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GROWTH OF FIVE SPECIES OF GAME FISHES BEFORE AND AFTER INTRODUCTION OF THREADFIN SHAD INTO DALE HOLLOW RESERVOIR[1]

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ABSTRACT

The possible effect of threadfin shad stocking in Dale Hollow Reservoir on the growth of five predatory species was measured by analysis of scale samples taken before and after threadfin stocking. There was no significant change in growth rate of largemouth bass, *Micropterus salmoides*; smallmouth bass, *Micropterus dolomieui*; and spotted bass, *Micropterus punctulatus.* There was a significant increase in growth rate of walleye, *Stizostedion vitreum* and white crappie, *Pomoxis annularis.*

INTRODUCTION

Threadfin shad, *Dorosoma petenense*, have been widely introduced into warm-water reservoirs as forage for piscivorous game fishes. The objective of this study was to determine if the introduction of this shad into Dale Hollow Reservoir was followed by significant length increase in five species of game fishes: largemouth bass, *Micropterus salmoides*; smallmouth bass, *Micropterus* dolomieu; spotted bass, *Micropterus punctulatus*; white carppie, *Pomoxis an*nularis; and walleye, *Stizostedion vitreum.*

The first known stocking of about 400 shad into Dale Hollow occurred in the spring of 1954. That stocking, as well as a subsequent stocking of about 7,000 shad in 1961, failed to produce a sustaining threadfin population. In April, 1965, several stocking totaling about 25,000 shad were made and in subsequent years a continuing population of threadfin shad has existed.

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The effective stocking of 1965, plus the availability of scale samples collected by the Tennessee Game and Fish Commission prior to the 1965 stocking, provided an excellent opportunity to use the scale method to evaluate the effect of the threadfin shad stocking on the growth of certain game fishes. Collections made by the author provided the scale data since the 1965 stocking. As only total length was recorded from game fish sampled prior to shad stocking, this investigation was confined to that parameter.

MATERIALS AND METHODS

Data for comparison of growth rate between prestocking and poststocking fish were obtained from scale samples of 113 largemouth bass, 155 smallmouth bass, 234 spotted bass, 115 white crappie, and 128 walleye.

Most of the prestocking fish were collected in 1963, 1964, and 1965 as part of the Large Impoundment Investigations and Fish Population Studies conducted by the Tennessee Game and Fish Commission. These fish were collected during July, August, and October using the cove sampling method described by Chance (1957). Some of the prestocking fish, particularly walleye and crappie, were collected by nets.

Poststocking fish were collected by trammel nets, gill nets, and electrofishing from January through December, 1970. Most of the black basses were collected with an electrofishing boat similar to that described by Stubbs (1965). Most of the walleye and crappie, as well as a few bass, were collected by trammel and gill nets.

Scales from each fish were removed from the body near the tip of the left pectoral fin and stored in a labled envelope. Total length, weight and date of capture were recorded on each envelope. Impressions of scales were made on clear cellulose acetate strips by using a Carver laboratory heated press operating at about 25,000 psi and 180 F. Impressions were examined on an Eberback laboratory projector using a scale-image magnification of 40 X. Using these scale images, tagboard strips were marked with positions of the focus, annuli, and anterior margin of the scale. Each scale was read on two different occasions; some scales were read more than twice before agreement as to the position of annuli was reached. These strips were used on a nomagraph as described by Carlander and Smith (1944).

The Lee Method (Carlander, 1969) was used to calculate from the scale measurements the length of the fishes at various ages. The method assumes that the mathematical relationship between body length and scale radius is expressed by the formula:

$$Ln = a + \frac{Sn\ (Lc - a)}{Sc}$$

where Ln is the length at time of annulus formation; Lc is the length at capture; Sn is the scale measurement to a given annulus; Sc is the scale measurement from focus to anterior edge; and a is the intercept determined by fitting a body-scale regression.

In many studies, the a value has been equated to the length of the fish at the time of complete scalation. In this study, a values were calculated for each species of fish using the formula described by Miller (1966):

$$a = \frac{(\ \ L)(\ \ S^2) - (\ \ S)(\ \ LS)}{N\ \ S^2 - (\ \ S)^2}$$

where L is the total length, S is the anterior scale radius, and N is the number of fish in the sample. The a values for crappie, walleye, and smallmouth bass proved unreasonable; therefore, values obtained from the literature were used for these species.

The tagboard strip was placed on the nomograph so that the mark for the focus was on the line corresponding to the a value and the mark designating the scale margin was on the line corresponding to the length of the fish at capture.

The length of the fish at the time of each annulus formation was then read directly from the nomograph, using the marks designating each annulus.

After total length at each annulus was calculated for all fish, data for each species was divided into prestocking and poststocking groups. January 1, 1965, was used as the date of separation of the two groups, with growth occurring before this date considered prestocking and after this date poststocking.

The actual backcalculated total lengths and increments from each fish were used in making comparisons between the prestocking and poststocking years. All the total lengths at a particular annulus, for example annulus 1, from before stocking were compared to all total lengths for that species at annulus 1 for the poststocking fish. A similar calculation was made with the annual growth increments. This compared all growth for a certain year before stocking with all growth for that same year after stocking. By use of these actual lengths and annual growth increments, a valid comparison of growth could be obtained using the "t" test (Bishop, 1966; Snedecor, 1956).

RESULTS AND DISCUSSION

The following a values were used in calculation of growth by the Lee Method: Largemouth bass, 30 m (calculated); smallmouth bass, 32 mm (Everhardt, 1949); spotted bass, 26 mm (calculated); walleye, 45 mm (Priegle, 1964); and white crappie, 27 mm (Siefert, 1965).

Largemouth Bass

The number of largemouth bass available from prestocking and poststocking years seemed to be adequate for comparing the first three years of growth (Table 1). The "t" test indicated no significant difference in total length or annual increment between prestocking and poststocking fish. There was, however, an 18 mm difference in average calculated growth increment at annulus 3.

Smallmouth Bass

The number of pre- and poststocking smallmouth bass that were compared for the first two years of growth seemed to be adequate; however, the number of three-year old fish was quite small (Table 2). There was no significant difference at annulus 1 and 2, but there was a significant difference in both total length and increment at annulus 3. The small number of fish used in this third-year comparison makes this conclusion questionable.

Spotted Bass

The number of poststocking spotted bass greatly exceeded the number of available prestocking fish (Table 3). The number of fish used in comparisons for the first two years was probably adequate, but only three prestocking fish are represented in the third year comparison. A significant increase in both total length and increment occurred only at annulus 3.

White Crappie

White crappie showed no significant difference in growth at annulus 1, but there was a significant increase in poststocking fish at annulus 2 and 3 (Table 4). Sample size of crappie at annulus 3 was quite small. Goodson (1965) found that crappie over six inches in length foraged heavily on threadfin shad. In Isabella Lake, California, white crappie two years old or older had higher growth rates after shad introduction, but younger crappie did not show an increase in growth (Burns, 1966).

Walleye

Poststocking walleye showed a faster growth rate at annulus 1, 2, 3, and 4, but this increase was significant only at annulus 1 and 3 (Table 5). Libbey (1969) found that walleye of all ages forage heavily on threadfin shad in Dale Hollow. Other studies have indicated that young-of-the-year walleye are voracious feeders and, after a length of two inches, feed primarily on fish (Goodson, 1966; Eschmeyer, 1950).

Table 1. Total Length at Annulus Formation and Annual Growth Increments for Largemouth Bass, *Micropterus salmoides* (Lacepede), From Before and After Stocking of Threadfin Shad Into Dale Hollow Reservoir With "t" Test Values Indicating Significance of Difference.

	Mean calculated total length at annulus		
Annulus	1	2	3
Years before stockinga	127 (49)b	234 (33)	306 (9)
	Mean calculated total length at annulus		
Annulus	1	2	3
Years after stockingc	120 (28)	220 (22)	300 (15)
((t)) cal value	0.14	1.16	0.28
D.f.	75	53	22
Significance	None	None	None
	Mean calculated yearly increment at annulus		
Annulus	1	1	3
Years before stocking	127 (49)	107 (33)	92 (9)
	Mean calculated yearly increment at annulus		
Annulus	1	2	3
Years after stocking	120 (28)	100 (22)	80 (15)
"t" cal value	0.14	0.79	0.4
D.f.	75	53	22
Significance	None	None	None

aWeighted mean of values obtained from 1963 and 1964 collections containing a total of 70 fish.
bThe number of fish used for this section of comparison.
cWeighted mean of value obtained from 1970 collection containing a total of 43 fish.

Table 2. Total Length at Annulus Formation and Annual Growth Increment For Smallmouth Bass, *Micropterus dolomieui* Lacepede, From Before and After the Stocking of Threadfin Shad Into Dale Hollow Reservoir with "t" Test Values Indicating Significance of Difference.

	Mean calculated total length at annulus		
Annulus	1	2	3
Years before stocking[a]	97 (70)[b]	183 (14)	332 (4)
	Mean calculated total length at annulus		
Annulus	1	2	3
Years after stocking[c]	100 (59)	175 (39)	259 (8)
"t" cal value	0.97	0.68	2.1
D.f.	127	51	10
Significance	None	None	90%
	Mean calculated yearly increment at annulus		
Annulus	1	2	3
Years before stocking	97 (70)	86 (14)	149 (4)
	Mean calculated yearly increment at annulus		
Annulus	1	2	3
Years after stocking	100 (59)	75 (39)	84 (8)
"t" cal value	0.97	0.18	1.8
D.f.	127	41	10
Significance	None	None	90%

[a]Weighted mean of values obtained from 1963, 1964, and 1965 collections containing a total of 97 fish.
[b]The number of fish used for this section of comparison.
[c]Weighted mean of values obtained from 1970 collection containing a total of 60 fish.

Table 3. Total Length at Annulus Formation and Annual Growth Increments For Spotted Bass, *Micropterus punctulatus* (Rafinesque) From Before and After Stocking of Threadfin Shad Into Dale Hollow Reservoir With "t" Test Values Indicating Significance of Difference.

	Mean calculated total length at annulus		
Annulus	1	2	3
Years before stocking[a]	111 (25)[b]	188 (17)	224 (3)
	Mean calculated total length at annulus		
Annulus	1	2	3
Years after stocking[c]	108 (119)	192 (97)	251 (32)
"t" cal value	0.69	0.208	2.8
D.f.	142	112	33
Significance	None	None	99%
	Mean calculated yearly increment at annulus		
Annulus	1	2	3
Years before stocking	111 (25)	73 (17)	36 (3)
	Mean calculated yearly increment at annulus		
Annulus	1	2	3
Years after stocking	108 (119)	84 (97)	59 (32)
"t" cal value	0.69	2.03	3.4
D.f.	142	112	33
Significance	None	None	99%

aWeighted mean of values obtained from 1963, 1964, and 1965 collections containing a total of 32 fish.
bThe number of fish used for this section of comparison.
cWeighted mean of values obtained from 1970 collection containing a total of 216 fish.

Table 4. Total Length at Annulus Formation and Annual Growth Increments For White Crappie, *Pomoxis annularis* Rafinesque, From Before and After the Stocking of Threadfin Shad Into Dale Hollow Reservoir With "t" Test Values Indicating Significance of Difference.

	Mean calculated total length at annulus		
Annulus	1	2	3
Years before stocking[a]	80 (29)[b]	152 (9)	189 (2)
	Mean calculated total length at annulus		
Annulus	1	2	3
Years after stocking[c]	75 (84)	172 (50)	235 (10)
"t" cal value	1.28	2.70	2.42
D.f.	111	57	10
Significance	None	90%	95%
	Mean calculated yearly increment at annulus		
Annulus	1	2	3
Years before stocking	80 (29)	72 (9)	37 (2)
	Mean calculated yearly increment at annulus		
Annulus	1	2	3
Years after stocking	75 (84)	97 (50)	63 (10)
"t" cal value	1.28	2.82	.375
D.f.	111	57	10
Significance	None	90%	None

[a]Weighted mean of values obtained from 1963 and 1964 collections containing a total of 31 fish.
[b]The number of fish used for this section of comparison.
[c]Weighted mean of values obtained from 1970 collection containing a total of 88 fish.

Table 5. Total Length at Annulus Formation and Annual Growth Increments For Walleye, *Stizostedion vitreum* (Mitchill), From Before and After Stocking of Threadfin Shad Into Dale Hollow Reservoir With "t" Test Values Indicating Significance of Difference.

Annulus	Mean calculated total length at annulus				
Years before stocking[a]	208[1](87)[b]	344[2](74)	447[3](34)	538[4](13)	654[5](3)
	Mean calculated total length at annulus				
Annulus	1	2	3	4	5
Years after stocking[c]	228 (44)	357 (44)	487 (30)	554 (21)	634 (7)
"t" cal value	2.76	1.14	3.6	0.85	---
D.f.	139	116	62	32	---
Significance	99%	60%	99%	50%	---
	Mean calculated yearly increment at annulus				
Annulus	1	2	3	4	5
Years before stocking	208 (87)	136 (74)	103 (34)	91 (13)	116 (3)
	Mean calculated yearly increment at annulus				
Annulus	1	2	3	4	5
Years after stocking	228 (44)	129 (44)	131 (30)	67 (21)	80 (7)
"t" cal value	2.76	0.422	1.8	2.98	---
D.f.	139	116	62	33	---
Significance	99%	None	90%	99%	---

[a]Weighted mean of values obtained from 1964, 1965, and 1966 collections containing a total of 87 walleye.
[b]The number of fish used in this section of comparison.
[c]Weighted mean of values obtained from 1966 and 1970 collections containing a total of 60 walleye.

The threadfin shad in Dale Hollow Reservoir is mainly a pelagic species. This fact is reported by O'Rear (1970) from netting studies done by the U.S. Bureau of Sport Fisheries and Wildlife. Predatory species which frequently inhabit the pelagic environment are probably more likely to utilize the threadfin shad than are predators which do not frequent the pelagic waters. None of the three species of black basses exhibited any significant change in growth after the threadfin introduction. These fish do not utilize the open water environment as commonly as do species such as the walleye. The bass are usually found in areas where good cover exists. Thus, in Dale Hollow where there is a great deal of open water, the basses were probably not able to utilize the threadfin to a great extent.

Walleye and white crappie in Dale Hollow seem to utilize the open water more frequently than do the black basses. Both of these species were frequently observed, in large numbers, foraging on shad in open water at night. Myhr (1971) compared the growth rates of white bass, *Morone chrysops* collected before and after threadfin shad stocking in Dale Hollow and found a significant increase in total length from age class I through IV after threadfin were stocked. The fact that these species are able to forage on threadfin shad in its primary habitat may have resulted in their increased growth rates since introduction of the threadfin.

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