lakes over the past 10 years and serve well as fish concentration points. With the exception of the spring inshore crappie fishing, better than 90 percent of the crappie harvest is around the marked shelters.

Bank fishing piers installed on both lakes provide fishing for those fishermen not wanting to go out in a boat.

LITERATURE CITED

Bureau of Sports Fisheries and Wildlife. 1963. Published and unpublished creel census data from Southeastern reservoirs. 27 pp. (Mimeo.)

Eschmeyer, R. W. 1936. Essential considerations of fish management in lakes. Trans. First. Amer. Wildlife Conf. 332-339.

————. 1944. Norris Lake fishing. Bull. Div. of Game and Fish., Tenn. Dept. of Cons. 18 pp.

————, D. E. Manges and O. F. Huslbauer. 1947. Trends in fishing on T.V.A. storage waters. Jour. Tenn. Acad. Sci. 22:(1)45-56.

————. 1955. Fish conservation fundamentals. Sports Fishing Institute Bulletin. No. 38: (Jan., 1955).

Houser, Alfred and Michael G. Bross. 1963. Average growth rates and length-weight relationships for fifteen species of fish in Oklahoma waters. Okla. Fish. Res. Lab. Dept. 85:1-75.

Hulsey, Andrew H. 1958. A proposal for management of reservoirs for fisheries. Proc. Southeast. Assoc. Game and Fish Comm. 12:132-143.

Irwin, W. H. 1956. The management of large impoundments for fish production. Proc. Southeast. Assoc. Game and Fish Comm. 10:271-279.

Jackson, Samuel W., Jr. 1957. Comparison of the age and growth of four fishes from Lower and Upper Spavinaw Lakes, Oklahoma. Proc. Southeast. Assoc. Game and Fish Comm. 11:232-249.

————. 1958. Summary of the three-year creel census on Lake Eucha and Spavinaw Lake, Oklahoma, with comparisons of other Oklahoma reservoirs. Proc. Okla. Acad. Sci. Vol. 38:146-154.

Jenkins, Robert and Gordon Hall. 1953. The influence of size, age and condition of waters upon the growth of largemouth bass in Oklahoma. Okla. Fish. Res. Lab. Dept. No. 30:43 pp.

Lambou, Victor W. and Herbert Stern, Jr. 1958. Preliminary report on effects of removal of rough fish on the Clear Lake sport fisheries. Proc. Southeast. Assoc. Game and Fish Comm. 12:36-56.

————. (Editor) 1963. Recommended method of reporting creel survey data for reservoirs prepared by reservoir committee Southern Division of the American Fisheries Society. 30 pp. (Mimeo.)

Rose, Earl T. and Tom Moen. 1952. The increase in game fish populations in East Okoboji Lake, Iowa, following intensive removal of rough fish. Trans. Amer. Fish. Soc. Vol. 82:104-114.

Weese, A. O. 1951. Age and growth of *Lepibema chrysops* in Lake Texoma. Proc. Okla. Acad. Sci. 30(1949):45-58.

AGING AND GROWTH OF LARGEMOUTH BASS, BLUEGILL, AND REDEAR SUNFISH FROM LOUISIANA PONDS OF KNOWN STOCKING HISTORY [1]

ROBERT J. MUNCY [2]

ABSTRACT

Scales of largemouth bass taken from two ponds at Baton Rouge, Louisiana over a three-year period agreed closely with the known past stocking history on these fish. Largemouth bass scales from a 50-acre pond at Clinton, Louisiana indicated agreement with the six years fish

[1] Supported as L.S.U. Project 1048 and 1074 by Sch. of For. and Wildl. Mgt. and Agric. Exp. Stat., La. State Univ., Baton Rouge, La.

[2] Present address: Iowa Coop. Fishery Unit, Iowa State Univ., Ames, Iowa.

had been stocked. Total length growth rates of bass were increased by controlled fall drawdown; however, prolonged summer droughts decreased total length growth and condition factors.

Spawning and drastic drawdowns resulted in more pronounced growth checks than winter cessation on the scales of bluegill and redear sunfish from ponds of known stocking history.

INTRODUCTION

Although numerous age and growth studies of largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*), and other sunfish have been conducted in the northern United States, there have been only limited studies in the southern tier of states. Studies conducted on known age or known stocking history are even more limited. Lambou (1962a, 1962b, and 1962c) reported available literature failed to reveal data on validity of the scale method for aging bluegill, redear sunfish (*Lepomis microlophus*), or warmouth sunfish in Louisiana. Viosca (1943) reported on growth rates of largemouth bass in hatchery ponds; however, there were no comments on aging. Viosca (1953) reported on the growth rates of black bass, spotted bass and crappie from a newly flooded impoundment over a 5.5 to 6.5 month period for 1949, 1950 and 1951. Scales of these young-of-the-year bass were found to agree with age group 0 classification. Brashier (1965) reported agreement between total lengths and assigned ages of largemouth bass from False River and Old River, Louisiana.

Research was initiated in 1960 to study growth characteristics of fishes in Louisiana waters as revealed by hard body structures such as scales. A 50-acre lake at Louisiana State University Idlewild Experimental Station, Clinton filled and stocked in 1958, and two ponds (four and 16 acres) on the Louisiana State University Ben Hur Farm, Baton Rouge, filled and stocked in 1961, were selected as study areas. Idlewild Lake water management consisted of natural rainfall; whereas, water levels of Ben Hur ponds were changed by fall drawdown. The Ben Hur ponds management practices were made as identically as possible by location adjacent on same soil type, similar depth, filling from the same artesian water source, fertilizing at the same rate per surface acre, original stocking at 100 largemouth bass and 1,000 bluegill and redear sunfish per acre, and no removal of fish. In October 1961, water level of the larger (16-acre) pond was reduced from six feet to two feet with a resulting two-thirds decrease in surface area. Water level in the smaller pond (four-acre) was maintained at maximum capacity. Severe spring drought prevented full use of the artesian well for filling the larger pond until July 1962, resulting in lowered water levels and prevented bass spawning. Both ponds were drawn down to one-third capacity in the fall of 1962. The spring drought of 1963 prevented use of artesian water source. Continued hot, dry weather during June 1963 resulted in oxygen depletion and partial fish-kill on June 13, 1963 in the four-acre pond. Following this fish-kill and limited reproduction of bass, fish populations of the Ben Hur ponds were removed during the fall and restocked in 1964.

METHODS AND MATERIALS

Fish were collected from the four- and 16-acre ponds with a 50-foot by six-foot bag seine. Limited collections were also obtained with a 110-volt, 1,600-watt A.C. electric shocker. Fish were collected from the 50-acre Idlewild Lake by hook and line, seining, and electric shocker.

Total lengths were measured to the nearest 0.1 inch. Weights to the nearest gram for fish under one pound and nearest 0.1 pound for larger fish were recorded for a majority of fish taken from Idlewild Lake and Ben Hur ponds.

Scales were removed posterior to the depressed pectoral fin and below the lateral line. Cellulose acetate impressions (Smith, 1954) were prepared of scales. If difficulties were experienced in examining cellulose acetate impressions, wet mounts of scales (Lewis and Carlander, 1949) were also examined. A Tri-Simplex Micro Projector was used to examine scale impressions or wet mounts at magnifications of 23 times. Criteria

used for recognition of annulus-like marks on scales included "crossing over" of circuli and erosion in the posterior field of scale.

The Fraser modification of the direct proportion method (Rounsefell and Everhart, 1953) was used to calculate total lengths at each annuli. Correction for the "a" intercept of total length to scale length regression was computed by least squares method for each species from each body of water.

Condition factors (C) were calculated by dividing the individual weight in hundreds of a pound by the cube of the total length in inches times 100,000.

Fish were identified with strap, streamer, and Petersen tags; however, such marks were of short duration. Tagged fish lost these marks within a short time or were greatly affected in growth characteristics and mortality rates. Such efforts were discontinued until a separate study could be conducted on suitability of tags for these species in this area.

RESULTS

Largemouth bass

Examination of scales from largemouth bass of known stocking history in the Ben Hur ponds revealed strong annulus-like marks which corresponded with winters these fish had been present in the ponds (Table 1). Examination of scales as well as length-frequency plots

Table 1. Calculated total lengths of largemouth bass from four-acre (A) and 16-acre (B) ponds on the Louisiana State University Ben Hur Farm, Baton Rouge, Louisiana, 1961-63.

Year Class	Age Group	Number Examined	Total length (in.) at Annulus 1	2	Avg. total length at capture
1961 A	I	19	7.7	—	8.6
1961 B		27	8.4	—	9.1
1962 A (Reprod.)		22	8.9	—	9.1
1961 A	II	31	8.2	11.8	12.5
1961 B		71	9.0	12.8	14.9

(Table 2) and seine samples failed to reveal largemouth bass reproduction in the larger pond; however, limited reproduction for 1962 was revealed by scale examination and length-frequency data for the smaller pond. Spring seine samples in Idlewild Lake revealed reproduction during all years following 1958. Scales of largemouth bass from this lake demonstrated close agreement between the original stock and subsequent reproduction (Table 3). Fall drawdown of the Ben Hur ponds nor spring droughts resulted in check marks on largemouth bass scales examined.

Recent studies of largemouth bass from False River and Old River, Louisiana (Brashier, 1965) and the Mississippi River Delta at Pilottown, Louisiana (Carver, 1965) revealed close agreement between annuli and sizes of fish as well as formation of only one such mark per year in the early spring. Growth and scale characteristics of largemouth bass from widely varied habitat indicated previous growth and age of these fish in Louisiana waters. Bennett (1937) reported growth data up to 11 years for 30 specimens of largemouth bass from Louisiana; however, validity of the annulus was not discussed. Viosca (1953) examined scales of young-of-the-year largemouth bass and spotted bass in an impoundment at Springhill, Louisiana and found agreement with age group 0 fish.

Condition factors (C) for largemouth bass varied in the three study areas depending upon size of fish and available food supply. Original stock of largemouth bass in the smaller Ben Hur Pond average condition factors (C) were 42, 46, and 58 for the first, second, and third

Table 2. Length-frequency of largemouth bass from four acre (A) and 16-acre (B) ponds, Louisiana State University Ben Hur Farm, Baton Rouge, Louisiana, 1961-63.

Dates	Pond	Total length (inches) 5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0
7-61	A	—												
	B	4												
8-61	A	3												
	B	—												
9-61	A	—	6											
	B	1	1											
11-61	A	—	—	—	—	—								
	B	—	—	—	6	2								
1-62	A	—	—	5	1	—	—							
	B	—	1	2	7	1	1							
6-62	A	—	—	—	10	1	—							
	B	—	—	—	—	—	1							
8-62	A	—	2	1	—	—	—	—						
	B	—	—	—	—	—	—	3						
9-62	A	—	—	2	1	—	2	—	—					
	B	—	—	—	—	—	1	—	2					
10-62	A	—	—	—	3	2	1	1	—	—	—			
	B	—	—	—	—	—	—	—	—	1	—			
12-62	A	—	—	—	3	2	1	3	1	—	—			
	B	—	—	—	—	—	—	1	4	2	—			
2-63	A	—	—	—	2	6	1	1	2	1	—			
	B	—	—	—	—	—	—	—	1	—	—			
3-63	A	—	—	—	—	1	1	4	4	3	1			
	B	—	—	—	—	—	—	—	—	—	—			
5-63	A	—	—	1	4	—	—	—	2	—	1	—	—	
	B	—	—	—	—	—	—	—	—	—	1	—	1	
6-63	A	—	—	—	—	—	1	1	3	4	—	—	—	—
	B	—	—	—	—	—	—	—	—	—	—	—	—	—
10-63	A	DEAD	—	—	—	—	—	—	—	—	—	—	—	—
	B	—	—	—	—	—	—	—	—	1	29	19	16	2

Table 3. Calculated total lengths of largemouth bass from Idlewild Lake, Clinton, Louisiana, 1960-1964.

Year Class	Age Group	Number Examined	Total length (in.) at annulus 1	2	3	4	5	6	Avg. length at capture
	I								
1959		2	8.3						8.3
1960		12	8.3						10.1
1961		4	7.0						7.0
1962		1	7.1						7.1
	II								
1958		15	9.6	10.5					10.5
1959		10	9.5	10.6					11.3
1960		9	8.0	10.6					10.6
1961		4	7.0	9.5					9.5
1962		1	6.7	10.2					12.0
	III								
1958		11	9.1	10.9	11.5				11.8
1959		3	9.3	11.1	11.8				11.8
1960		4	7.0	9.4	10.0				10.0
1961		1	7.9	10.1	11.2				12.6
	IV								
1958		1	9.2	10.4	11.5	13.2			13.2
	V								
1958		1	8.2	9.8	10.7	11.8	12.6		13.0
	VI								
1958		1	9.3	11.5	13.8	16.4	17.9	19.6	19.6

years of life; whereas, largemouth bass in the larger Ben Hur pond average condition factors (C) were 44, 56, and 61 for the same period. Condition factors in both ponds increased following fall drawdown. Largemouth bass reproduction in the smaller Ben Hur pond average condition factor (C) was 48. Condition factors from both ponds agree favorably with those reported by Brashier (1965) for largemouth bass from False River and Old River, Louisiana. Largemouth bass in Idlewild Lake average condition factors (C) were 42, 46, 41, 34, and 49 for 1960 through 1964. Lower values for 1962 and 1963 represent drought years. Water area decreased from 50 acres to 10 acres in 1963.

Bluegill

Bluegill averaging 1.1 inches total length were stocked in the Ben Hur ponds on January 17, 1961. Examination of scales over a three-year period revealed the first annulus at an average of 0.7 inches (uncorrected for the total length to scale regression) and 1.4 for the corrected data. Following stocking, scales collected in September revealed annulus-like marks. Average calculated total length of 4.9 inches for these marks corresponded with total lengths of ripe bluegill during July and August. Scales collected from the original stocks of bluegill for the following two years revealed a strong annulus-like mark at the same calculated total length (4.9 inches). Annulus-like marks representing resumption of growth following the second winter appeared on scales collected in June; however, these marks were not too distinctive. The annulus for the third winter did not appear on any scales.

Examination of scales from bluegill stocked in the Ben Hur ponds indicated annulus-like marks formed during the first summer spawning period were more distinctive than marks following resumption of spring growth. However, these bluegill represented extremely fast growth during the first year after stocking and reduced growth during drawdown and drought years. Bluegill in many cases attained almost as much growth in the first winter following stocking as in the remaining three years. The annulus-like mark formed the first spring following removal from crowded hatchery ponds and stocking in new farm ponds would be difficult to detect without prior knowledge of such fish.

Scales of bluegill collected from Idlewild Lake for the first three years indicated annulus-like marks in the spring corresponding with the known stocking history. However, false annulus-like marks were found on 80 per cent of 28 scales examined.

A study of a newly created pond near Ames, Iowa (Sprugel, 1954) revealed a high percentage of bluegill scales with false marks. False marks after the first annulus seemed to be connected with sexual activity. Regier (1962) concluded that the scales method was generally valid for age and growth determinations of bluegills in 24 small farm ponds near Ithaca, New York. Lambou (1962a) examined bluegill scales collected from 36 bodies of water representing various types of freshwater throughout Louisiana and stated: "I have concluded that for routine studies it is impossible to age bluegill in Louisiana by the scale method with any reasonable degree of accuracy. Even with more intensive studies, the validity of the method is doubtful." Lambou and Williams (1964) concluded that many fish are laying down more than one annulus-like mark per year in a variable manner. Carver (1965) examined scales from 200 bluegill collected from shallow ponds on the U. S. F. and W. S. Delta National Wildlife Refuge, Louisiana. Scale growth after formation of the last annulus-like mark indicated several growth cessations which prevented accurate aging.

Difficulties in assessing the age and growth of bluegill in Louisiana from scale examination may be associated with reproduction occurring during the middle of the summer growing period rather than immediately following the winter period as occurs with largemouth bass and crappie. Water level changes may have more immediate effect on the food supply of bluegill than on bass. In fact, the effects appear to be opposite for these two species. Possible rapid growth to adult size and sexual maturity within one year could result in telescoping bluegill growth into a shorter time than for other fishes. Lambou

(1962a) discussed effects of temperature, area of state, type of water, yearly variation, and size of fish on the formation of annulus-like marks on bluegill scales.

Condition factors (C) of mature bluegill studied averaged 81; however, bluegill condition factors varied with ponds and years. For example, the smaller Ben Hur pond had a three-year average of 91; however, condition factors averaged over 100 prior to the 1962 fall drawdown when the average condition factor decreased to 77. Average condition factor (C) for bluegill in the larger Ben Hur pond decreased from 81 prior to the 1962 fall drawdown to 56 thereafter.

Redear Sunfish

Redear sunfish scales were collected over a three-year period from the Ben Hur ponds. Reproduction was very limited especially in the smaller pond. Examination of 49 redear sunfish scales from the small Ben Hur pond revealed three scales (six per cent) with possible false annuli. Average calculated total lengths were 1.2, 7.3 and 7.9 inches which agree closely with the average total lengths (1.1, 7.5 and 8.2 inches) of redear stocked in winter of 1960 and seined in the winters of 1961 and 1962. However, scales of redear sunfish collected from the larger Ben Hur pond revealed 45 of 50 samples contained strong marks corresponding to the size (4.9 inches) of the fish at 1961 drawdown. Another annulus-like mark was formed at an average calculated total length of 6.5 inches for collections after August but prior to 1962 fall drawdown. Scales collected on October 10, 1963 revealed the first annulus-like mark at 1.2 inches, a second strong annulus-like mark averaging 5.4 inches and a third mark averaging 7.2 inches. Additional less distinctive marks were present on 28 per cent of these scales. The strongest marks corresponded closely with the total lengths of redear sunfish at fall drawdown rather than spring collections.

Condition factors (C) of the redear sunfish averaged 79 for the smaller and 74 for the larger Ben Hur pond. The highest average condition factor (C=95) was recorded during the first winter in the smaller pond and were lowest (C=72) when water levels were drawn down.

Scale patterns and growth characteristics of redear sunfish suggest that routine age and growth studies of this species in Louisiana may not reveal accurate results. Lambou (1962b) stated that annulus-like marks are laid down over an extended period during the summer (June through September) in a somewhat variable manner for redear sunfish from 25 bodies of water throughout Louisiana.

LITERATURE CITED

Bennett, G. W. 1937. The growth of the largemouth black bass, *Huro salmoides* (Lacepede), in the waters of Wisconsin. Copeia (2):104-118.

Brashier, Jerry. 1965. A study of the age and growth of largemouth bass in False River and Old River, Pointe Coupee Parish, Louisiana. M.S. Thesis, La. State Univ. Library, Baton Rouge. 53 p.

Carver, Dudley Clay. 1965. Ecological factors affecting distribution and abundance of the centrarchids of the recent delta of the Mississippi River. M.S. Thesis, La. State Univ. Library, Baton Rouge. 111 p.

Lambou, V. W. 1962a. Formation of annulus-like markings on the scales of bluegill sunfish in Louisiana. La. Wild Life and Fish. Comm. D-J Proj. F-10-R July 16, 1962 Report: 32 p. (mimeo.).

Lambou, V. W. 1962b. Formation of annulus-like markings on the scales of redear sunfish in Louisiana. La. Wild Life and Fish. Comm. D-J Proj. F-10-R Report: 20 p. (mimeo.).

Lambou, V. W. 1962c. Formation of annulus-like markings on the scales of warmouth sunfish in Louisiana. La. Wild Life and Fish. Comm. D-J Proj. F-10-R: 11 p. (mimeo.).

Lambou, V. W. and Joann Williams. 1964. Dingell-Johnson Project F-10-R Age and growth studies. La. Wild Life and Fish. Comm. 10th Biennial Rept. 1962-1963: 144 p.

Lewis, W. M. and K. D. Carlander. 1949. A simple method of mounting scales. Prog. Fish-Cult. 11:263.
Regier, H. A. 1962. Validation of the scale method for estimating age and growth of bluegills. Trans. Amer. Fish. Soc. 91(4):362-374.
Rounsefell, George A. and W. Harry Everhart. 1953. Fishery science its methods and applications. John Wiley & Sons, Inc., New York. 444 p.
Smith, Stanford H. 1954. Method of producing impressions of fish scales without using heat. Prog. Fish-Cult. 16:75-78.
Sprugel, G. Jr. 1954. Growth of bluegills in a new lake, with particular reference to false annuli. Trans. Amer. Fish. Soc. 83:58-75.
Viosca, P. Jr. 1943. Phenomenal growth rates of largemouth black bass in Louisiana waters. Trans. Amer. Fish. Soc. 72:68-71.
Viosca, P. Jr. 1953. Growth rates of black bass and crappie in an impoundment of northwestern Louisiana. Trans. Amer. Fish. Soc. 82:255-264.

MOVEMENT OF NATIVE AND STOCKED FISH IN D'ARBONNE LAKE AFTER IMPOUNDMENT[1] [2]

JANICE S. HUGHES
Fisheries Biologist
Louisiana Wild Life and Fisheries Commission
Monroe, Louisiana
and
NEIL H. DOUGLAS
Associate Professor of Zoology
Northeast Louisiana State College
Monroe, Louisiana

Presented at the Southeastern Association
of Game and Fish Commissioners
Tulsa, Oklahoma
1965

ABSTRACT

A total of 3,174 native fish of 29 species was tagged and released in Bayou D'Arbonne during the spring and summer of 1963. The distance and direction of movement of captured fish were recorded before inundation and again after the flooding of the 15,000-acre impoundment, D'Arbonne Lake, in January 1964. Of the 57 tagged fish returned before inundation, 54 were recaptured in the same location. One fish moved upstream for a distance of 3.3 miles and two fish moved downstream for an average distance of 6.8 miles. After the lake was filled, the fish exhibited extensive movements and only 11 percent of the returns occurred in release areas. Thirty-three of the 84 fish recaptured in the lake moved toward the headwaters while 35 fish moved toward the spillway. A total of 4.4 percent of the native fish tagged were recovered. Tagged hatchery reared bluegill, *Lepomis macrochirus*; largemouth bass, *Micropterus salmoides*; channel catfish, *Ictalurus punctatus*; and black crappie, *Pomoxis nigromaculatus* numbering 9,173 individuals were stocked in D'Arbonne Lake. The direction and distance of movement of these fish were also recorded. Sixty-one hatchery reared fish (0.7 percent) were recovered from the lake. Largemouth bass

[1] This paper is based in part on a thesis presented for partial fulfillment of requirements for the degree of Master of Science from Northeast Louisiana State College, Monroe, Louisiana.

[2] This study was financed in part with Federal Aid in Fish Restoration funds under Dingell-Johnson Project Number F-7-R.