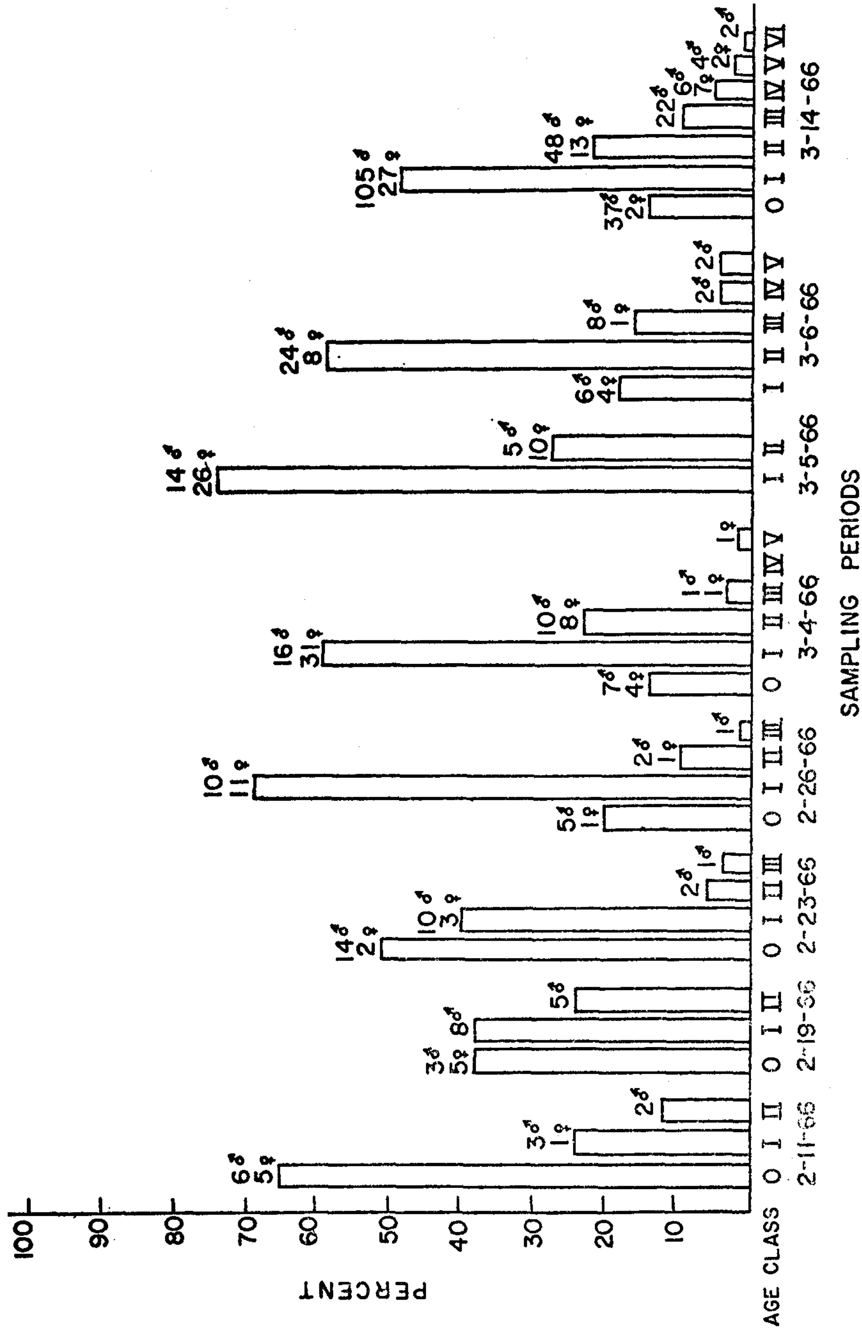


Figure 1. — Age class composition of white bass in samples taken in the early part of the 1966 spawning migration. The numbers above the bars represent total number of individuals of each age class in the sample.

In 1967, nine to 11 days elapsed between the initiation of migration and the start of spawning. On March 16, twelve female bass out of 16 were ripe. Water temperature was 54° F. On March 18 several spawning acts were observed in the headwaters.

*Timing*

In 1966 spawning was first observed on the night of March 19. The water temperature area was 53° F. Spawning continued until March 27. Trammel nets and the electro-fishing device failed on March 27 and 28 to catch white bass. Water temperature dropped from 55° F. on March 24 to 52° F. on March 27. Spawning activity was next observed on April 2 when the water temperature was 54° F.

On March 16, 1967 ovaries were ripe in many of the female white bass. The water temperature was 53° F. from March 16 through March 19. During the afternoon of March 18, 1967, six spawning acts were observed. Nets were set in the spawning area on the evening of March 19. The water temperature was 52° F. on the morning of March 20 and only 17 white bass were in the nets. Netting on March 23 produced only 15 white bass and the water temperature again was 52° F. On the night of March 26, the water temperature rose to 54° F. and 55 white bass were caught in the same net sets and several spawning acts were observed.

*Description of the Spawning Act*

Acts of spawning and the behavior demonstrated by groups of white bass prior to the spawning act was observed many times. The female swam to the area alone but soon began to be followed by one or more males. The males swam to the female and bumped her abdominal area with their snouts. She swam away from the males but they followed. After several minutes, the female stopped, the males clustered closely around her and continued to bump her abdominal area with their snouts. Suddenly she rose to the surface with the males close around her. She swam in a circle at the surface and twisted her body violently. One or two males remained in bodily contact with her and milt was seen in the water. The actual spawning act lasted no longer than five seconds.

Depth of the water in which spawning occurred varied from one foot to 10 feet, but usually was one to three feet deep. Shoreline areas were used for spawning more frequently than mid-channel areas. The bottom in the spawning area was covered by rocks and boulders.

*Sex Ratio*

The sex ratio of three samples taken at the spawning area during the early part of the 1966 spawning season varied from seven males: two females; to nine males: one female.

One-half mile down the lake from the spawning area females greatly outnumbered the males. Most of these females were not ripe while those females captured in the spawning area were all ripe. During the latter part of the 1966 spawning season, females in the samples outnumbered males. On April 14, 1966, 98 of 113 white bass netted at the spawning area were females.

*Duration of the Spawning Season*

The 1966 spawning season started on March 19. Spawning activity was observed as late as April 24. Of the females netted on April 24, 80 percent were spent and 20 percent were ripe. A check of angler's creels on April 28 revealed that 90 percent of the females caught were spent. This data indicated that spawning was not over by the end of April and probably continued into May. The length of the spawning season is, therefore, approximately one and one-half to two months.

*Other Species*

The headwater area where white bass spawn was utilized as a spawning area by other species. Walleye, *Stizostedion vitreum* (Mitchell), spawned in this area approximately the same time as the white bass. Redhorse, *Moxostoma sp.* and spotted suckers, *Minytrema melanops* (Rafinesque), spawned in this area shortly after the white bass began to spawn.

*Fluctuating Water Levels*

White bass eggs have a shorter incubation period than do the eggs of many other species and water level has to drop quickly to expose the viable eggs. Horrall (1961) reported that white bass eggs hatched in the laboratory in 45 hours at 20.2 C. (60° F.) and in 41 hours in 21.5 C. (71.3° F.). The yolk sac was absorbed in eight days.

On March 19, 1966, when spawning was first observed, the lake level was at elevation 639 and falling. The lake level continued to fall until April 10 when the water level was 635. As a result of the falling water level millions of adhesive white bass eggs on rocks and boulders were exposed to the air.

It is possible that the 1966 year class of white bass was smaller than it would otherwise have been had the water level been stable during that period. Walleye eggs suffered similarly; however, fewer exposed walleye eggs were seen.

## AGE AND GROWTH

*Annulus Formation*

The period of annulus formation on white bass scales appears to be during late March and early April. Although crossing-over of newly formed circuli was noted on many scales obtained from samples taken during this period, definite annuli could not be detected because of the close proximity of these circuli to the margin of the scale. Therefore, fish which were captured during late winter and early spring and had completed their growth for the first year were placed in age class 0. Fish with scales exhibiting one annulus and the following increment of growth to the margin were included in age class I, etc.

White bass added an annulus during late April at Lake Texoma (Bonn, 1961).

*Age Composition of the Spawning Population*

Most age and growth studies include some discussion on the age composition of the population. The two main objectives of this type of analysis are to gain knowledge about age class survival and to determine the relative strength of a particular year class in the population. The advantages and potential usefulness of knowing this type of information are obvious. However, to be useful or to serve as a basis for further investigations these data must be reasonably accurate. The prime requirement for accuracy is random sampling.

From February 11, 1966 to March 23, 1966, 642 white bass were taken for age and growth studies. The percentage each age class comprised of the total number of scales examined was as follows: O—16.1%, I—45.6%, II—23.9%, III—7.0%, IV—3.1%, V—2.9%, and VI—1.4%.

The precentage of each age class in the samples changed as the 1966 spawning season progressed (Figure 1). Due to the different age composition of the spawning population at successive periods, data collected during a few periods are not representative of the total spawning population of white bass. Since data for age and growth studies were not collected throughout the entire spawning period, the percent of each age class in the total spawning population is unknown.

Horrall (1961) found that the age class composition of white bass samples changed over the course of the spawning run at Lake Mendota, Wisconsin; however, in his study, older age classes made up higher percentages of the total sample early in the season than they did late in the season. It is recommended that reference be made to Horrall (1961) before studying spawning populations of white bass.

Although the total sample (642) of white bass taken for age and growth studies is considered to be biased and nonrandom in regard to age composition analysis, some reliable general information can still be obtained from the data. Two-year-old fish are the most numerous age class in the spawning population since they were the most abundant age class in nearly every sample. White bass in Center Hill Reservoir do live for as long as eight years, but they rarely live longer than three years. Tompkins and Peters (1951) found that at Herrington Lake, Kentucky, age class II was the most abundant age class in the spawning population of white bass.

*Growth Analyses*

Data from 542 white bass (354 males and 188 females) were used in the back calculation computer program already described. The calculated lengths at each annulus and mean lengths at capture are included in the data presented in Tables 1, 2, and 3. The growth of males is shown in Table 1, the growth of females is shown in Table 2 and the growth of males and females combined is shown in Table 3. Also included in these tables are the estimated weights for the average calculated lengths. These weights were determined by using the formulae that are presented in the section of this paper on length-weight relationship. Length and weight increments for the average calculated total lengths and weights are included in these tables also.

The average size of females is larger than the average size of males at all ages, but the length increment of males and females is approximately the same for each year of growth with the exception of the first year. Therefore, it appears that the longer sizes attained by female white bass is due to growth attained during the first year. Males of age class VI demonstrated a greater growth than did females of age class VI during their first year. However, the small size of the sample may be a reason for the apparent discrepancy.

For the first year of growth there is a great range in mean length attained by the different age classes, but by the end of the third year the respective age classes show little variation in length. Therefore, it appears that the fish will catch up or compensate by growing more in succeeding years if growth during the first year was poor. Ward (1951) stated that there was evidence of growth compensation occurring in white bass at Lake Duncan, Oklahoma. Thompson (1951) found compensation in growth during the second year of life occurred in white bass in Lake Overholser, Oklahoma, if there was poor growth the first year.

The large mean length at capture of age class O may be due to one or both of the following explanations: the capture method (primarily trammel nets) may have been selective so that the smaller individuals in age class O were not captured or perhaps only the sexually mature (therefore larger) individuals of age class O were present in the spawning area.

For both males and females the greatest increase in average length was during the first year of life, while the greatest increase in weight came during the second year of life.

White bass in Center Hill Reservoir appeared to grow larger and live longer than white bass in other waters. The absolute growth of white bass in Center Hill Reservoir is compared in Table 4 with the absolute growth rates of white bass in other localities. Grand Reservoir, Oklahoma, is the only place where white bass exhibited a faster growth rate than do the white bass at Center Hill, but the ones in Center Hill Reservoir attain a larger maximum size.

The oldest age attained by white bass in Center Hill is compared in Table 5 with the oldest ages attained by white bass in other localities. White bass live longer in Center Hill than they do in other southern bodies of water, but they do not live quite as long as do the white bass in New York and Iowa.

*Age and Size at Maturity*

All two-year-old white bass in Center Hill Lake were sexually mature. All one-year-old males longer than 230mm were sexually mature with the exception of one specimen that was 247mm long. The smallest mature female was 262mm long. Females that attained a length of 275mm by the end of the first year were sexually mature.

Tompkins and Peters (1951) reported that 80% of the one-year-old males and 15% of the one-year-old females were mature in Herrington Lake, Kentucky. Mature male white bass averaged 208mm total length

TABLE 1 — AVERAGE CALCULATED TOTAL LENGTHS, WEIGHTS, AND AVERAGE LENGTH AND WEIGHT INCREMENTS FOR EACH AGE CLASS OF MALE WHITE BASS COLLECTED IN CENTER HILL RESERVOIR DURING 1966.

| Age Class | Number of fish | Mean length at capture (mm) | Mean calculated total length (mm) at annulus 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|
| 0 | 62 | 254 | | | | | | |
| I | 156 | 345 | 188 | | | | | |
| II | 83 | 389 | 224 | 359 | | | | |
| III | 31 | 410 | 233 | 360 | 394 | | | |
| IV | 7 | 426 | 228 | 353 | 398 | 415 | | |
| V | 12 | 441 | 229 | 342 | 391 | 416 | 429 | |
| VI | 3 | 449 | 247 | 356 | 396 | 415 | 428 | 440 |
| Average Calculated total length (weighted mean) | | | 206 (8.1)[1] | 357 (14.1) | 394 (15.5) | 416 (16.4) | 429 (16.9) | 440 (17.3) |
| Increment of average calculated lengths | | | 206 (8.1)[1] | 151 (6.0) | 37 (1.4) | 21 (0.9) | 13 (0.5) | 11 (0.4) |
| Estimated average weight (g) calculated from length-weight relationship formula | | | 132 (0.29)[2] | 631 (1.39) | 844 (1.86) | 972 (2.14) | 1035 (2.28) | 1162 (2.56) |
| Increment of estimated average weight | | | 132 (0.29)[2] | 449 (1.10) | 213 (0.47) | 128 (0.28) | 63 (0.14) | 127 (0.28) |

[1] Equivalent total length in inches.
[2] Equivalent total weight in pounds.

TABLE 2 — AVERAGE CALCULATED TOTAL LENGTHS, WEIGHTS, AND AVERAGE LENGTH AND WEIGHT INCREMENTS FOR EACH AGE CLASS OF FEMALE WHITE BASS COLLECTED IN CENTER HILL RESERVOIR DURING 1966.

| Age Class | Number of fish | Mean length at capture (mm) | Mean calculated total length (mm) at annulus 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|
| 0 | 9 | 254 | | | | | | |
| I | 99 | 369 | 209 | | | | | |
| II | 45 | 410 | 231 | 378 | | | | |
| III | 7 | 436 | 240 | 384 | 418 | | | |
| IV | 13 | 446 | 240 | 361 | 407 | 433 | | |
| V | 9 | 468 | 257 | 371 | 413 | 436 | 455 | |
| VI | 6 | 470 | 243 | 358 | 410 | 433 | 448 | 461 |
| Average calculated total length (weighted mean) | | | 222 ( 8.7 )[1] | 373 (14.7) | 411 (16.2) | 434 (17.1) | 452 (17.8) | 461 (18.1) |
| Increment of average calculated lengths | | | 222 ( 8.7 )[1] | 151 ( 6.0 ) | 38 ( 1.5 ) | 23 ( 0.9 ) | 18 ( 0.7 ) | 9 ( 0.3 ) |
| Estimated average weight (g) calculated from length-weight relationship formula | | | 177 (0.39)[2] | 795 (1.75) | 1053 (2.32) | 1262 (2.78) | 1411 (3.11) | 1507 (3.32) |
| Increment of estimated average weight | | | 177 (0.39)[2] | 618 (1.36) | 258 (0.57) | 209 (0.46) | 149 (0.33) | 96 (0.21) |

[1] Equivalent total length in inches.
[2] Equivalent total weight in pounds.

TABLE 3 — AVERAGE CALCULATED TOTAL LENGTHS, WEIGHTS, AND AVERAGE LENGTH AND WEIGHT INCREMENTS FOR EACH AGE CLASS OF WHITE BASS COLLECTED IN CENTER HILL RESERVOIR.

| Age Class | Number of fish | Mean length at capture (mm) | Mean calculated total length (mm) at annulus 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|
| 0 | 71 | 254 | | | | | | |
| I | 255 | 354 | 196 | | | | | |
| II | 128 | 396 | 226 | 366 | | | | |
| III | 38 | 415 | 234 | 365 | 398 | | | |
| IV | 20 | 440 | 236 | 358 | 404 | 427 | | |
| V | 21 | 453 | 241 | 355 | 400 | 424 | 440 | |
| VI | 9 | 464 | 245 | 358 | 406 | 426 | 441 | 454 |
| Average calculated total length (weighted mean) | | | 212 ( 8.3 )[1] | 364 (14.3) | 401 (15.8) | 426 (16.8) | 440 (17.3) | 454 (17.8) |
| Increment of average calculated lengths | | | 212 ( 8.3 )[1] | 152 ( 6.0 ) | 37 ( 1.5 ) | 25 ( 1.0 ) | 14 ( 0.5 ) | 14 ( 0.5 ) |
| Estimated average weight (g) calculated from length-weight relationship formula | | | 132 (0.29)[2] | 704 (1.55) | 935 (2.06) | 1108 (2.44) | 1221 (2.69) | 1317 (2.90) |
| Increment of estimated average weight | | | 132 (0.92)[2] | 572 (1.26) | 231 (0.41) | 173 (0.38) | 113 (0.25) | 96 (0.21) |

[1] Equivalent total length in inches.
[2] Equivalent total weight in pounds.

TABLE 4 — COMPARISON OF GROWTH RATE OF CENTER HILL RESERVOIR WHITE BASS WITH GROWTH RATES OF WHITE BASS FROM VARIOUS LOCALITIES.

| Locality | Reference | Mean calculated total length at each annulus 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| Center Hill Resv. Tennessee | Webb (1967) | 212[1] (8.3)[2] | 364 (14.3) | 401 (15.8) | 426 (16.8) | 440 (17.3) | 454 (17.8) | 464 (18.3) | | |
| Oneida Lake New York | Forney and Taylors (1963) | 135 (5.3) | 262 (10.3) | 312 (12.3) | 338 (13.3) | 356 (14.0) | 373 (14.7) | 391 (15.4) | 406 (16.0) | 442 (17.4) |
| Herrington Lake Kentucky | Tompkins and Peters (1951) | 213 (8.4) | 340 (13.4) | 384 (15.1) | 422 (16.6) | | | | | |
| Shafer Lake Indiana | Riggs (1953) | 160 (6.3) | 251 ( 9.9 ) | 318 (12.5) | 351 (13.8) | 371 (14.6) | 389 (15.3) | 404 (15.9) | | |
| Wheeler Resv. Alabama | Howell (1945) | 193 (7.6) | 267 (10.5) | | | | | | | |
| Lake Texoma Oklahoma | Jenkins (1957) | 188 (7.4) | 302 (11.9) | 358 (14.1) | 384 (15.1) | 411 (16.2) | 434 (17.1) | | | |
| Grand Resv. Oklahoma | Jenkins (1957) | 231 (9.1) | 373 (14.7) | 414 (16.3) | 450 (17.7) | | | | | |

[1] Total length in millimeters.
[2] Total length in inches.

TABLE 5 — LONGEVITY OF WHITE BASS AT DIFFERENT LOCALITIES.

| Locality | Reference | Total No. of Fish | Oldest Age in Years | No. Fish of Oldest Age |
|---|---|---|---|---|
| Center Hill Resv. Tennessee | Webb (1967) | 703 | 8 | 2 |
| Wheeler Resv. Alabama | Howell (1945) | 730 | 4 | 9 |
| Herrington Lake Kentucky | Tompkins and Peters (1961) | 543 | 5 | 3 |
| Lake Duncan Oklahoma | Ward (1949) | 154 | 5 | 7 |
| Lake Overholser Oklahoma | Thompson (1949) | 368 | 4 | 2 |
| 34 Lakes in Oklahoma | Jenkins (1957) | 3430 | 6 | 6 |
| Oneida Lake New York | Forney and Taylor (1963) | 628 | 10 | 1 |
| Spirit Lake Iowa | Sigler (1949) | 490 | 9 | 5 |
| Shafer Lake Indiana | Riggs (1953) | 1389 | 8 | 5 |

while mature females averaged 264mm. Most male white bass in Wheeler Reservoir, Alabama, were mature by the end of the first year of life (Howell, 1945) while only a few females were mature by the time they were 220mm long. The smallest mature female he collected was 304mm long. Sigler (1949) found that all the white bass in Spirit Lake, Iowa, did not reach maturity until they were three years old. He stated that 36% of the males and 76% of the females were mature at the end of the second year.

*Length-Weight Relationship*

The formula used to express the length-weight relationship of the white bass in Center Hill Reservoir was:

$$W = aL^B$$

where W=weight, L=total length, a=a constant, and B=an exponent.

The computed length-weight relationship for 419 male white bass is: $W = 2.83 \times 10^{-5}L^{2.88}$ when measurements are in millimeters and grams. If measurements are in inches and pounds then $a = 6.92 \times 10^{-4}$.

For 235 female white bass the length-weight equation is: $W = 1.64 \times 10^{-5}L^{2.99}$ when measurements are in millimeters and grams. If measurements are in inches and pounds then $a = 5.79 \times 10^{-4}$.

The equation for the length-weight relationship of 672 male and female white bass is: $W = 1.12 \times 10^{-5}L^{3.04}$ when measurements are in millimeters and grams. If measurements are in inches and pounds then $a = 6.92 \times 10^{-4}$.

*Growth of Young-of-the-Year White Bass*

Two different size classes of fingerling white bass were seined in August 1966. A group seined on August 6 averaged 64mm long and ranged from 49 to 85mm. A group collected on August 13 averaged 123mm long and ranged from 99 to 142 mm. Seining and netting during March 1967 captured age class 0 white bass that ranged from 107 to 303mm long.

White bass collected by rotenone sampling in Chickamauga Reservoir, Tennessee, during late October 1942 belonged to two separate size groups. One group averaged 85mm long and the other group averaged 142mm (Eschmeyer, Stroud, and Jones, 1944). Eschmeyer (1944) found young-of-the-year white bass in the tailwaters of Norris Reservoir, Tennessee, that ranged from 170 to 279mm at the end of one year of growth.

White bass in Center Hill Reservoir exhibited a large variation in length at the end of the first year of growth. This great variation may be due to the long spawning season.

## FOOD HABITS

The stomachs of 571 adult white bass were examined. Seventy (12%) of these stomachs contained food items. Of the identifiable items shad occurred most frequently in white bass stomachs (Table 6). During winter and early spring 1966, 37 (7.5%) of 490 white bass stomachs contained food. Food items were found in 18 (28.5%) of the 63 stomachs that were collected during winter and early spring 1967. Food was present in 15 (83%) of the 18 stomachs collected during autumn 1966.

TABLE 6 — THE PER CENT OF OCCURRENCE FORAGE ITEMS IN 70 WHITE BASS STOMACHS CONTAINING FOOD ITEMS.

| Forage Species | Percent of Occurrence |
|---|---|
| Threadfin shad | 15 |
| Gizzard shad | 7 |
| Unidentifiable shad | 18 |
| Minnows | 11 |
| Brook silversides | 3 |
| Unidentified fish | 45 |
| Insects | 1 |

During January and February, prior to the spawning migration, all white bass stomachs were empty. At the same time white crappie stomachs were gorged with small (25mm) threadfin shad. The water temperature during the period was 45° F. Cold water temperatures possibly suppressed the feeding of white bass. Sigler (1949) concluded that white bass fed little or not at all under the ice in Spirit Lake, Iowa, during the winters of 1943 and 1945.

Abundance of forage may be a major factor which caused seasonal differences in feeding activity. During late February, March, and early April forage in the headwaters may not have been present in sufficient numbers to feed the white bass and walleye which moved into the area.

One incident of cannibalism was noted. On March 16, 1967, a 470mm female had swallowed an immature white bass 165mm long.

Two size classes of fingerling white bass were collected by seining during August 1966. Eighty percent of the items in the stomachs of 29 fingerlings ranging from 60 to 85mm collected on a sandy beach were unidentified species of larval fish which averaged 10mm in length. Ten percent of the items were insects and 10% were unidentifiable.

A week after the first group was collected another group of 11 white bass ranging from 99 to 142mm was seined from a gravelly beach two miles below Burgess Falls. Twenty-four (68%) of the items in their stomachs were minnows, nine (26%) were mayflies, and two (6%) were amphipods.

## SUMMARY

The major spawning area for white bass in Center Hill Reservoir is located in the headwaters between Webb's Camp Boat Dock and the Great Falls Hydro Plant. White bass migrated to the spawning area in late February and early March as water temperatures began to rise above 45° F. Spawning started during mid-March after water temperatures reached 53° F. The duration of the spawning season was one and one-half to two months. White bass ceased spawning and moved downstream if the water temperature dropped below 53° F. The duration

of the period between the start of the migration and the start of spawning is related to or dependent upon the time at which the critical water temperature for spawning is reached.

Early, male white bass were at the spawning grounds in greater numbers than females. Females outnumbered the males during the latter part of the spawning season. Young fish made up a higher percentage of the samples early in the spawning run than they did late in the spawning run.

Rapidly falling water levels destroyed great numbers of white bass eggs during 1966. The absolute growth rate of white bass in Center Hill Reservoir was faster than white bass at other localities.

Generally, male and female white bass in Center Hill Reservoir were sexually mature when they were 230mm long and 275mm long, respectively.

The 1966 year class of white bass ranged from 107 to 303mm long at the end of the first year of growth. This great variation in growth is considered to be the result of a long spawning season.

White bass in Center Hill Reservoir lived for as long as eight years. Since samples were not taken during the full length of the spawning season, data used for analysis of age class composition was judged to be biased.

Shad were the primary forage species for adult white bass. Fingerling white bass foraged chiefly on unidentifiable fish and insects. White bass did not feed very often during the winter.

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# SPOTTED GAR PREDATION ON BLUEGILL AND SELECTED FORAGE SPECIES [1]

BY TOM M. SCOTT, JR.[2]

## ABSTRACT

Fingerling spotted gar, *Lepisosteus oculatus* (Winchell), stocked at rates of 100 and 148 per acre into four Alabama ponds containing bluegills, *Lepomis macrochirus*, and fathead minnows, *Pimephales promelas*, failed to control crowding of bluegill within a 22-month experiment.

Plastic-lined pools stocked with adult gar and equal numbers of bluegills, golden shiners, *Notemigonus crysoleucas*, largemouth bass, *Micropterus salmoides*, and white catfish, *Ictalurus catus*, showed the least reduction in numbers of bluegill, followed by golden shiners, white catfish, and largemouth bass. An emaciated condition that developed in the largemouth bass may have contributed to their vulnerability.

## INTRODUCTION

Gar, *Lepisosteus spp.*, may be a liability through competition with or predation on more desirable species, or an asset by reducing the numbers of overabundant forage species (Lagler, et al. 1943; Hunt, 1952; and Holloway, 1954).

This report is an evaluation of spotted gar as a predator on bluegill, in four Alabama ponds and their relative preference for selected species in plastic-lined pools.

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