FLORIDA AND NORTHERN LARGEMOUTH BASS: GROWTH AND SURVIVAL IN A HEATED RESERVOIR

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In Boomer Lake, a shallow, turbid Oklahoma reservoir receiving a heated effluent, Florida largemouth bass (*Micropterus salmoides floridanus*) grew significantly faster than northern largemouth bass (*M. s. salmoides*) during the first summer of life. Because Florida bass were smaller when stocked, however, the faster growth does not indicate a difference in growth potential. On the average, Florida and northern bass were the same size by the first fall, and the two subspecies grew at a similar rate over the next 1.5 years. Both subspecies suffered heavy initial mortality, presumably from stocking stress. After the first summer, the survival of northern bass was: winter 1976-77, 100%; summer 1977, 97%; and winter 1977-78, 45%. Seasonal survival rates of Florida bass over the same periods, 43, 45, and 58%, respectively, were independent of winter severity. Total survival of northern bass (10%) was significantly higher than that of Florida bass (1%) over 2 years. Florida bass offer no apparent management benefits in Boomer Lake.

INTRODUCTION

The Florida largemouth bass (*Microperus salmoides floridanus* Lesueur, hereafter called Florida bass) is separated morphologically, physiologically, and ecologically from the northern subspecies (*M. s. salmoides* Lacépède, hereafter called northern bass). The benefits of introducing Florida bass into waters with populations of northern bass have been pointed out (1, 2, 3), but low survival of Florida bass in more northerly regions because of an intolerance to low or decreasing water temperature could limit their potential in Oklahoma (1, 3, 4). Florida bass might survive, however, in lakes that receive thermal effluents, providing that a large enough area is heated sufficiently to create a winter "sanctuary" (3). In each of three years — 1974, 1975, and 1976 — young-of-the-year Florida bass were introduced along with northern bass into a small heated reservoir in Stillwater, Oklahoma, to compare the growth, survival, and relative success of the subspecies. In this paper we discuss the results of the 1976 introductions of bass into Boomer Lake, and the potential of Florida bass in Oklahoma.

STUDY AREA AND METHODS

Boomer Lake is a shallow, turbid reservoir in the northeastern section of Stillwater, Oklahoma. The lake has a surface area of 102 ha, a shoreline length of 13.8 km, and mean and maximum depths of 3.0 and 7.6 m, respectively (5). Except for the old creek channel at the upper end, most of the lake is open and windswept. Several age-classes of indigenous northern largemouth bass and many other species common to reservoirs in central Oklahoma are present (3). The lake receives effluent normally heated 4 to 6.5°C above ambient temperatures from a conventional gas-fired steam-electric power plant with a capacity of 9 to 23 MW/h. Water circulates through the cooling system at a rate of 76 to 106 m^3/min, depending upon electrical demand. Prevailing winds and bottom topography confine the heated water mostly to the small cove where it enters the lake.

In June 1976, 3213 Florida and 1245 northern bass from the Holdenville (Oklahoma) State Fish Hatchery were introduced into Boomer Lake. Hatchery personnel were responsible for insuring the genetic integrity of the stocks, and the fish released had meristic counts and coloration patterns characteristic of the respective subspecies (6). Cauterized fin-clips were used to mark the bass for future identification: a left pectoral fin was removed

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from Florida bass and a right pectoral fin from northern bass.

Populations, growth, and survival were estimated each spring and fall from bass marked and recaptured (7) with a 240-V AC electroshocker mounted on a 5-m flat-bottomed boat. The Schnabel formula (8) was used to estimate the part of the bass population that included all bass up to 50 mm longer than the longest introduced bass that was expected. Separate estimates were made for the upper and lower portions of the lake, and samples were stratified by size according to the length of the introduced bass and the number of recaptures in each length group. The number of introduced bass was then estimated on the basis of percent representation in the sample; therefore, it was necessary to assume equal vulnerability of the subspecies to electrofishing. Since the fin-clips were assumed to be permanent, the estimates were not corrected for loss of marks.

Florida and northern bass collected during the semi-annual sampling periods were weighed to the nearest gram and measured to the nearest millimeter; these data were used to calculate instantaneous daily growth rates over seasonal and yearly intervals (8). Formulae for the variance in growth rate, the t-test used to compare growth rates, and the degrees of freedom for the t-statistic were given by Nieman (9) and Rieger and Summerfelt (3). Characteristics of the two species compared were limited to growth and survival.

Survival of the subspecies was estimated as a percentage of the original number stocked that was still alive during each sampling period. We tested differences in survival of the two subspecies for significance, using a Chi-square statistic (10), by comparing the relative frequency of occurrence in a sample with the population proportions at the time of stocking or at the time the previous sample was taken. The level of significance was determined by comparing the value of Chi-square with a tabulated distribution with one degree of freedom.

RESULTS

Florida bass, which were smaller than northern bass when the fish were stocked, grew significantly faster during the first summer, so that by the first fall the fish of the two subspecies were almost identical in size (Table 1). Florida bass grew at

TABLE 1. *Growth of Florida and northern largemouth bass introduced into Boomer Lake in 1976.*

	Time of sample				
	Spring 1976	Fall 1976	Spring 1977	Fall 1977	Spring 1978
Florida bass					
Number of fish	50	41	28	8	4
Mean length (mm)	58	151	178	247	258
Mean weight (g)	1.4	45.5	75	158	243
Elapsed time (days)		118	171	170	197
Instantaneous growth					
Seasonal		0.029	0.003	0.006	0.002
Annual			0.014	0.004	0.004
Total		0.029	0.014	0.011	0.008
Northern bass					
Number of fish	50	46	78	53	56
Mean length (mm)	75	159	170	268	292
Mean weight (g)	4.1	50	62	233	336
Elapsed time (days)		118	171	170	197
Instantaneous growth					
Seasonal		0.022	0.001	0.008	0.002
Annual			0.010	0.005	0.005
Total		0.022	0.010	0.009	0.007

approximately the same rate as northern bass during both winters. Northern bass grew significantly faster than Florida bass during the second summer, and on the average, were larger at the end of 2 years. However, growth rates calculated over the period from fall 1977, when the subspecies were first the same size, to spring 1978 were almost identical (0.0035 for northern bass and 0.0033 for Florida bass).

Survival of Florida bass was significantly less than that of northern bass over the first summer, although survival of both subspecies was low (Table 2). Later survival of northern bass was high until the winter of 1977-78, and an estimated 10% of the number stocked survived through the end of the 2-year study. In contrast, the overall survival of Florida bass was less than 1%, and survival varied little with season (Table 2). Even though Florida bass survived better than northern bass over the winter of 1977-78, the change in sample proportion from fall 1977 to spring 1978 was not significant. The estimated population of Florida bass was never as large as that of northern bass, although 2.5 times as many Florida bass were stocked. The ratio of Florida to northern bass in the samples changed significantly between every period except the last two (Table 2). Total survival of the northern bass was significantly higher than that of the Florida bass ($P \simeq 0$).

DISCUSSION

Recent comparisons of growth of the northern and Florida bass in Texas (11) and California (2) showed that northern bass grew faster than Florida bass through the first two years, after which Florida bass grew faster. These findings were partly supported by data from Boomer Lake, since northern bass reached a larger maximum size in two years, although overall growth was similar and neither subspecies was clearly superior. The poorer survival of Florida bass in Boomer Lake was the major difference between the subspecies, and indicated that the introduction of Florida bass was not a success. Although reasons why Florida bass did not survive are obscure, it appears that the high mortality was not due to an intolerance to low water temperature in Boomer Lake. Florida bass survived as well through two severe winters as they did through the intervening summer. Inasmuch as the survival of Florida bass through both winters was similar to that reported by Rieger and Summerfelt (3) for the mild winter of 1975-76, winter severity was not correlated with overwinter mortality. Clady (12) found no evidence that low water temperature caused mortality of young-of-the-year Florida bass in a small pond 13 km from Boomer Lake. The most convincing evidence, however, is that Florida bass stocked in Dripping Springs Lake, Oklahoma, in 1976 survived as well as northern bass through the winters of 1976-77 and 1977-78 (13, 14). Since Dripping Springs Lake is a new reservoir, with much clearer water and abundant cover in the littoral zone and without an established indigenous bass population or thermal effluent, dif-

TABLE 2. *Population estimates, percent seasonal and total survival, and X^2 analysis of relative catch for the 1976 introduction of Florida and northern bass.*[a] *Observed proportions of the subspecies in the samples are given in parenthesis under sample size.*

Season and year	Northern bass n	Northern bass $\hat{N}$	Northern bass Survival (%) Seasonal	Northern bass Survival (%) Total	Florida bass n	Florida bass $\hat{N}$	Florida bass Survival (%) Seasonal	Florida bass Survival (%) Total	X^2 P
Spring 1976	--	1245[b] (.28)	21.5	21.5	--	3213[b] (.72)	7.3	7.3	27.0 P<<.001
Fall 1976	46 (.53)	267	111.6	23.9	41 (.47)	235	42.6	3.1	109.0 P ≃ 0
Spring 1977	77 (.74)	298	97.0	23.2	27 (.26)	100	45.0	1.4	105.0 P ≃ 0
Fall 1977	53 (.87)	289	44.6	10.4	8 (.13)	45	57.8	0.8	63.7 P ≃ 0
Spring 1978	31 (.89)	129			4 (.11)	26			

[a] n = sample size; $\hat{N}$ = population estimate
[b] Number (and proportion) stocked

ferences, in physical and biotic conditions between it and Boomer Lake may contribute to the greater success of Florida bass in Dripping Springs Lake.

The results of studies of Florida bass in Oklahoma have been highly variable. The smaller mean size and poorer survival of Florida bass in Boomer Lake suggests that the subspecies has little potential in reservoirs similar to it. However, Florida bass do survive in other types of reservoirs in the state, and may provide benefits there. In Dripping Springs Lake, where Florida bass survived well, their growth was also superior to that of northern or hybrid northern x Florida bass (13, 14). The environmental factors that limit survival of Florida bass in Oklahoma should be identified so that introductions are made only in suitable reservoirs.

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