Growth History of Black Crappie Spawned 1980, St. Johns River, Florida

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Abstract: Growth rates for the 1980 year class of black crappie were determined from samples collected in the St. Johns River, Florida, 1981 through 1987. Actual mean lengths of groups of black crappie aged by otolith evaluation were compared to back calculated lengths from otoliths of black crappie collected each year. Differences in actual and back calculated lengths for black crappie collected were not significant ($P > 0.05$). Coefficient of determination values (r^2) dropped rapidly as differential growth rates increased. Overall, back calculated lengths for age I and II black crappie increased as fish aged, exhibiting a reverse of Rosa Lee's phenomenon. The phenomenon was probably the result of size selective mortality. Black crappie collected between 1981 and 1986 indicated that the 1980 year class was larger than any other year class sampled. At actual age 6, the 1980 year class still comprised almost 8% of all black crappie collected.

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Knowledge of age and growth of fish populations is critical for successful management of lake and river systems. Age and growth data, when correlated with other factors such as harvest, natural mortality, recruitment, and environmental effects can aid in making prudent management decisions.

Confidence in "accepted" techniques involving scales or length frequency has been eroded over time. Crumpton et al. (1986) found bias resulting from size overlap in black crappie (*Pomoxis nigromaculatus*) as early as between ages 1 and 2 when age grouping by length frequency alone. Lentsch and Griffith (1987) reported bias due to lack of annulus formation on scales, and O'Gorman et al. (1987) found discrepancies between ages determined from scales and otoliths.

Newer techniques utilizing bony structures (spines, vertebrae, and otoliths) are now being used with confidence because those techniques have been validated for

many species. Otoliths, among recent literature, seems to be the more widely used of these structures. Otolith validation studies have been reported by Coleman et al. (1984) for largemouth bass (*Micropterus salmoides*); Crumpton et al. (1986) for black crappie; Heidinger and Clodfelter (1987) for walleye (*Stizostedion vitreum*), striped bass (*Morone saxitilis*), and smallmouth bass (*Micropterus dolomieui*); and Maceina and Betsill (1987) for white crappie (*Pomoxis annularis*).

In this study, ages were determined for black crappie of the 1980 year class from the St. Johns River, Florida, using whole otoliths. Back calculated lengths were taken from photographs of whole otoliths and used to illustrate a growth history of the 1980 year class over a 7-year period. Actual mean lengths of age groups were compared to back calculated mean lengths.

Methods

Black crappie were collected from the St. Johns River during the late winter and early spring months 1981 to 1987. Fish were collected from Lake Harney downstream to Doctors Lake near Jacksonville. Black crappie were collected by electrofishing, hoop net, pound net and trawl. Fish were individually measured for total length (TL) in mm, weighed (g), and sexed. Sex was determined by hand squeezing individual fish for flowing milt or eggs, or by dissection and visual observation of gonads. Sexes were combined because Crumpton et al. (1986) showed no size differences between male and female black crappie from the St. Johns River over a 5-year period.

Pairs of sagittal otoliths were removed from each fish utilizing a technique described by Crumpton et al. (1986). A technique utilizing whole otoliths instead of ground otolith cross-sections was validated in 1981 and 1982 and was also described by Crumpton et al. (1986). Whole otoliths only were used from 1983 to 1987.

Back calculations for growth were derived from photographs of whole otoliths. The procedure was modified from a technique described by Doerzbacher and Schramm (1984). Modifications included the use of a photographic enlarger (C760 Berkey-Omega) with an extremely bright light source, a clear 35-mm photographic slide in conjunction with the negative carrier instead of a water dish, and satin finish polycontrast photographic paper. Otoliths were photographed only 4 to a page, making annuli readily visible and measurements easy. Aperture settings varied from f11 to f4.5. Exposure times were somewhat subjective, varying from 9 to 12 seconds, depending on size and thickness of otoliths. Exposed sheets were processed in standard solutions of Kodak dektol, indicator stop bath, and rapid fixer. Chemical rates recommended by package direction were utilized. Otolith photographs and otoliths were measured with calipers to determine enlargement rates. Enlargement rates varied for 8.9 to 11.1 times.

Back calculation to each otolith annulus was necessary in order to estimate historic growth. As a result, a computer program utilizing the Fraser-Lee method adapted from Frie (1982) was used to back calculate growth rates and analyze data.

The program was described by Coleman et al. (1984). Back calculation measurements were made from the center of the nucleus to the anterior edge of the otolith. The center of the nucleus was determined by finding the widest points of the nucleus area, longitudinally and latitudinally, with calipers. The points were connected by 2 lines and the intersecting point was considered the nucleus center. A straight line was drawn from the nucleus to the extreme edge of the otolith. A permanent mark was made on the outer edge of each annulus and the outer edge of the otolith along that line. Readings were taken no fewer than 4 times.

To determine if a reverse of Rosa Lee's phenomenon had occurred during the growth of the 1980 year class, mean distances between the center of the nucleus and the outside edge of the first annulus for 1-year-old and 7-year-old black crappie were compared.

Differences between actual and back calculated length were compared by *t*-test.

Results and Discussion

Ages and total lengths for the 1980 year class of black crappie were determined from 816 fish collected from the St. Johns River between 1981 and 1987. Ages were determined from whole otoliths because Crumpton et al. (1986) reported 100% agreement between whole and transverse sections of otoliths in 186 and 235 black crappie in 1981 and 1982. Maceina and Betsill (1987) showed little difference in whole and transverse sections of otoliths in white crappie. In 257 fish aged, only 3 (1%) were underestimated.

Total numbers, actual mean lengths and back calculated mean lengths are illustrated in Table 1. The coefficient of determination (r^2) for body length-otolith radius is also shown. Crumpton et al. (1986) indicated there were no significant differences in the sizes between sexes of black crappie from the St. Johns River for a 5-year period (1981–1985). Hepworth and Pettengill (1979) also observed no difference in size between sexes for black crappie in a study on Lake Powell, Utah. As a result, sexes were combined for both actual and back calculated lengths.

Back calculated mean length for black crappie at age I was <17mm the actual mean length of fish collected. This was understandable because all fish measured were collected after the annulus was formed. Back calculated mean lengths were overestimated 3 to 9 mm at age II, III, and V, and underestimated 2 to 9 mm at age IV, VI, and VII. All differences between actual and back calculated lengths were not significant ($P > 0.05$).

Coefficients of determination for body length vs. otolith radius (Table 1) were high the first 3 years black crappie were collected. At that point, differential growth rates became so great that r^2 values began to drop rapidly.

Decline in back calculated lengths for age I black crappie over the first 3 years fish were collected could possibly have resulted from random variation but could have also been the result of a typical Rosa Lee's phenomenon as described by Bagenal and Tesch (1978). Back calculated length at actual age 3 was less than back

Table 1. Actual ages, numbers, actual mean total lengths (TL), back calculated TL, and coefficients of determination for black crappie from the St. Johns River, Florida, 1981–1987.

Actual age	N	Actual mean TL (mm)	Back calculated TL (mm)							r^2
			I	II	III	IV	V	VI	VII	
1	101	163	146							0.92
2	178	215	153	221						0.83
3	364	249	143	208	252					0.88
4	80	307	163	233	277	298				0.52
5	48	329	164	230	270	305	339			0.19
6	32	339	175	233	284	308	326	341		0.16
7	13	344	181	237	273	299	318	330	340	0.11

calculated length at actual age 1 or 2. At actual age 4, the back calculated age I length was greater than the back calculated length at actual age 1. Age I back calculated growth for actual age 5, 6, and 7 was greater than back calculated growth at actual age 1. Back calculated lengths for older black crappie were greater than younger black crappie. Bagenal and Tesch (1978) described this as a reverse of Rosa Lee's phenomenon. They indicated that this reversal occurs commonly in large year classes within populations. The phenomenon typically manifests itself when there is size selective mortality bearing heavily on smaller fish of an age group allowing the faster growing fish to survive. This could have occurred in the 1980 year class. Collections from 1981 through 1986 indicated the 1980 year class was larger than any other year class represented. It still comprised almost 8% of all black crappie collected in 1986. However, early mortality does not seem to be the case because more 1980 year class fish were collected at age 3 than at age 1 or 2.

Since there was a definite relationship between total fish length and otolith radius ($r^2 = 0.928$), if a reverse of Rosa Lee's phenomenon occurred and if selective mortality occurred, differences in mean distances at 1 and 7 years would be measurable. Results indicated that there was a marked difference (7.8 mm) between the mean distances from the nucleus to the edge of annulus 1 for age 1 and 7 black crappie, demonstrating that a reverse of Rosa Lee's phenomenon had occurred.

Conclusions

1. Although back calculated lengths for black crappie were overestimated or underestimated in all cases, differences between actual and back calculated lengths were not significant.

2. A reverse of Rosa Lee's phenomenon was observed after the first 2 years of growth in back calculated black crappie lengths. The occurrence of the phenomenon was demonstrated when mean distances between the nucleus and annulus 1 were measured for actual age 1 and 7-year-old black crappie.

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