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I am submitting herewith a thesis written by Robert Parker Smith entitled "A Growth Comparison of Two Subspecies of Largemouth Bass in Tennessee Farm Ponds." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Wildlife and Fisheries Science.

J. Larry Wilson

J. Larry Wilson, Major Professor

We have read this thesis
and recommend its acceptance:

David S. Edwin

Gary D. Carter

Accepted for the Council:

Hilton A. Smith

Vice Chancellor
Graduate Studies and Research

Ag-VetMed
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# A GROWTH COMPARISON OF TWO SUBSPECIES OF LARGEMOUTH BASS IN TENNESSEE FARM PONDS

A Thesis

Presented for the

Master of Science

Degree

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Robert Parker Smith

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## ABSTRACT

A study was conducted to determine if any growth rate differences occurred between two subspecies of largemouth bass. Two ponds near Lenoir City, Tennessee, were partitioned into equal halves by a nylon fish barrier. Northern strain fingerlings, Micropterus salmoides salmoides (Lacepede), were stocked in one side of each pond and Florida bass, Micropterus salmoides floridanus (Lesueur), in the other sides. Micropterus salmoides salmoides showed a significantly faster rate of growth (1 percent level) than M. s. floridanus. Mean coefficients of condition (K) and specific growth rates (G) were consistently higher for M. s. salmoides during the five-month study. Since the subspecies were grown in the same water under apparently similar environmental conditions but separated by a barrier, growth differences observed from the fingerling stage to five months of age were thought to be genetic in nature.

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# CHAPTER I

## INTRODUCTION

Few species of fish have provided as popular and dependable sport fisheries as the largemouth bass, Micropterus salmoides (Lacepede). Still fewer have the proven potential for intensive management within natural and man-made waters. Consequently, a keen interest in the largemouth is shared by the angler and fishery biologist alike. It seems fitting, therefore, to augment our current knowledge of largemouth bass management with further studies that may serve to guide researchers to the optimum usage of America's most popular warmwater game fish.

Because of its growth capacity as related to the other blackbasses, the largemouth has received considerable attention from fishery management and related fields (Bryan, 1964; Clugston, 1964; Bottroff, 1967; Robbins and MacCrimmon, 1974; and Thrasher, 1974). Results from length-weight studies within its native range show the general trend is for shortest mean total lengths in colder waters, and longest lengths in warmer waters. Weight follows a similar trend (Robbins and MacCrimmon, 1974).

Two subspecies of largemouth bass are known to exist. The Florida subspecies, Micropterus salmoides floridanus (Lesueur), has a restricted natural range and differs from

the more widely distributed northern form, M. s. salmoides (Lacepede) in coloration, size and number of scales (Buchanan, 1968 and Thrasher, 1974), and a larger maximum size (Bailey and Hubbs, 1949). Within its natural range, the Florida bass (hereafter referred to as floridanus) often attains a weight of 14 to 16 lbs., and occasionally an individual will exceed the 20 lbs. (Buchanan, 1968). The northern largemouth (hereafter referred to as salmoides) rarely reaches 12 lbs. (Gresham, 1966).

In recent years the fact that floridanus attains a consistently larger size on the average than does salmoides has come to the attention of fishery biologists as well as bass angling organizations. In the interest of possibly increasing the genetic potential for size, several states have started stocking programs for the introduction of floridanus with varying degrees of success. Only six years after the introduction of floridanus in California waters in 1959, a new state record was established. The record was broken five more times in the next ten years, and now stands with a 20 lb., 15 oz. (9 kg., 425 gm.) fish caught in Lake Miramar, San Diego County, in 1973 (Thrasher, 1974). As a result of the successful stocking program in California, other states began to follow suit. Graham (1973) reported high mortality among floridanus and superior overall growth by salmoides when the subspecies were compared in Missouri ponds. Working in Florida, Clugston (1964) concluded,

"There is very little evidence to indicate that the southern subspecies of largemouth bass is genetically superior to the northern form as far as growth is concerned." In an Alabama study, Thrasher (1974) concluded that no genetic differences in growth potential seem to exist, but that there appears to be a significant difference in catchability between the two subspecies, with floridanus being the most difficult to catch. Another study in southern Alabama by Addison and Spencer (1971) showed fastest growth from salmoides X floridanus hybrids.

The primary objective of this study was to compare growth rates of the two subspecies in Tennessee ponds under as similar conditions as possible. It is hoped that the results of such a study can be of some aid in arriving at a rational decision concerning the future of floridanus introductions in Tennessee.

# CHAPTER II

## LITERATURE REVIEW

Much has been written on the largemouth bass as evidenced by the publication of an indexed bibliography (Heidinger, 1974). For this study comments will be confined to matters of growth and to certain sport fishery related aspects such as catchability. Major emphasis is placed on floridanus introductions and floridanus - salmoides interactions and comparisons.

### Growth

There is some disagreement as to the relative importance of the environment as opposed to genetic influence in attempting to explain growth rate differences between the two subspecies. Bailey and Hubbs (1949) attributed fast growth of floridanus to the long growing season in peninsular Florida. Bennett (1962) stated that in the production of fish above average size, a large source of available food per individual fish is more important than length of the growing season. Buss (1965) said that growth rates of largemouth bass vary with environmental circumstances, and that the environment, not heredity, is the factor which serves to explain the large size attained by floridanus. Sasaki (1961) indicated that environmental conditions were more important than genetic differences in determining

growth rates. He reported no significant differences in growth rates of floridanus and salmoides stocked in California.

Davies (1973) compared first year growth differences in floridanus, salmoides, and their $F_1$ hybrids under similar water conditions where forage (quantity and quality) could be controlled. He reported that salmoides grew faster than floridanus with the hybrids being intermediate in size between the two. Davies concluded that this variation in growth should be considered genetic in nature, since the environment was kept reasonably constant.

Clugston (1964) made one of the first growth rate comparisons of the subspecies. A major objective of his study was to determine whether or not floridanus and salmoides would show differences in growth rate when grown under similar circumstances in Florida, where temperatures are suitable for growth during the entire year. Although both subspecies grew fast in the study ponds, Clugston reported the fastest growth from one of the salmoides ponds. The marked decline in growth of salmoides during the winter months which is characteristic of salmoides in northern habitats was lacking in the Florida ponds. He also found that salmoides grew faster than floridanus during the first few months after stocking.

Addison and Spencer (1971) compared floridanus, salmoides, and their hybrids in 21 south Alabama ponds.

Again, a major objective was to determine which of the three strains grew fastest and/or largest during the 27 month study period. Although they claim their data are rather inconclusive due to vast dissimilarities in the study ponds, they found the fastest growth observed was that of the hybrids.

Graham (1973) evaluated fish growth in some Missouri ponds stocked with floridanus and others with floridanus and and salmoides stocked together. Because he experienced high mortality among floridanus, the validity of growth measurements was influenced by the differential mortality of the two subspecies. He found, however, that after two years the best overall bass growth was made by salmoides in ponds stocked with both subspecies.

In a meristic comparison of the two subspecies in California reservoirs, Bottroff (1967) reported and interesting phenomenon involving mixed populations of bass that had reached reproductive ages. There seemed to be an introgression of floridanus over salmoides. When relatively small numbers of floridanus were stocked in reservoirs containing established salmoides populations, complete intergradation would occur in three years. Bottroff offered a speculative explanation that keys on spawning times for the subspecies. Since floridanus does spawn slightly earlier (with some overlap) than salmoides, the fry produced in a mixed population by these early spawners would be primarily hybrids with some pure-strain floridanus present. These

fry would have a selective advantage over those produced in the latter half of the spawning season (principally hybrids and salmoides) in that they would be larger and would prey heavily on smaller fry produced a month or two later. In the following years intergrades (and the few floridanus x floridanus progeny) would have the advantage. Eventually intergrades would compose a majority of the spawning bass, the original pure subspecies having been eliminated by fishing pressures and/or natural mortality.

## Catchability

There seems to be definitive evidence to show that floridanus is a more difficult largemouth to catch than salmoides. In a study conducted in California, Smith (1971) marked 700 floridanus and 700 salmoides and released them in a reservoir. In two years 43.2 percent of the salmoides were boated by anglers as opposed to 17.1 percent of the Florida subspecies. In a follow-up study, 1,000 of each subspecies were tagged and released plus 600 $F_1$ hybrid bass, and the catch rates were 53 percent for salmoides, 20 percent for floridanus, and 37 percent for the $F_1$ hybrids. It is important to note that Smith does not give mortality figures, thus previously reported differential mortality between the two subspecies may be reflected in these catch rates.

# CHAPTER III

## MATERIALS AND METHODS

Two ponds located in the Hines Valley area near Lenoir City, Tennessee, were utilized for the study. The ponds had formerly been used for commercial catfish production by Harrison Poultry Farms. They were arranged in a stair-step fashion and were equipped with standpipes and six inch drains. The upper pond (Pond A) was 0.54 ha (1.34 acres) and the lower pond (Pond B) was 0.47 ha (1.15 acres). These measurements were taken while the ponds were completely full with winter rains and spilling water out the emergency spillways. Water level in the ponds was determined entirely by runoff from a pasture watershed.

### Barrier Construction

The ponds were secured in January, 1974 and preparations for the study began shortly thereafter. It was planned to construct fish barriers bisecting each pond, thus converting the two ponds into four sections. Pond B was drained and the bottom allowed to dry. A line was taken across the shortest distance of the pond that would divide it into equal halves with approximately the same amount of shallow and deep areas per side. The barrier line went from the center of the levee on Pond B to the center

of the Pond A levee, and was 65.9 m in length. Metal poles were sunk into the pond bottom at 10 m intervals to lend vertical support to the nylon fish barrier. A 0.7 m extension of these poles above the water line was deemed adequate to prevent mixing of the subspecies by individuals jumping the barrier. Two steel cables were stretched along the poles and anchored into the levee at each end to provide horizontal support for the mesh netting. With poles firmly positioned and cables stretched, the next step was to hang the barrier itself. A single piece of 6 mm mesh nylon seine material which measured 70 m in length and 3 m deep was clipped to the top and middle cables with copper hog rings. The excess netting was then rolled in metal fence posts and buried in the pond bottom.

Water from Pond A was drained into Pond B in order that Pond A could dry. A similar barrier was constructed in the same fashion. Again, care was taken to insure that not only the halves were of equal size, but also that each side contained the same amount of deep and shallow substrate. Since there was no pond above Pond A, runoff water was relied on to refill the pond.

Forage Organisms

Once both ponds had refilled to an acceptable level, forage organisms for the fingerling bass were considered. Both ponds were rich with three species of fish that were

considered acceptable as food for largemouth. Bluegill were first proposed as the food fish, but because of the time of year they were unavailable. It was decided to use the three species that occurred not only in the two study ponds but in other adjacent ponds. These were the mosquito fish (Gambusia affinis)(Baird and Girard), fathead minnow (Pimephales promelas) (Rafinesque), and green sunfish (Lepomis cyanellus) (Rafinesque). Pond B already had a substantial population of all three species, because water from Pond A which contained fish was drained into Pond B. Some forage fish from B were transferred into A, and other forage of the same species composition were transferred from nearby ponds into Pond A. By the time the young bass arrived, both ponds had what appeared to be thriving populations of all three forage species.

In addition to fishes, both ponds had abundant populations of aquatic organisms that could have supplemented the bass diet. Insect nymphs were identified by referring to Needham and Westfall (1955) and Usinger (1956). Microcrustaceans were identified by referring to Ward and Whippee (1959). Odonata nymphs frequently used the fish barrier as a surface to crawl out of the water and emerge, as evidenced by cast exuviae left clinging to the mesh. Dragonflies of the genera Anax, Tetragoneuria and Aeschna were collected, as well as damselflies of the genus Agrion. Mayflies of the genus Caenis were observed in both ponds.

Microcrustaceans of the genera Cyclops, Daphnia, and Cypridopsis were collected in plankton samples, as well as few tardigrades. There appeared to be plenty of aquatic food in both ponds to offer optimum conditions for largemouth growth.

Stocking and Sampling

Fingerlings of floridanus were flown to Knoxville from Richloam Fish Hatchery near Tampa, Florida, on May 23, 1974. They were packaged in oxygen filled plastic bags nested in styrofoam coolers. They were no mortalities attributed to shipping. Since both ponds received runoff from a heavily used pasture, it was decided to stock at fertilized rates, adding an extra 10 percent for mortality. Seventy-four floridanus fingerlings were stocked in one side of Pond A, and 64 in a side of Pond B. The fish were first acclimated and seemed to swim off in good shape. Average length for the floridanus fingerlings was 47 mm, and the average wet weight per fish was 1.15 g.

The salmoides fingerlings arrived the next day and were stocked in the same numbers in the remaining side of each pond. During the acclimating process, the young salmoides were observed actively feeding on tiny Gambusia fry that entered the styrofoam coolers along with pond water. The salmoides fingerlings came from Cohutta Federal Fish Hatchery, Cohutta, Georgia, and were smaller than the

floridanus. Average length of the salmoides was 30 mm, and average wet weight was 0.25 g each.

At weekly intervals after the fish were stocked, the barriers were examined by the author using mask and snorkel to make sure they were intact. Young fish of all three forage species were observed passing freely back and forth through the barrier. The fingerling bass were much too large to go through 6 mm mesh.

Beginning on the 24th of June, 1974, and at 30 day intervals thereafter for the next five months, a random sample of at least 14 fish was taken from each side of each pond by seining. In June, a 3-m minnow seine with 9-mm mesh was used. In July, a 20-m bag seine with 12-mm mesh was used, and for the last three months of the study fish were collected with a 30-m bag seine with 25-mm mesh. Each fish in a sample was weighed with hospital grade spring scales accurate to $\pm$ 5 g, and total length in mm was taken using a measuring board. The water temperature was recorded for each pond during sampling.

## Statistical Procedure

A two-way analysis of covariance was computed for both ponds for the first two months of the study, and a one-way analysis of covariance for the entire study period in Pond B (Snedecor, 1956). Both procedures incorporated time (X) and weight (Y) in an effort to determine any significant differences in growth rates between the subspecies.

Other Evaluative Methods

Coefficients of condition (K) (Lagler, 1956) were calculated for each fish sampled; mean K values were computed each month. Specific growth rates (G) (Brown, 1956) were computed using mean weights at the beginning and end of each 30-day sampling period.

# CHAPTER IV

## RESULTS AND DISCUSSION

Adequate data were available for both ponds only for the first two months; data from Pond B fish were obtained for the entire five-month period. Pond A data for the last three months were deemed unreliable due to several breaks in the fish barrier below the water line, introducing the possibility of the subspecies mixing. The breaks were caused by livestock being driven into the shallow end of Pond A and through the barrier. The subspecies could not be separated with certainty because meristic counts needed from parent stock were unavailable. If the subspecies could have been separated by examination at the end of the study, the interspecific competition resulting from both forms being in direct contact for the last three months would have been a variable found in Pond A but not in B. Therefore, it was decided to terminate Pond A after the July sampling.

A two-way analysis of covariance was computed from the June and July data for both ponds (Table 1). Significant differences between subspecies and between ponds were obtained (1 percent level), with interaction not significant. The subspecies grew at significantly different rates in each pond, and did so independently of differing pond conditions.

TABLE 1

TWO-WAY ANALYSIS OF COVARIANCE FOR COMPARISON OF THE LARGEMOUTH SUBSPECIES IN PONDS A AND B

| Source | SS | df | MS | F |
|---|---|---|---|---|
| Between Subspecies | 1927.1 | 2 | 963.55 | 4.89* |
| Between Ponds | 6422.8 | 2 | 3211.40 | 16.30* |
| Interaction | 181.4 | 2 | 90.60 | 0.456 |
| Error | 23470.9 | 118 | 198.91 | |
| Total | 32002.2 | 124 | | |

*Significant at 1% level.

Pond differences can be explained, at least in part, by low water levels encountered in Pond A. As stated earlier, stocking rates for the two ponds were determined at a time when both were at full pool. It was fully expected that, after the barriers were constructed, both ponds would refill to their maximum levels with spring rains. Pond B reached full pool, because water from Pond A was drained into B during barrier construction. However, Pond A never filled completely due to extremely dry conditions during the spring and summer. As a result, bass introduced into Pond A were overstocked for the amount of water actually present. Such crowded conditions were no doubt less than optimum for growth, at least relative to Pond B.

A one-way analysis of covariance was computed for the entire five-month study for Pond B. The relationship between growth and time was significantly different (1 percent level) for each subspecies (Table 2), and the rates of growth were significantly different (1 percent level) for each subspecies (Table 3).

In both ponds during the first two months of the study, salmoides showed a significantly faster rate of growth than floridanus. This trend continued through the entire five months in Pond B, with rate differences being even more pronounced in the later months. The young salmoides fingerlings were considerably smaller on the average than floridanus at stocking, but exceeded floridanus in average weight after 60 days (Table 4).

TABLE 2

ONE-WAY ANALYSIS OF COVARIANCE TABLE FOR COMPARISON OF THE LARGEMOUTH SUBSPECIES IN POND B: HYPOTHESIS OF COMMON LINE

| Source | SS | df | MS | F |
|---|---|---|---|---|
| Between Subspecies | 142947.4 | 2 | 71473.77 | 99.8* |
| Error | 117419.3 | 164 | 716.0 | |
| Total | 260366.7 | 166 | | |

*Significant at the 1% level.

TABLE 3

ONE-WAY ANALYSIS OF COVARIANCE TABLE FOR COMPARISON OF THE LARGEMOUTH SUBSPECIES IN POND B: HYPOTHESIS OF PARALLEL LINES

| Source | SS | df | MS | F |
|---|---|---|---|---|
| Between Subspecies | 854521.2 | 1 | 854521.2 | 1193.4* |
| Error | 117419.3 | 164 | 715.9 | |
| Total | 971940.5 | 165 | | |

*Significant at the 1% level.

TABLE 4

MEAN WEIGHTS (gms) AND CORRESPONDING STANDARD DEVIATIONS FOR THE LARGEMOUTH SUBSPECIES AT EACH SAMPLING TIME

| Month | Pond A | | Pond B | |
|---|---|---|---|---|
| | floridanus | salmoides | floridanus | salmoides |
| June | 10.11<br>± 2.56 | 10.17<br>±10.76 | 12.43<br>± 3.37 | 12.19<br>± 3.64 |
| July | 32.00<br>± 6.19 | 41.27<br>±10.55 | 50.67<br>± 7.89 | 63.80<br>±12.61 |
| August | --<br>-- | --<br>-- | 96.25<br>±15.16 | 132.00<br>±26.83 |
| September | --<br>-- | --<br>-- | 139.80<br>±28.24 | 214.90<br>±44.28 |
| October | --<br>-- | --<br>-- | 154.93<br>±34.95 | 261.13<br>±42.63 |

Coefficients of condition (K) (Lagler, 1956) were computed for each fish sampled, and a mean value arrived at for each month (Table 5). The northern subspecies were found to be consistently more robust, as evidenced by their higher K value each month. In Pond B, floridanus gained condition for the first two months, and then steadily lost for the remaining three. On the other hand, salmoides gained condition throughout the study.

Specific growth rate (G) was computed from mean weights for both subspecies. G values characteristically decrease with age during any one growth cycle in fishes, thus conforming to Metawar's fourth and fifth laws of growth (Brown, 1957). As was the case with coefficient of condition, G values were consistently higher for salmoides for all months (Table 6).

Since bass in Pond B were grown under the same environmental conditions but kept separate by the barrier, differences in growth observed over the five-month period could be considered genetic in nature. The northern form grew at a significantly faster rate than did floridanus. Because of pond differences and the loss of data from Pond A, it would not be statistically sound to predict the same results anywhere in Tennessee. Further studies are needed to determine any genetic superiority as far as growth is concerned in Tennessee. A longer study of perhaps ten years would be

TABLE 5

MEAN K VALUES FOR THE LARGEMOUTH SUBSPECIES

| Month | Pond A | | Pond B | |
|---|---|---|---|---|
| | floridanus | salmoides | floridanus | salmoides |
| June | 1.37 | 1.60 | 1.20 | 1.33 |
| July | 1.34 | 1.52 | 1.41 | 1.55 |
| August | -- | -- | 1.45 | 1.58 |
| September | -- | -- | 1.43 | 1.64 |
| October | -- | -- | 1.37 | 1.64 |

*From Lagler, 1956; $K = \frac{W \times 10^5}{L^3}$.

TABLE 6

SPECIFIC GROWTH RATES FOR THE LARGEMOUTH SUBSPECIES

| Growth Period of 30 Days | Pond | floridanus Weight at Start of Period (gms) | floridanus Specific Growth Rate | salmoides Weight at Start of Period (gms) | salmoides Specific Growth Rate |
|---|---|---|---|---|---|
| May | A | 1.15 | | .25 | 12.35 |
| June | A | 10.11 | 7.25 | 10.17 | 4.67 |
| July | A | 32.00 | 3.84 | 41.27 | |
| May | B | 1.15 | | .25 | |
| June | B | 12.43 | 7.94 | 12.19 | 12.96 |
| July | B | 50.67 | 4.68 | 63.80 | 5.52 |
| August | B | 96.25 | 2.14 | 132.00 | 2.42 |
| September | B | 138.60 | 1.22 | 214.90 | 1.63 |
| October | B | 154.93 | 0.37 | 261.13 | 0.65 |

needed to demonstrate any ultimate growth differences between the subspecies in this state.

Differences in catchability, although not within the scope of this study, may be a key factor in explaining maximum sizes reached by the subspecies. A greater longevity achieved by a bass that resists fishing pressure may serve to explain the larger size attained by floridanus in other states. In mixed populations such as described by Bottroff (1967), intergradation seems likely. Catchability studies by Smith (1971) show that intergrades are more difficult to catch than pure-strain salmoides. Careful consideration should be given to the potential effects of decreased catchability before floridanus are stocked in waters where pure-strain salmoides already provide a suitable fishery.

# CHAPTER V

## SUMMARY

1. Growth of two subspecies of largemouth bass, Micropterus salmoides salmoides (Lacepede) and M. s. floridanus (Lesueur), was evaluated for a five-month period in two Tennessee farm ponds. The principal objective of the study was to determine if first year differences in growth rates exist between the subspecies.

2. The northern subspecies, M. s. salmoides, grew at a significantly faster rate (1 percent level) than the Florida bass, M. s. floridanus.

3. Mean coefficients of condition (K) were consistently higher for salmoides throughout the study.

4. Specific growth rates (G) computed from mean weights between sampling periods were higher for salmoides in all months.

5. Since the two subspecies were grown in the same ponds (separated by a barrier) under apparently similar environmental conditions, it was concluded that the observed differences in growth are probably be genetic in nature.

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## LITERATURE CITED


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# VITA

Robert Parker Smith was born in Chattanooga, Tennessee, on April 4, 1951. He attended public schools in Chattanooga and was graduated from Chattanooga High School in 1969. The following September he entered the University of Tennessee, Knoxville, and in June 1973, he received a Bachelor of Science degree in Animal Husbandry.

In the summer of 1973, he accepted a research assistantship at the University of Tennessee and began study toward a Master of Science degree in Wildlife and Fisheries Science. He received this degree in December 1976, and was employed by the Tennessee Wildlife Resources Agency several months prior to completion. He is a member of The Honor Society of Phi Kappa Phi and Gamma Sigma Delta Honor Society.