In summation, some rapid methods of processing data have been presented. These methods and their applications are not "cure alls"; they entail considerable planning, control and supervision. However, we do feel that punch card methods are a practical approach to the problem of processing large amounts of fishery research data.

ACKNOWLEDGMENTS

Acknowledgments are made to the many employees of the Remington Rand Corporation and Louisiana Wild Life and Fisheries Commission who helped with the development of the procedures described. This report is a joint contribution from the Remington Rand Division of Sperry Rand Corporation and Louisiana Federal Aid in Fish Restoration Project F-1-R.

Question: Is more than one card prepared when a party is creeled?
Answer: Yes. Four cards for this illustration.

Question: Where is the original card prepared?
Answer: In the field but no figures are totaled or coding inserted.

Question: What is the cost of installation and operation?
Answer: Basic machines are punch machine and sorter. These would cost about $6,000 but the total operating cost would depend upon the volume of work done.

Question: How many cards were prepared when nothing was caught?
Answer: One card.

COMPARISON OF THE AGE AND GROWTH OF FOUR FISHES FROM LOWER AND UPPER SPAVINAW LAKES, OKLAHOMA

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INTRODUCTION

Purpose of Study

This study of the fishery resources of Lower and Upper Spavinaw Lakes was begun in January, 1952, and continued through December, 1954. Special effort was made to compare the growth rates of four species of fish common to both lakes—the gizzard shad (*Dorosoma cepedianum*), the spotted sucker (*Minytrema melanops*), the largemouth bass (*Micropterus salmoides*), and the white crappie (*Pomoxis annularis*). Without a basic understanding of the age and growth of the various species of fish present, as well as other factors of population dynamics, these reservoirs cannot be intelligently managed as a sport fishery.

Management procedures which have been undertaken in these two reservoirs in the past years included (1) prior to 1951, annual stocking of largemouth bass, white and black crappie, and miscellaneous sunfishes from the municipal hatchery (Aldrich, 1943); (2) rough fish removal by gill-netting, trapping, seining, and rotenoning; (3) construction and maintenance of brush shelters; (4) imposing size and creel limits; (5) imposing closed seasons on portions of the lake during spawning periods. These methods were instituted without adequate knowledge of the existing populations and little attempt has been made to evaluate their effectiveness.

Location, Purpose, History, and Description of Spavinaw Lakes

The drainage basins of the two Spavinaw Lakes, located in northeastern Oklahoma, include approximately 400 square miles of Ozark foothills, 80 per cent of which is timbered land (McMurray, 1945)—principally the dry, oak-hickory forest that covers the chert-mantled hillslopes and crests (Blair and Hubbell, 1938). Both lakes are water supply reservoirs for the city of Tulsa, Oklahoma. No attempt is made here to delimit the drainages of the two lakes, but the total drainage encompasses the entire watershed from the head of

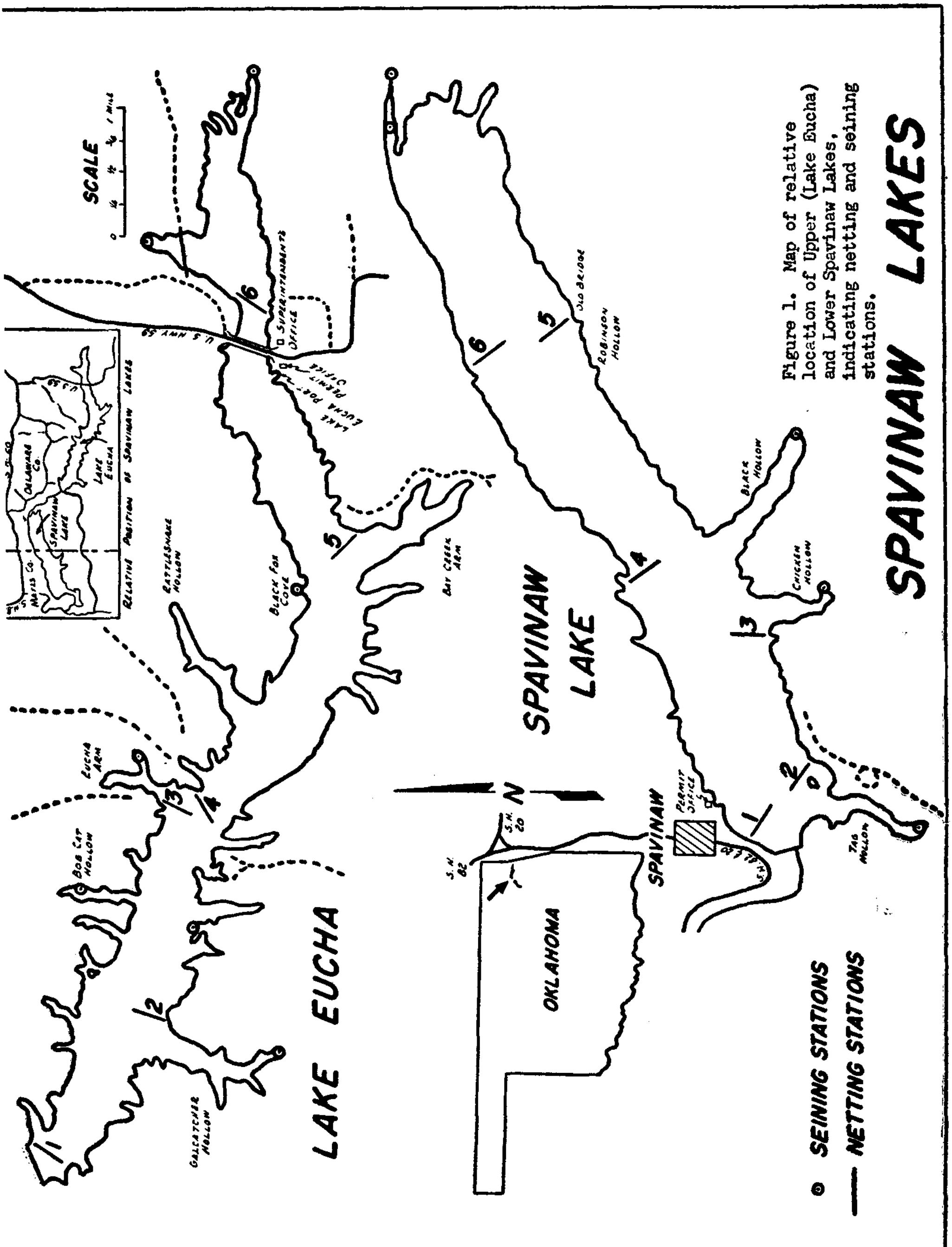

Figure 1. Map of relative location of Upper (Lake Eucha) and Lower Spavinaw Lakes, indicating netting and seining stations.

Spavinaw Creek near Gravette, Arkansas, to the dam of Lower Spavinaw Lake. In addition to Spavinaw Creek, three intermittent streams enter Upper Spavinaw Lake (Lake Eucha); including Dry Creek, Brushy Creek and Rattlesnake Creek (Figure 1). Two intermittent streams enter the Lower Lake, one at the southern end of the Black Hollow arm, the other at the southern end of Tag Hollow (Figure 1).

The average rainfall for the watershed is 44.39 inches annually (U.S.D.A., 1941). The Oklahoma Planning and Resources Board (1949, 1950, 1951, 1952, and 1953), determined the total dissolved solids as 110, and the total $CaCO_3$ hardness as 85.8 parts per million. The average pH was determined to be 7.9.

Lower Spavinaw Lake was thermally stratified during late spring and summer, and stratification occurred in Upper Spavinaw Lake normally in June and continued throughout the summer to early winter. The thermocline occurs 20 to 33 feet below the surface in the Lower Lake and between 18 feet and 29 feet in the Upper Lake. Surface temperatures on both lakes may rise to 90° F., but the bottom temperatures were not normally above 70° F.

Lower Spavinaw Lake. This lake is located in Mayes and Delaware counties in northeastern Oklahoma (Figure 1), and was impounded in 1923. The dam is located at Spavinaw, Oklahoma, and the lake is accessible by State Highways 20 and 82. Although the reservoir was constructed primarily for water storage, fishing, boating, and allied activities have made it a popular recreational area.

The dam that impounds Lower Spavinaw Lake is located on Spavinaw Creek, four miles upstream from its confluence with Grand River, and approximately 40 miles from its source near Gravette, Arkansas. The lake is 5.4 miles in length along the northeast-southwest axis and has an average width of 0.47 miles; the maximum width is 0.59 miles. The dam is 55 feet high and impounds 1,637 surface acres of water with an approximate average depth 18.7 feet, and a storage capacity of 30,660 acre feet at spillway level. Maximum depth was found to be 47 feet.

The predominant soil type of the drainage is the Okoee stony loam which has developed in place from cherty limestone (Boone chert). The lake is surrounded by generally forested areas with several species of oak (predominantly post oak and blackjack oak) and hickory. Most of the soil around the lake is too stony and thin for cultivation and is used primarily for grazing.

The bed of Spavinaw Creek as it enters the lower lake is predominantly flint and limestone ranging from sand to boulders and slabs of limestone where outcropping occurs.

Siltation has not been a major problem in the Lower Lake and much of the bottom is still gravel. The only areas where silt deposition is noticeable are at heads of hollows (bays) and at the extreme northeastern portion of the lake. In some parts of the latter area deposits of silt three to five feet deep are present.

The principal aquatic plant is *Dianthera americana.* Isolated patches of *Typha, Potamogeton, Ceratophyllum, Nyphaea, Ranunculus, Najas,* and *Heteranthera* also occur. The principal woody vegetation at the perimeter of the lake is *Salix nigra,* interspersed with *Cephalanthus occidentalis, Platanus occidentalis, Ulmus* spp., and *Quercus* spp.

Upper Spavinaw Lake. The Upper Lake (Lake Eucha, since 1955), located in Delaware County, Oklahoma (Figure 1), was impounded in 1952. The dam is on Spavinaw Creek approximately three miles above the head of Lower Spavinaw Lake, six miles southeast of Chloeta, and four miles south of State Highway 20. The reservoir was constructed primarily for water storage, but fishing, boating, and other recreational activities have made it a popular recreational area.

The dam is composed of two segments—500 feet of earth and rock fill over a concrete core, and the main concrete structure. Upper Spavinaw Lake extends 8.4 miles upstream in a southeasterly direction with an average width of 0.38 mile the maximum width is 0.66 mile. The lake is long and narrow with many diverging fingers running from both sides of the main axis (Figure 1). The length of the shore line is 49 miles. Its configuration ranges from gradual slopes to exposed limestone and chert bluffs, which rise precipitously as high as 90 to 100 feet. Forested and open pasture lands of the chert-mantled type also touch the lake's edge.

According to figures based on area capacity curves prepared by W. R. Holway and Associates, consulting engineers for the city of Tulsa, the surface area of the lake is 2,880 acres at spillway level (778 feet above mean sea level) and 3,292 acres at maximum lake level (785 feet above mean sea level). The storage capacities of the lake at spillway level and maximum level are approximately 80,000 and 104,000 acre-feet, respectively.

Work began on the dam in 1949 and water impoundment began in January, 1952. Due to the extreme drought which occurred from 1952 through 1954, the lake level has not attained 778 feet.

The clearing of wooded areas on the lake floor consisted of complete cutting and burning, leaving stumps at a maximum height of eight inches. During the clearing operations, certain areas were selected for the location of brush shelters and two trees were left standing at each site for anchorage. Brush piles were then placed between them and secured with cable and wire to hold them in place.

The Major Soil Areas Map, Delaware County, S.C.D., Ok-SCD, Region 4, Fort Worth, Texas, May 19, 1942, indicates that the soil types which comprise the major portion of the bottom of the Upper Lake are mostly bottom land alluvial soils composed primarily of Huntington gravely silt loam, Riverton very fine sand loam, Verdigris silt loam and Okoee stony loam. The Boone chert, composed of flint and limestone of various sizes, is the principal soil type of the stream bed.

Because of fluctuating water levels, emergent aquatic plants have not become established. The woody vegetation surrounding the lake is essentially the same as that of the Lower Lake, except that *Salix nigra* is not yet as abundant.

MATERIALS AND METHODS

Collections of fishes were made with gill nets, seines, rotenone, and by angling. These several methods were used to reduce the selectivity which is inherent in any one collection method. Sixty-seven species of fish were taken during this study and two introductions have been found since 1955 (Table I).

Six gill-netting stations were established in the Lower Lake in 1950 and six in the Upper Lake in 1952 (Figure 1). These stations were fished regularly throughout the study. Five kinds of nylon gill nets were used: (1) "experimental" gill nets with seven sections, each 14 2/7 yards long and 7 feet deep, and of ¾-, 1-, 1¼-, 1½-, 1¾-, 2-, and 2½-inch mesh, respectively; (2) 1½-, and (3) 2-inch mesh nets, each 100 yards long and 7 feet deep; (4) 3- and (5) 3½-inch mesh nets, each 150 feet long and 6 feet deep.

TABLE I

A LIST OF FISHES COLLECTED FROM UPPER AND LOWER SPAVINAW LAKES, 1952-54

Species		*Where Collected*		
Scientific Name	*Common Name*	*Lake* *Upper*	*Lower*	*Stream*
Ichthyomyzon gagei	Southern Brook Lamprey	x	–	x
Dorsoma cepedianum	Gizzard Shad	x	x	x
Salmo gairdneri [1]	Rainbow Trout	x	–	x
Ictiobus bubalus [2]	Smallmouth Buffalo	–	x	–
Carpiodes carpio [2]	River carpsucker	–	x	–
Moxostoma erythrurum	Golden Redhorse	x	x	x
Moxostoma duquensii	Black Redhorse	x	x	x
Moxostoma carinatum	River Redhorse	x	x	x
Hypentelium nigricans	Hog Sucker	x	x	x
Catostomus commersonni	White Sucker	x	x	x
Minytrema melanops	Spotted Sucker	x	x	x
Cyprinus carpio	Carp	x	x	x
Notemigonus crysoleucas	Golden Shiner	–	x	x
Semotilus atromaculatus	Creek Chub	x	–	x
Chrosomus erythrogaster	Southern Redbelly Dace	x	–	x
Hybopsis biguttata	Hornyhead Chub	x	x	x
Hybopsis amblops	Bigeye Chub	–	–	x
Notropis percobromus	Plains Shiner	–	–	x

TABLE I—*Continued*

A LIST OF FISHES COLLECTED FROM UPPER AND LOWER SPAVINAW LAKES, 1952-54

Species		Where Collected		
		Lake		Stream
Scientific Name	Common Name	Upper	Lower	
Notropis rubellus	Rosy Shiner	–	–	x
Notropis zonatus pilsburyi	Bleeding Shiner	x	x	x
Notropis umbratilis	Redfin Shiner	–	–	x
Notropis greeni	Wedgespot Shiner	–	–	x
Notropis camurus	Bluntface Shiner	x	x	x
Notropis lutrensis	Red Shiner	x	x	x
Notropis boops	Pigeye Shiner	x	–	x
Notropis volucellus	Mimic Shiner	–	–	x
Dionda nubila	Ozark Minnow	x	–	x
Pimephales promelas	Fathead Minnow	x	x	x
Pimephales notatus	Bluntnose Minnow	x	x	x
Pimephales vigilax	Parrot Minnow	–	x	x
Pimephales tenellus	Slim Minnow	–	x	x
Campostoma anomalum	Stoneroller	x	x	x
Ictalurus punctatus	Channel Catfish	x	x	x
Ictalurus melas catulus	Southern Black Bullhead	x	x	x
Ictalurus natalis natalis	Northern Yellow Bullhead	x	x	x
Pilodictis olivaris	Flathead Catfish	x	x	–
Noturus exilis	Slender Madtom	x	–	x
Anguilla rostrata [3]	American Eel	–	x	–
Fundulus sciaticus	Plains Topminnow	–	–	x
Fundulus notatus	Blackstripe Topminnow	x	x	x
Fundulus olivaceus	Black Spotted Topminnow	x	–	–
Fundulus catenatus [4]	Common Studfish	–	–	x
Gambusia affinis	Gambusia	x	x	x
Labidesthes sicculus	Brook Silversides	x	x	x
Morone chrysops	White Bass	–	x	–
Micropterus punctulatus	Spotted Bass	x	x	x
Micropterus salmoides	Largemouth Bass	x	x	x
Micropterus dolomieui	Smallmouth Bass	x	–	x
Chaenobryttus coronarius	Warmouth	x	x	x
Lepomis cyanellus	Green Sunfish	x	x	x
Lepomis microlophus	Redear Sunfish	x	x	x
Lepomis megalotis	Longear Sunfish	x	x	x
Lepomis macrochirus	Bluegill	x	x	x
Lepomis humilis	Orangespotted Sunfish	–	–	x
Amblopites rupestris	Rock Bass	x	–	x
Pomoxis annularis	White Crappie	x	x	x
Pomoxis nigromaculatus	Black Crappie	x	x	x
Percina caprodes carbonaria	Southwestern Logperch	x	x	x
Ethostoma saxatile	Speckled Darter	x	–	x
Ethostoma zonale	Banded Darter	x	–	x
Etheostoma blennioides	Greenside Darter	x	–	x
Etheostoma punctulatum	Stippled Darter	x	–	x
Etheostoma spectabile	Orangespot Darter	x	x	x
Etheostoma flabellane	Fantail Darter	x	–	x
Etheostoma microperca	Least Darter	–	–	x
Aplodinotus grunniens	Freshwater Drum	–	x	–
Cottus carolinae	Banded Sculpin	x	–	x
Astyanax fasciatus mexicanus	Mexican Banded Tetra [5]	–	–	–
Eucalia inconstans	Brook Stickleback [5]	–	–	–

1 Five unsuccessful introductions between 1952 and 1956.
2 Very rare, only one specimen of each species taken in six years of sampling.
3 One specimen (total length, 22 inches), was caught on a trotline in Tag Hollow (Figure 1), April, 1953.
4 First authenticated record in Oklahoma. Collected January 22, 1955, by S. W. Jackson, Jr. and Virgil E. Dowell.
5 "Minnow-bucket" introductions which have been observed by author since 1954.

This list of fishes from the two Spavinaw Lakes, and from Spavinaw Creek upstream and downstream from the respective lakes is based on collections made during this study and the field notes of Dr. George A. Moore for 1939 and 1940, and Dr. A. P. Blair for 1948, made on collections from Spavinaw Creek. Collections were made by seines, gill nets, and rotenone at 13 collection stations, six on the Lower Lake and seven on the Upper Lake (Figure 1).

The netting stations in the Lower Lake (Figure 1) were chosen to represent the areas with different ecological conditions; when the stations for the Upper Lake were established, the same plan was followed. The nets were usually set between 4:00 and 5:00 p.m., in water varying in depth from 3 feet to 30 feet, depending on the time of year and the station. The nets were lifted the next morning by 9:00 a.m. The nets were set perpendicular to shore in all cases, and where circumstances permitted, one end of the net was located as near the shore as possible. The nets were set far enough below the surface of the water to prevent tangling with outboard motors. Two stations in the Lower Lake (I and IV, Figure 1) and one station in the Upper Lake (III, Figure 1) were selected for surface sets during the summer of 1954 to determine whether surface sets were more successful than sub-surface sets. Since only three surface sets were made, a valid comparison of surface and sub-surface catches is not possible.

Data were taken from a representative number of all fishes netted, shortly after they were caught, and included: (1) total-lengths in tenths of inches; (2) weights in fourths of ounces; (3) sex; (4) location of collection; and (5) general condition of the fish. Scale samples were placed in standard scale envelopes. Fish seined were placed in 10 percent formalin, and the data recorded included species and locality. Data from many of the fish which were taken during the regular program of rough fish removal have been utilized in this study even though the selectivity of the nets undoubtedly biased the results.

Selectivity of gill nets has been discussed by many workers including Koelz (1926), Pritchard (1926), and Martin (1952). Jenkins (1949) discussed selectivity on the basis of size-frequency and morphological characteristics of the various species captured in Great Salt Plains Reservoir, Oklahoma. Hile (1936) stated: "The action of a net of specified mesh depends first upon the range of lengths and abundance of fish within the population and second upon the morphological characteristics that determine in what manner the fish is held captive."

The seining equipment used included a 25-foot bag seine with ¼-inch mesh and a bag 8 feet deep; a 20 x 4 foot "common-sense" minnow seine with ⅛-inch mesh; and a 10 x 3 foot bobbinet fry seine. Seining sites were selected in the Upper Lake as well as a station in the creek above the lake (Figure 1). Several isolated "pot-holes" were also sampled when the Upper Lake was low. A complete list of species taken in seining samples is given in Table I.

On November 5, 1953, a portion of the Lower Lake was sampled (Jackson, 1956) by the use of 5 percent powdered rotenone and on August 18, 1954, rotenone was applied to a small area (Blackfox Cove) in Upper Spavinaw Lake. The results of the rotenone sample in the Upper Lake were poor, due to a continued dilution in the sample area due to wind action and bottom currents. This sample did not reflect a true picture of the entire lake population, but may have illustrated the status of the sunfishes in the Upper Lake.

Samples (total-lengths, weights, etc.) were taken randomly from the catches of sport fishermen from time to time over the two-year period. This method of sampling provided only limited data, principally from game fishes that were two years old or older. A creel census was initiated on both lakes in September, 1954, but because of the short period of its use, it provided only limited information for this study.

Age and growth histories of the gizzard shad, spotted sucker, largemouth bass, and white crappie of both lakes were determined by scale analysis. I successfully applied the tests for the validity of the scale method, suggested by Hile (1941), and the validity has also been established for these or closely related species by several other workers.

Scales were prepared in the manner employed at the Oklahoma Fishery Research Laboratory (Jenkins, 1953). Since the scales were all taken from the left side of the fish just below the lateral line near the distal portion of the pectoral fin and in line with the origin of the dorsal fin, it was relatively easy to select scales of similar size and shape. The scales were examined under a magnification of 45x with a microprojector similar to that described by Van Oosten, Deason, and Jorbes (1934) and Lagler (1950). After examining four to six scales, one containing the most distinct annuli was selected, and the distances from the focus to each annulus and to the anterior margin were measured along the central radius or a central axis. These measurements were recorded on the back of the scale envelope in which the scales were stored. Calculated growth was determined from these measurements.

The body-scale relationships of the four species discussed here were determined from ungrouped data, sexes combined, and the linear regression best representing these data was determined from the formula $Y = a + bX$. Here, Y represents the total body length (the independent variable); a the intercept of Y when X is zero; and b the slope of the regression line. Both a and b are constants in the formula.

Winsor (1946) indicates that there has been some disagreement among fishery investigators as to which regression should be used. In this study the procedure of Weese (1949) and Wilson (1950) was used. The scale length is the known quantity and the body length is the unknown to be determined from the scale measurement. The accuracy of this method was tested by computing the coefficient of correlation by the use of the formula:

$$r = \frac{\Sigma xy - \frac{\Sigma x \Sigma y}{N}}{\sqrt{\Sigma x^2 - \frac{(\Sigma x)^2}{N} \cdot \Sigma y^2 - \frac{(\Sigma y)^2}{N}}}$$

COMPARISON OF AGE, RATE OF GROWTH AND ABUNDANCE OF FOUR SPECIES OF FISHES FROM LOWER AND UPPER SPAVINAW LAKES

The gizzard shad, spotted sucker, largemouth bass, and white crappie were chosen for comparison of age and growth and abundance in both lakes because they were common to both lakes and pertinent data were easily collected. The gizzard shad was chosen as a representative of the forage fishes, and is the dominant forage species in both lakes. The spotted sucker was chosen as a representative of the rough or coarse fishes because of its great abundance in the Lower Lake and increasing numbers in the Upper Lake. The most important game species in the two lakes are the largemouth bass and white crappie.

Little information was found in the literature relative to a comparative study of two reservoirs on the same stream. Comparative pre- and post-impoundment studies in Oklahoma have been made by the Oklahoma Fishery Research Laboratory on Tenkiller and Fort Gibson Reservoirs (1952, 1953). Pre-impoundment (Hall, 1950) and post-impoundment studies (Latta, 1952) were conducted on Wister Reservoir in east-central Oklahoma. In all three studies, the growth of the fishes after impoundment was superior to the growth prior to impoundment and was primarily attributable to the influence of more abundant food and space, and is typical of expanding fish populations in new lake conditions.

In general, it can be expected that conditions in new reservoirs will produce good growth of the fishes during the first few years of impoundment (Eschmeyer and Jones, 1941; Bennett, 1946). These conditions existed in Upper Spavinaw Lake (Lake Eucha) and growth rates of the fishes examined generally exceeded the growth rates of the established population of the older Lower Lake.

Statewide growth studies of the largemouth bass (Jenkins and Hall, 1953) and of white crappie (Hall, Jenkins, and Finnell, 1954) of Oklahoma provided a basis for comparing the growth of these two species in Upper and Lower Spavinaw Lakes. Because of the lack of a statewide study on the spotted sucker and gizzard shad, growth data on these two species will be compared with those from individual lakes.

Largemouth Bass

Lower Spavinaw Lake. This lake has been renowned for the number and size of largemouth bass it produces. The largest individual recorded from the lake weighed 9 pounds and 6 ounces, and was caught in March, 1952. An 11-year-old fish weighing 8 pounds 12 ounces, was caught in March, 1953. Undoubtedly larger fish have been caught in state waters, but they have not been officially recorded.

In this study 161 largemouth bass were used in determining the body length-scale length relationship and the growth-history. The linear regression equation which best fitted the largemouth of the Lower Lake for total-length on scale radius (ungrouped data and sexes combined) is expressed as $Y = 6.3 + 1.60X$, and the coefficient of correlation is 0.989.

The average calculated total-lengths at the end of each year of life are presented in Table II. Largemouth bass in the Lower Lake attained an average length of 5.5 inches during the first year of life, 9.8 inches by the end of the second year of life, and 12.7 by the end of the third. Thus this species reaches 10 inches (the legal minimum length) during the early part of its third year. Of the largemouth bass included in this sample, 48.8 percent were less than 10 inches long, indicating that slightly more than 50.0 percent of the fish sampled would have been available to the angler. It has been suggested by Bennett (1954) that only 40.0 percent of the available stock can be removed by angling, and then only under exceptional conditions. Based on this assumption, it is probable that under the most ideal conditions, approximately 20 percent of the fish reaching 10 inches, or two and one-half years of age, would be removed by anglers in any one year.

TABLE II

COMPARISON OF THE AVERAGE CALCULATED TOTAL-LENGTHS AT THE END OF EACH YEAR OF LIFE OF LARGEMOUTH BASS, WHITE CRAPPIE, GIZZARD SHAD AND SPOTTED SUCKER FROM UPPER AND LOWER SPAVINAW LAKES, 1952-54

Species	*Reservoir*	*No. of Fish*	*Av. Calculated Total-Length (Inches) End of Year of Life* 1	2	3	4
Largemouth Bass	Upper Spavinaw Lake	144	7.3	12.6	15.2	17.7
Largemouth Bass	Lower Spavinaw Lake	151	5.5	9.8	12.7	15.5
difference in average calculated growth		...	1.8	2.8	2.5	2.2
White Crappie	Upper Spavinaw Lake	140	4.5	9.3	..	..
White Crappie	Lower Spavinaw Lake	460	4.6	8.2	..	..
difference in average calculated growth		...	..	1.1	..	..
Gizzard Shad	Upper Spavinaw Lake	230	7.7	12.1	13.8	..
Gizzard Shad	Lower Spavinaw Lake	274	6.5	8.8	10.4	..
difference in average calculated growth		...	1.2	3.3	3.4	..
Spotted Sucker	Upper Spavinaw Lake	64	6.1	11.3	15.2	16.3
Spotted Sucker	Lower Spavinaw Lake	388	5.1	10.2	12.7	14.7
difference in average calculated growth		...	1.0	1.1	2.5	1.6

The growth of the largemouth bass from Lower Spavinaw Lake is somewhat below the Oklahoma average (Jenkins and Hall, 1953) for the first six years of life, but exceeds that average in the later years of life.

The length-weight relationship of 161 largemouth bass from Lower Spavinaw Lake is expressed by the formula $\text{Log } W = -7.8793 + 3.1855 \text{ Log } L$. A 10-inch bass from the Lower Lake weighs approximately 0.5 pound; and at 12.5 inches, the average weight is 1.0 pound. This agrees closely with the state average (Jenkins and Hall, 1953) of 0.5 pound at 10.1 inches and 1.0 pound at 12.5 inches.

Upper Spavinaw Lake. Phenomenal largemouth bass fishing was experienced by fishermen on Upper Spavinaw Lake (Lake Eucha) in the fall of 1953 and spring of 1954 following impoundment of the reservoir early in 1952. From February to June, 1952, 150,000 fingerling bass (4-6 inches) were released in the Upper Lake. An estimate based on the numbers of bass 10 inches or longer taken by fishermen in rental boats from August 15, 1953, through September, 1953, indicated that the average catch per fisherman-day was five fish. The average number of fishermen per boat was two. Therefore, a total of 14,000 legal bass were taken during the 4-week period. This estimate does not include the bass caught by bank fishermen and fishermen in private boats. A continual creel-census was initiated on the Spavinaw Lakes in September, 1954, which sampled the catches of all types of fishermen. The largemouth bass continued to be the predominant species caught by anglers until May, 1955, when the last data used here were taken.

In the determination of the body length-scale length relationship of Upper Spavinaw Lake (Lake Eucha) largemouth bass, 174 fish were used. The linear regression equation which best fitted the largemouth bass of the Upper Lake for total-lengths on scale radius (ungrouped data and sexes combined is expressed as $Y = 34.3 + 1.44X$, and the coefficient of correlation is 0.986.

The phenomenon of accelerated growth by largemouth bass in new impoundments has been noted by Bennett (1948), Stroud (1948), and Jenkins and Hall (1953), and was evident in Upper Spavinaw Lake. Largemouth bass taken during the first year of impoundment (1952) exhibited very good growth and young-of-year were taken up to 10.8 inches in length during the first winter. However, fish of the same year-class taken from December, 1953, to February, 1954, showed only an average calculated growth of 6.9 inches, for the first year of life. It is difficult to explain this descrepancy between actual and calculated growth for 1952. It is possible that the natural mortality for the fast-growing fish may be greater, and it is probable that the rate of harvest for faster growing fish is higher.

Based on the combined sample at the end of 1954 (Table II), the average growth at the end of the first year of life was 7.3 inches, and 12.6 inches at the end of the second year of life, indicating that the largemouth bass in the Upper Lake reached 10 inches in the middle of their second year. Growth from Upper Spavinaw Lake compares favorably with the statewide average for new impoundments over 500 acres (Jenkins and Hall, 1953).

The length-weight relationship of 174 Upper Lake largemouth bass is described by the formula $\text{Log } W = -7.0289 + 3.2098 \text{ Log } L$. The average weight of a 10.0 inch bass from the Upper Lake is approximately 0.5 pound and approximately 1.0 pound at 12.5 inches. This agrees with the statewide average (Jenkins and Hall, 1953).

Comparison of Growth Rates of Upper and Lower Spavinaw Lakes. Largemouth bass in Upper Spavinaw Lake reached a length of 10 inches in the middle of their second year of life, while those of the Lower Lake did not attain 10 inches until the middle of the third year of life (Table II).

The average condition index (C factor based on total-length) of 162 Upper Spavinaw Lake largemouth bass between 5.0 inches and 17.5 inches was 49.5 as compared to 49.6 for 151 fish of the same length-range from the Lower Lake. Although the bass in the Upper Lake have a faster rate of growth, the ratio between length and weight in this length-range in both lakes coincide. These condition indexes compare favorably with the statewide averages (Jenkins and Hall, 1953). Based on Bennett's (1937) classification of condition index for Illinois, the largemouth bass of both Spavinaw Lakes fall into the range of 46.0 to 55.0 C(TL). Bennett expresses 56.0 to 65.0 C(TL) as reflecting good condition.

WHITE CRAPPIE

Lower Spavinaw Lake. The white crappie is probably the most abundant and popular game fish in Lower Spavinaw Lake. It has consistently remained the dominant species in the fisherman's catch. The best time for crappie fishing on the Lower Lake is in the spring when the fish move from winter concentrations in deeper water to the spawning areas in the shallower water. Fishing is good during late summer and early fall around brush shelters and good to excellent catches are made during the winter months in deep water in the vicinity of the dam.

A pronounced drop in the water level of the Lower Lake which persisted from 1951 through 1953 produced environmental alterations which seem to have retarded the growth of white crappie to a marked degree. The lake level was lowered eight feet during the latter part of 1951 and early 1952, to allow the installation of a new flow line at the Lower Spavinaw Lake Dam. Spring rains only partially refilled the lake during the 1952 spawning (April-May) season. The construction of the Upper Lake dam was completed at this time, and water that normally entered the Lower Lake was held in the new lake. Due to the impounding of the Upper Lake and lack of abundant rainfall in the spring of 1953, the Lower Lake level fell rapidly during the normal spawning periods of the forage fishes. Receding water at this critical time evidently reduced the forage crop since very few young-of-year were found in the rotenone sample conducted in the fall of 1953. Water was released from the Upper Lake in the spring of 1954 during the spawning season, a successful spawn occurred, and growth during the year was excellent. The 1951 year-class lagged a full year's growth behind the average rate of growth during a ten-year period, 1944 through 1954, following the prolonged draw-down (Table III).

TABLE III

COMPARISON OF GROWTH OF LOWER SPAVINAW LAKE WHITE CRAPPIE OF THE 1951 YEAR-CLASS WITH AVERAGE GROWTH FROM 1944 THROUGH 1954

	Average Calculated Length at End of Year of Life			
	1	*2*	*3*	*4*
1951 Year-Class	4.6	7.6	8.2	10.8
Average Growth, 1944 through 1954, Exclusive of 1951 Year-Class	4.6	8.2	10.2	12.3

In the determination of the body length-scale length relationship of white crappie of the Lower Lake, 460 fish were used. The linear regression equation which best fitted the white crappie of the Lower Lake for total-length on scale radius (ungrouped data and sexes combined) is expressed as $Y = 84.5 + 1.12X$. The coefficient of correlation is 0.837.

White crappie of the Lower Lake attained an average calculated length of 4.6 inches during the first year of life, 8.2 inches by the end of the second, and 9.4, 11.3, and 13.2 inches by the end of the third, fourth, and fifth years respectively (Table II). Hall, Jenkins and Finnell (1954) stated that crappie must reach eight inches in three years and 10 inches in four years to provide good fishing in Oklahoma. The white crappie of the Lower Lake fulfill this requirement, and attain a length of 8.0 inches by the end of the second year of life, and 11.3 inches by the end of the fourth year. The growth of the white crappie from the Lower Lake is somewhat faster than the state average of 3.3 inches during the first year of life, 6.9 inches by the end of the second, and 8.2, 11.9 and 12.9 inches by the end of the third, fourth, and fifth years respectively (Hall, Jenkins and Finnell, 1954).

The length-weight relationship of 478 Lower Spavinaw Lake white crappie is expressed by the formula $\text{Log } W = -8.7274 + 3.4690 \text{ Log } L$. A Lower Lake white crappie 10.2 inches in total-length weighed approximately 0.5 pound and the fish attained an average weight of 1.0 pound at 12.4 inches. This agrees closely with the state average (Hall, Jenkins and Finnell, 1954) of 0.516 pound at 10.0 inches and 0.953 pound at 12.0 inches.

Upper Spavinaw Lake. A total of 10,000 white and black crappie (3 to 7 inches, total-length) were released in Spavinaw Creek above the dam site in the fall of 1951. This was the only stocking of white crappie, although the species occurred in the stream at the time of impoundment and possibly in small ponds which were covered by the rising water. Very few white crappie appeared in gill-net collections until January, 1954, when nine individuals were taken near the dam. The rest of the sample was taken after this date, predominantly during the summer of 1954. The 1954 collection contained mostly 2-year-old fish.

The white crappie sample from the Upper Lake displays an irregular growth pattern. The nine yearling fish taken in January, 1954, from the area near the dam averaged 7.4 inches, but fish of the same year class (1953) taken near Dry Creek Arm in August and September, 1954, averaged only 4.4 inches. Two individuals taken in July, 1954 (1952 year-class), indicated a growth of 9.5 inches in 1952 and by the time of the annulus formation in 1954, these fish had reached a total-length of 12.7 inches.

In this study 140 white crappie were used in the determination of the body length-scale length relationships. The linear regression equation which best fitted the white crappie of the Upper Lake for total-length on scale radius (ungrouped data and sexes combined) may be expressed as $Y = 48.7 + 1.29X$. The coefficient of correlation was 0.958, indicating close agreement of the data.

White crappie of the Upper Lake attained an average growth of 4.5 inches during the first year of life, and 9.3 inches by the end of the second year of life (Table II). This closely approximates the averages of 5.1 inches during the first year of life and 9.3 inches the second year, presented by Hall, Jenkins and Finnell (1954) for Oklahoma reservoirs four years old or less.

The length-weight relationship of 140 Upper Spavinaw Lake white crappie is expressed by the formula $\text{Log } W = -8.1679 + 3.2845 \text{ Log } L$. A Upper Lake white crappie 10.1 inches in total-length weighed approximately 0.5 pounds; at 12.4 inches the fish attained an average weight of 1.0 pound, which agrees with the state average (Hall, Jenkins and Finnell, 1954).

Comparison of Growth Rates of Upper and Lower Spavinaw Lakes. White crappie of Upper Spavinaw Lake reached eight inches early in their second year of life, while those of the Lower Lake did not attain 8.0 inches until the end of the second year of life (Table II). This indicates that conditions in the new lake were more conducive to rapid growth than were conditions which existed in the older Lower Lake. Average lengths in the Upper Lake were 4.5 inches and 9.3 inches at the end of the first and second years of life respectively. In the Lower Lake, average lengths were 4.6 inches and 8.2 inches at the end of the first and second year of life, respectively. The difference in first year growth of white crappie from the Upper and Lower Lakes was not as great as might be expected, considering the difference in the ages of the lakes. The second year growth differences is more typical of comparative old and new reservoir growth rates. The growth of the Upper and Lower Lake white crappie is well above the Oklahoma average (Hall, Jenkins and Finnell, 1954) of 2.9 inches and 5.9 inches the first and second year of life, respectively. The growth pattern of both Lower and Upper Lake white crappie compares favorably with that of white crappie sampled from new reservoirs in Oklahoma.

The average condition index of 47.3 C(TL) for the Lower Lake white crappie is slightly higher than the index of 45.1 for the fish from the Upper Lake, and is due to a greater representation of large fish in the Lower Lake sample. The conditions indexes of these two lakes compare favorably with the state average of 46.7 (Hall, Jenkins and Finnell, 1954) but are below the average condition index of 50.0 established for Ohio waters by Roach (1941).

GIZZARD SHAD

Lower Spavinaw Lake. The gizzard shad was the most abundant species in Lower Spavinaw Lake (Table IV), representing 71.9 percent of all fish in the sample. Although gill-netting samples indicated that this species was second in abundance, it outnumbered all species combined (90 percent by number, 78.5 percent by weight) in the Black Hollow rotenone sample (Jackson, 1956). The gizzard shad has been found to be dominant in other Oklahoma reservoirs, including Grand Lake (Thompson, 1950; Jenkins, 1953) and Claremore Lake (Jenkins, 1951), two impoundments in northeastern Oklahoma within 40 miles of the Spavinaw Lakes.

The number of gizzard shad used in this study of the body length-scale length relationship was 274. The linear regression equation which best fitted Lower Lake individuals for total-length on scale radius (ungrouped data and sexes combined) is expressed as $Y = 48.8 + 1.05X$. The coefficient of correlations is 0.990.

Lower Spavinaw Lake gizzard shad attained an average calculated total-length of 6.5 inches at the end of the first year of life, and 8.8 inches by the end of the second year of life and 10.4, 11.7, and 12.8 inches by the end of the third, fourth, and fifth years respectively (Table II). The fast rate of growth

TABLE IV

RELATIVE PERCENTAGES OF FOUR SPECIES OF FISH APPEARING IN THE TOTAL SAMPLE FROM LOWER AND UPPER SPAVINAW LAKE, 1952-1954

Reservoir	*Species*	*No of Fish in Sample*	*Percent of Total Sample*
Lower Spavinaw Lake:	Gizzard Shad	16,709	71.9
	Spotted Sucker	2,952	12.7
	White Crappie	570	2.4
	Largemouth Bass	528	2.3
	Others	2,474	10.7
Upper Spavinaw Lake:	Gizzard Shad	1,589	39.8
	Largemouth Bass	162	4.0
	White Crappie	145	3.6
	Spotted Sucker	92	2.3
	Others *	2,017	50.3

* Composed mostly of black bullheads, which were very susceptible to gill-net capture. The black bullhead composed 41.9 percent of the total sample; however, I feel that this is biased because of their susceptibility to gill-nets.

in the first year renders this species unavailable as forage to all but the largest predators after the first summer of life.

The 1953 year-class was greatly reduced and was outnumbered by yearling fish (1952 year-class) in a fall, 1953, rotenone sample. This was possibly due to increased predation by largemouth bass, white bass, channel catfish, and crappie, made possible by concentration of the population due to extreme low water—a condition which did not exist during 1952. Jenkins (1953), attributed a similar situation in Grand Lake, Oklahoma, to low water levels and poor spawning conditions.

The length-weight relationship of 274 Lower Spavinaw Lake gizzard shad is expressed by the formula Log W = -7.5567 + 3.025 Log L. A Lower Lake gizzard shad weighing 0.5 pound has an average total-length of 11.5 inches, and a fish weighing 1.0 pound would have an average total-length of 14.5 inches. In the Lower Lake this species loses its usefulness as a forage fish after the first year of life at a weight of 0.09 pound (approximately 1½ ounces).

Upper Spavinaw Lake. The gizzard shad was the second most abundant species sampled in the Upper Lake, representing 39.8 percent of the total number removed by gill-netting, trapping, and rotenone (Table IV). Shad were outnumbered in the collections only by black bullheads which represented 41.9 percent of the sample.

Growth of the 1952 year-class was very poor in 1954, possibly because of extreme intra-year class competition. The scales indicated that annulus formulation took place from July 10, through September, 1954, and some individuals showed only slight cutting over in the anterior field of the scale as late as November, 1954. Annuli were apparent on most scales in the December collections. This lack of growth was not apparent in the 1951 and 1953 year-classes, so it is assumed that intra-year class competition was an important factor in the reduction of growth.

The body-scale relationship of 244 Upper Spavinaw Lake gizzard shad utilized in this study is described by the formula Y = 38.1 + 1.19X. This represents the linear regression equation which best fitted the gizzard shad of the Upper Lake for total-length on scale radius (ungrouped data and sexes combined). The coefficient of correlation is 0.972, indicating good agreement in the data presented.

Upper Spavinaw gizzard shad attained an average growth of 7.7 inches by the end of the first year of life, 12.1 inches by the end of the second year, and 17.2 inches by the end of the third year (Table II). As in the case of the Lower Lake gizzard shad, this rapid growth made this species ineffective as a forage fish by the end of the first year of life.

The length-weight relationship of 244 Upper Lake gizzard shad is expressed by the formula Log W = -7.7115 + 3.086 Log L. Upper Lake shad average 0.5 pound at a total-length of 11.2 inches and 1.0 pound at 14.0 inches.

Comparison of Growth Rates of Upper and Lower Spavinaw Lakes. Gizzard shad in the Lower Lake reached an average total-length of 6.5 inches at the end of the first year of life, and in the Upper Lake attained a total-length of 7.7 inches (Table II). The more rapid growth in the Upper Lake again indicated that conditions in the new lake were more conducive to rapid growth of this species than were those in the older lake.

Very little is known concerning the effect of large shad populations upon other species of fishes, but studies conducted by the Oklahoma Fishery Research Laboratory (Jenkins, 1956) indicates that the presence of a large shad population has a depressing effect on the growth and condition of sunfishes and crappies. Both Upper and Lower Spavinaw Lakes apparently would benefit by some control on this species.

The condition index of 244 of the faster growing Upper Lake gizzard shad was 34.6, as compared to 32.9 for the slower-growing individuals (274) in the Lower Lake. These condition indexes approximate that of 32.3 for the gizzard shad which Dr. Hunter Hancock (unpublished) found in Ft. Gibson Reservoir, a reservoir 25 miles southwest of Upper and Lower Spavinaw Lakes. The average condition indexes for Upper and Lower Spavinaw Lakes are well below the average condition index of 40.0 as determined for Ohio waters by Roach (1949).

Spotted Sucker

Few studies have been published on the age and growth of the spotted sucker, *Minytrema melanops.* Eddy and Carlander (1942), in their growth studies of Minnesota fishes, mentioned this species, as did Hall and Jenkins (1953), in a report on Tenkiller Reservoir, Oklahoma. Latta (1952) presented data on the validity of the scale method for this species and measured the distance from the focus to the dorsal rather than the anterior edge of the scale. Spoor (1938) used this method of measurement on a similar species, the white sucker, in calculating its growth. However, the anterior radius was used in this study.

The spotted sucker is common in the lakes of northeastern and east-central Oklahoma, and is usually one of the more common species when present, especially if a component of an older population.

Spotted suckers from the Spavinaw Lakes made annual spawning migrations up Spavinaw Creek, starting from the deeper waters and moving into the stream in great numbers, where they are quite vulnerable to netting and gigging. The migration in Lower Spavinaw Lake begins late in January and early February and continues until the spawning activity is over, usually by the end of May. By late December, the males develop tubercles on the snout, and by the end of February the tubercles are well developed. The spawning period, based on personal observations of individuals taken in gill-netting operations, is from the last week in April through May. Examination of ovaries showed that in mature females the eggs had begun to separate as early as April 11, in 1952. Nearly all females observed after May 30 were spent. Residual eggs were always present in spent females.

I have observed spawning of spotted suckers on riffles above larger pools in Spavinaw Creek, where the water temperature ranged from 59° F. to 65° F. In many cases spawning occurred after dark. The eggs hatch from 7 to 12 days, depending upon the water temperature, and are apparently untended after spawning is completed.

The relatively fast growth of this species makes it unavailable as a forage fish by the end of the first summer of life. Only the larger game fish and flathead catfish can utilize this species effectively as food. Since it is not harvested by hook and line fishermen, removal by netting is an established management procedure. Only four fish in the entire sample of 388 fish were five years old. Since most of the specimens examined were mature by their third year of life (Age-group II), it is assumed that this first does not spawn more than three times.

Lower Spavinaw Lake. The spotted sucker was the second most abundant species in Lower Spavinaw Lake collections (Table IV), representing 12.7 percent of the total sample. Based on local reports, this species has become the dominant catostomid fish since the impoundment of the lake. Redhorses, *Moxostoma* spp., were the dominant suckers in the stream before the lake was impounded.

The body length-scale length relationship was determined from 388 spotted suckers. The linear regression equation which best fitted this species from the Lower Lake for total-length on scale radius (ungrouped data and sexes combined) may be expressed as $Y = 32.0 + 1.13X$. The coefficient of correlation was 0.932. The greatest deviation occurred at either end of the length range where the number of individuals sampled was small.

The spotted sucker from Lower Spavinaw Lake attained an average calculated total-length of 5.1 inches at the end of the first year of life, 10.2 inches by the end of the second year of life, and 12.7, 14.7, and 16.5 inches by the end of the third, fourth, and fifth years of life, respectively (Table II). This species is harvested only during the spring migration run when it is gigged or speared by local residents.

The length-weight relationship of 388 fish from Lower Spavinaw Lake is expressed by the formula $\text{Log } W = -8.7156 + 3.3412 \text{ Log } L$. A Lower Lake spotted sucker weighing 0.5 pound had an average total-length of 10.7 inches, and one weighing 1.0 pound had an average total-length of 13.7 inches. The largest individual recorded from the Lower Lake was 17.1 inches in total-length and weighed 2.13 pounds.

Upper Spavinaw Lake. Spotted suckers from Upper Spavinaw Lake exhibited rapid growth after impoundment, following the general growth pattern in new reservoirs. The increase in abundance of this species from 1952 to 1954 was indicated by its greater occurrence in gill-netting collections.

The body-scale relationship of 64 Upper Spavinaw Lake spotted suckers utilized in this study is described by the formula $Y = 49.7 + 1.07X$. This represents the linear regression equation which best fitted the spotted sucker of the Upper Lake for total-length on scale radius (ungrouped data and sexes combined). The coefficient of correlation was 0.967.

In Upper Spavinaw Lake the spotted sucker attained a total-length of approximately 6.1 inches the first year of life, 11.3 inches by the end of the second year, and 13.3, 16.1, and 17.3 inches by the end of the third, fourth, and fifth years respectively (Table II).

The length-weight relationship of 64 Upper Spavinaw Lake spotted suckers is expsessed by the formula $\text{Log } W = -8.403 + 3.3390 \text{ Log } L$. Computations were made in the same manner as others in this study. An Upper Lake spotted sucker with an average weight of 0.5 pound had an average total-length of 10.6 inches; at an average weight of 1.0 pound, the calculated length was 13.0 inches.

Comparison of Growth Rates of Both Upper and Lower Spavinaw Lakes. Very little information is available for comparison of growth of spotted suckers in Oklahoma waters. Latta (1952), in his post-impoundment study of Wister Reservoir in east-central Oklahoma examined 78 individuals, and the Oklahoma Fishery Research Laboratory (unpublished data) determined the age of 30 specimens from Greenleaf Lake in northeast Oklahoma. Comparison of Upper Spavinaw Lake and Greenleaf Lake spotted suckers indicates similar growth patterns. Both exceed the growth in later years of life of the fish from Wister Reservoir and Lower Spavinaw Lake.

A search of the literature did not reveal other comparable information on the spotted sucker. I assume that the fish in age-group V for both lakes are among the largest recorded in the literature. One fish taken on July 13, 1954, was 18.2 inches in total-length and weighed 3.0 pounds; another individual taken August 18, 1954, was 18.2 inches in total-length and weighed 2.74 pounds. Both individuals were females and were taken in the area where Spavinaw Creek enters Upper Spavinaw Lake.

In the Upper Lake spotted suckers reached a total-length of 6.1 inches at the end of the first year of life, one inch more than the growth of the spotted sucker in the Lower Lake (Table II). The Lower Lake population compares favorably with the other studies in Oklahoma, but is below the growth rate of the Upper Lake. The Upper Lake population displays the fastest growth of any of the Oklahoma studies.

Spotted suckers represented 12.7 percent of the total collection from the Lower Lake, and only 2.3 percent of the Upper Lake collection (Table IV). It is probable that this species will become relatively more abundant in the population in the Upper Lake. Based on local reports of the numbers of this species in the Lower Lake when it was first impounded, and its prominence in the present population sample, it can be assumed that the spotted sucker in the Upper Lake will eventually become the dominant catostomid fish, replacing to a great extent the present redhorse population.

The condition index C(TL) for the Upper Lake spotted sucker, 44.7, was higher than the 41.1 for the Lower Lake fish. I found no comparable information on condition index of this species from other lakes.

CONCLUSIONS

The data presented here indicate that the rates of growth of the four species studied were substantially faster in the new reservoir, Upper Spavinaw Lake (Lake Eucha), impounded in 1952, than in the old reservoir, Lower Spavinaw Lake, impounded in 1923. These data substantiate the premise that environmental conditions created by impoundments during the initial years of inundation are more conducive to rapid fish growth than are the conditions which exist in older reservoirs where the fish populations have been longer established. Contributing to this conclusion is the fact that after a prolonged low level of water in the Lower Lake, the growth rates of the species studied increased when the lake was again filled to near normal level in 1954. The prolonged low level of Lower Spavinaw Lake (1951-1953) resulted in a definite retardation of growth of the white crappie during the 1953 growing season (Figures 2 and 3; Table III). There was a definite recovery of growth during the 1954 growing season after the lake level was raised.

Based on the total collections from the two lakes, the fish populations differed considerably, both in species composition and percentages of the population which each species common to both lakes comprised (Table IV). An outstanding difference was the large population of gizzard shad in the old lake (71.9 percent of the total sample) compared with that in the new lake (39.8 percent).

White bass and freshwater drum were recorded from the Lower Lake in considerable numbers but were not collected from the upper reservoir. Black bullheads were very abundant in the new reservoir, but only two individuals were taken in the old lake. Largemouth bass and white crappie were represented by higher percentages of the total sample in the new reservoir than in the old.

From observations on the Upper Lake shortly after impoundment, a very successful spawn of largemouth bass occurred during the first and second years. After the prolonged low lake level and subsequent refilling of the Lower Lake, it was noted that a large spawn also occurred. It would appear from these observations that lowering the water level in the fall of the year and gradually raising it after the time of spawning is beneficial to largemouth reproduction.

Based on reports of local residents who have lived in the area since before the Lower Lake was impounded, it would appear that Upper Spavinaw Lake is going through ecological changes similar to those which the Lower Lake underwent as a new reservoir. It appears that large predators, primarily largemouth bass, dominate the population in the early years of impoundment, but are unable to maintain their prominence in the population, and eventually reach a level where there are no material fluctuations unless some environmental alteration such as marked draw-down and refilling takes place.

The stocking of largemouth bass in the lower reservoir for 12 years (Aldrich, 1943) did not materially influence the decline of this species or increase its appearance in the creel. Therefore, stocking largemouth bass in the Lower Lake or subsequently in the Upper Lake would not be a worthwhile management practice.

Future management projects on these reservoirs should incorporate measures to reproduce conditions similar to "new lake" conditions. Based on the findings in this study, controlled water-level fluctuation appears to be the most feasible; particularily in situations such as Lower Spavinaw Lake, where control is possible. The higher predator species composition which accompanies this condition is a factor not to be overlooked.

SUMMARY

1. A study was made of the growth rates of fishes from two reservoirs located on the same mainstream in northeastern Oklahoma; one an old reservoir (Lower Spavinaw Lake; impounded 31 years), and the other a new reservoir (Upper Spavinaw Lake; impounded two years).

2. Four species of fishes from each lake were selected for study; the large-mouth bass as a representative predator or game species, the white crappie as a representative pan fish, the gizzard shad as a forage species, and the spotted sucker as a rough or coarse fish.

3. Sixty-seven species of fish have been recorded from that part of the Spavinaw Creek upstream from the dam of the Lower Lake.

4. Gill-nets, rotenone, seines, and wire traps were used for collecting.

5. The growth rates of four species studied in the Upper Lake were faster than those of the same species from the older Lower Lake.

6. Rapid growth of the fishes occurred in the new impoundment in the first two years of impoundment, but appeared to decline as the reservoir became older.

7. Prolonged draw-down of the Lower Lake during 1951-1953, apparently retarded growth during the 1953 growing season. Substantial increases in growth were noted in most species following a return to normal water level in 1954.

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PRELIMINARY EXPERIMENTS ON WINTER FEEDING SMALL FATHEAD MINNOWS

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The fathead (*Pimephales promelas*) is a very popular bait minnow, especially among crappie fishermen, and, therefore, has been raised extensively by commercial minnow producers during the last 10 years. Fatheads weighing four pounds or more per thousand are preferred as bait for bass; however, minnows weighing 2.5 to 3.0 pounds per thousand are acceptable for use as bait for crappie. Fatheads smaller than these sizes are not generally salable.

The fathead lays eggs periodically from early spring until the water temperature drops below 60 to 65° F. in the fall. As a result a large proportion of the total number of minnows produced is too small for sale when the rearing ponds are drained. In experiments conducted at Auburn, Alabama, over the past 10 years, 20 to 40 percent of all fatheads produced in fertilized rearing ponds that were stocked in January had not reached a useable size by the end of the year. Even in experiments where supplemental feeds were added to ponds during the fall and winter before draining, approximately 15 percent of the minnows failed to reach a salable size within one year.

Fathead minnows are in demand principally during the period of February to May. Consequently, the bulk of the crop must be raised to a suitable size for late winter and early spring sales. Therefore, it appeared necessary to drain the ponds during late fall or in the winter, store or sell those of desirable size,