

COMPARISON OF GROWTH, SURVIVAL, AND CATCHABILITY OF FLORIDA, NORTHERN, AND HYBRID LARGEMOUTH BASS IN A NEW OKLAHOMA RESERVOIR

GARLAND L. WRIGHT, Oklahoma Department of Wildlife Conservation, Route 3, Box 45, Holdenville, OK 74848

GREGORY W. WIGTIL, Oklahoma Fishery Research Laboratory, 1416 Planck Street, Norman, OK 73069

Abstract: Florida largemouth bass, *Micropterus salmoides floridanus*, northern largemouth bass, *M. s. salmoides*, and their F¹ hybrid were stocked in a new 420 ha reservoir, and their growth, relative survival and relative catchability were compared. The Florida and hybrid bass were found to achieve the best overall growth by the end of the study period. However, of the 3 strains, Florida bass appeared to have the greatest potential for growth. Hybrid bass suffered less relative mortality than Florida bass, which suffered less than northern bass. Differences in relative catchability were not observed among the three strains of bass.

Proc. Ann. Conf. S.E. Assoc. Fish & Wildl. Agencies 34:31-38

Research findings on growth differences between northern largemouth bass and Florida largemouth bass have been somewhat contradictory. Some investigators have either found similar growth rates of the two subspecies, or that northern bass grew faster at early ages (Sasaki 1961, Clugston 1964, Zolczynski and Davies 1976). These investigators concluded that the larger sizes reported for Florida bass were due to favorable environmental conditions in their native range. Others have found differences in growth which they attributed to genetic rather than environmental factors (Inman et al. 1977, Bottroff and Lembeck 1978). In these studies, Florida bass outgrew northern bass at older ages. Inman et al. (1977) found that hybrid bass had the best overall growth rates of the three bass strains. However, Bottroff and Lembeck (1978) indicated that growth rates of hybrid bass were intermediate to those of the parental subspecies.

Childers (1975) has warned that the introduction of Florida bass into the native ranges of the northern subspecies could result in the incorporation of maladaptive genes. Johnson and Anderson (1974) reported that Florida bass were not tolerant to prolonged low water temperatures in small Missouri ponds and under laboratory conditions. Florida bass also had consistently higher winter mortality than northern bass in other midwestern ponds (Johnson and Graham 1978). While Florida bass in a heated power generation lake in Oklahoma suffered greater mortality rates than northern bass, mortality of the Florida subspecies subsequent to the initial summer period seemed to be independent of season (Nieman 1978). In Texas, however, the mortality rates of northern bass were higher than those of either Florida bass or hybrid bass (Inman et al. 1977). Similar situations were evident in California, where Florida bass appeared to be hardier than northern bass (Miller 1965, Bottroff 1967).

The objective of this study was to evaluate the growth, relative survival, and relative catchability of three strains of largemouth bass (the Florida subspecies, the northern subspecies, and their F¹ hybrid) under the same environmental conditions. This study was supported in part by funds from the Federal Aid in Fish Restoration Act under Oklahoma Project F-33-R Job 2.

METHODS

Source of Fish

Bass fingerlings were produced at the Oklahoma Department of Wildlife Conservation fish hatchery at Byron. Northern bass brood stock had been hatchery raised in Ok-

lahoma. The original source of Florida bass brood stock was the Welaka National Fish Hatchery at Welaka, Florida. Hybrid bass were produced by crossing both Florida males with northern females and Florida females with northern males.

Description of Study Area

Dripping Springs Lake, an impoundment constructed in 1975 in Okmulgee County, is relatively clear with abundant cover in the form of submerged brush, trees, and aquatic vegetation. The lake did not fill rapidly because of near drought conditions. Approximate surface areas of the lake in 1976, 1977, 1978, and 1979, were 80, 120, 160, and 420 ha, respectively. Public fishing was not allowed on this lake until January 1, 1980.

Marking Procedures

Prior to stocking, approximately 15,000 fish of each strain were marked for future differentiation by having a fin clipped and cauterized. During the marking procedure, fish were anesthetized with quinaldine for ease of handling. Manicure scissors were used for clipping fins, and the base of each clipped fin was cauterized with a soldering gun to prevent regrowth. These fish ranged in length from 75 to 125 mm at the time of marking. Approximate means weights by strain were 9 g for northern bass, 5 g for Florida bass, and 6 g for hybrid bass. Fish were stocked either immediately after marking or the following day. Stocking dates were the 14th, 23rd, and 30th of July, 1976.

Sampling Methods

Electrofishing was conducted each fall (October) and spring (May) following stocking from 1976 through 1979. An effort was made to collect a minimum of 200 marked bass each season. Sampling was conducted in all areas of the lake suitable for electrofishing, and marked fish of each strain collected were counted, measured to the nearest millimeter (total length), and weighed to the nearest gram.

A total of 323 angler-hours of fishing were conducted by Oklahoma Department of Wildlife Conservation personnel on October 17th and 18th, 1979, to determine possible differences in the relative catchabilities of the three strains of bass. Only artificial lures were used, and all angling was conducted from boats. There were no restrictions concerning the areas of the lake fished or the types of lures used.

Data Analysis

Total length data and weight data from each sampling period (season) were statistically compared among the three strains as were relative weight data (Wege and Anderson 1978). Only data gathered by electrofishing were used for these analyses. Cochran C tests (Roscoe 1975) indicated that Kruskal-Wallis tests and multiple confidence interval procedures (Marascuilo and McSweeney 1977) would better analyze the data than analysis of variance tests. Sample sizes, medians, means, standard deviations, and 20mm length-frequencies were calculated for each sampling period.

Stocking frequencies (numbers) and electrofishing frequencies were used to determine relative survival among the strains. It was assumed that each strain was equally susceptible to electrofishing. A chi-square test of homogeneity of proportion plus post hoc multiple comparisons (Marascuilo and McSweeney 1977) were used to determine any changes of each strain's proportion in the sample as time progressed. Spring and fall electrofishing frequencies from a particular year were combined because it was assumed that a difference in these frequencies was an artifact due to random chance.

Finally, a chi-square test of homogeneity of proportion was used to test for catchability differences among the strains. Angling catch data from Fall, 1979, were compared to Fall, 1979, electrofishing data. The level of significance for all statistical tests was set at $\alpha = 0.05$.

RESULTS

Marking

Initial mortality of fish due to the marking procedure was low (less than 1%); however, no estimate of delayed mortality was made. No regrowth of clipped fins was noted, and there was no problem identifying strains under field conditions.

Growth

A high numerical rank for a given sampling period and strain indicates the strain contained significantly longer, heavier, or plumper fish than a strain with a lower rank, while a tied rank indicates that there was no significant difference between the strains involved (Table 1).

There were significant differences in both lengths (Table 1) and weights (Table 2) among the 3 strains for all sampling periods. Initially, both the Florida and northern subspecies were significantly longer and heavier than the hybrids. By Fall, 1977, Florida bass were significantly longer and heavier than the northern subspecies and with the exception of weight in Spring, 1978, remained so throughout the duration of the study. After Spring, 1977, lengths and weights of hybrid bass were similar to or significantly greater than those of northern bass, and in Fall, 1978, and Fall, 1979, their lengths and weights were similar to those of Florida bass.

In Spring, 1977, there were no significant differences in condition between northern bass and hybrid bass, but hybrid bass were plumper than Florida bass (Table 3). A similar situation occurred during Fall, 1977, except that Florida bass were plumper than hybrid bass. Florida bass were significantly plumper than hybrid bass, and similar to or plumper than northern bass in all subsequent samples.

Survival

Each strain's proportion in the sample over time was set by the end of 1977 (Table 4). The proportion of northern bass in the sample was significantly smaller in 1977 than at time of stocking. The proportion of Florida bass remained roughly the same over this time period, while the proportion of hybrid bass increased significantly. From 1977 through 1979, none of the strains showed any significant changes in their respective proportions in the catch from year to year. Overall, hybrid bass occurred in greater proportion, Florida bass occurred in about the same proportion, and northern bass occurred in lesser proportion at the end of the study than at the time of stocking.

Catchability

During the 323 angler-hours of fishing conducted during Fall, 1979, 178 marked bass were caught. The 34 (19%) northern bass, 29 (16%) Florida bass, and 115 (65%) hybrid bass caught did not make up significantly different proportions in the catch than the 25 (18%) northern bass, 33 (24%) Florida bass, and 81 (58%) hybrid bass collected while electrofishing.

DISCUSSION

Growth

The similar sizes of Florida and northern bass at early ages agree with the findings of Sasaki (1961) and Inman et al. (1977). However, by 18 months of age, Florida bass were significantly larger than northern bass, and remained so throughout the duration of the study. Superior growth of Florida bass as compared to northern bass at older ages was also noted by Inman et al. (1977) and Bottroff and Lembeck (1978). Although initially smaller than the other 2 strains, by the end of the study, hybrid bass were significantly larger than northern bass and similar in size to Florida bass. However, superior growth of hybrid bass compared to Florida bass (Inman et al. 1977) was not noted in this study. As the

Table 1. Body length statistics of 3 largemouth bass strains from Dripping Springs Lake, Oklahoma.

Sampling Period	STRAIN														
	Northern						Florida						Hybrid		
	N	Median (mm)	Rank	Mean (mm)	S.D. (mm)	N	Median (mm)	Rank	Mean (mm)	S.D. (mm)	N	Median (mm)	Rank	Mean (mm)	S.D. (mm)
Fall, 1976	38	121	2.5	122	20	74	116	2.5	125	29	88	100	1	103	17
Spring, 1977	21	117	a	125	29	59	135	a	137	30	120	106	a	111	22
Fall, 1977	39	201	1.5	201	18	59	221	3	232	41	102	204	1.5	202	19
Spring, 1978	48	215	1.5	233	51	54	238	3	262	63	98	214	1.5	215	26
Fall, 1978	94	278	1	282	25	94	307	2.5	316	47	219	301	2.5	302	25
Spring, 1979	52	300	1.5	314	46	76	368	3	371	53	86	321	1.5	319	29
Fall, 1979	25	331	1	336	26	33	386	2.5	392	58	81	361	2.5	364	34

a No clear rankings were possible, but the Floridas were significantly longer ($P < 0.05$) than the hybrids.

Table 2. Body weight statistics of 3 largemouth bass strains from Dripping Springs Lake, Oklahoma.

Sampling Period	STRAIN														
	Northern						Florida						Hybrid		
	N	Median (g)	Rank	Mean (g)	S.D. (g)	N	Median (g)	Rank	Mean (g)	S.D. (g)	N	Median (g)	Rank	Mean (g)	S.D. (g)
Fall, 1976	38	20	2.5	22	13	74	17	2.5	26	21	88	12	1	14	9
Spring, 1977	21	19	2.5	24	18	59	25	2.5	31	24	120	13	1	17	28
Fall, 1977	39	94	1.5	95	29	59	127	3	166	129	102	90	1.5	94	28
Spring, 1978	48	111	a	190	183	54	155	a	285	244	98	108	a	119	62
Fall, 1978	93	257	1	282	96	92	380	2.5	459	292	217	334	2.5	349	110
Spring, 1979	51	356	1.5	472	282	76	715	3	833	441	85	444	1.5	445	141
Fall, 1979	25	458	1	519	170	33	820	2.5	981	584	81	648	2.5	677	229

a No clear rankings were possible, but the Floridas were significantly heavier ($P < 0.05$) than the hybrids.

Table 3. Relative weight statistics of 3 largemouth bass strains from Dripping Springs Lake, Oklahoma.

Sampling Period	STRAIN														
	Northern					Florida					Hybrid				
	N	Median	Rank	Mean	S.D.	N	Median	Rank	Mean	S.D.	N	Median	Rank	Mean	S.D.
Fall, 1976	38	91	1.5	92	13	74	90	1.5	93	13	88	96	3	100	16
Spring, 1977	21	84	a	89	12	59	82	a	83	11	120	88	a	90	12
Fall, 1977	39	86	b	85	8	59	86	b	86	6	102	83	b	83	6
Spring, 1978	48	88	2.5	89	11	54	89	2.5	89	11	98	83	1	84	8
Fall, 1978	93	85	1.5	86	5	92	88	3	89	10	217	85	1.5	86	5
Spring, 1979	51	95	2.5	95	8	76	98	2.5	99	11	85	92	1	91	6
Fall, 1979	25	90	1.5	90	7	33	93	3	97	10	81	91	1.5	91	7

a No clear rankings were possible, but the hybrids were significantly plumper than the Floridas.

b No clear rankings were possible, but the Floridas were significantly plumper than the hybrids.

Table 4. Proportions of each strain of largemouth bass in the electrofishing sample from Dripping Lakes, Oklahoma.

Year	Proportion in Sample			
	N	Northern	Florida	Hybrid
1976 ¹	44,799	0.34	0.34	0.33
1977	400	0.15	0.30	0.56
1978	607	0.23	0.24	0.52
1979	353	0.22	0.31	0.47

¹At stocking.

environmental conditions were the same for all 3 strains in this study, it is felt that the observed differences in growth were due to genetic factors.

Overall, Florida bass appeared to have the greatest potential for growth of the 3 strains in this study. They had the greatest variation in lengths and weights, and their length-frequency distributions usually extended to higher ranges than those of the other 2 strains. Consequently, the largest specimens collected in most samples were of the Florida subspecies. The higher observed mean lengths and weights of Florida bass were generally due to the presence of these larger fish. The heaviest Florida bass collected during the study weighed 2,778 g, which was considerably larger than either the heaviest hybrid bass (1,701 g) or the heaviest northern bass (1,588 g). Shortly after the study was completed and the lake was opened to fishing, an angler caught a Florida bass weighing 3,765 g. This fish was less than 4 years old at the time of its capture. The fastest growth previously reported for an Age IV bass from Oklahoma waters was 2,771 g (Houser and Bross 1963).

It is important to note that ideal conditions for growth may not have been present in this study. Because of the low water level at time of stocking (80 ha) and the number stocked (45,000), the stocking rate was quite high (562/ha). Spawning of bass indigenous to the watershed also added to the population. The lake was slow to fill, and relative weights of bass during this period indicated that forage fish availability was low. Therefore, it is probable that the full growth potential of these fish was not realized. The apparent deficiency of forage may also explain why hybrid bass and Florida bass were not plumper than northern bass after Age II as reported by Inman et al. (1977).

Survival

From the proportions of each strain in the sample for each year, it may be inferred that hybrid bass suffered less mortality than Florida bass, which suffered less mortality than northern bass. It was interesting to note that the proportion of each strain in the catch was set by 1 year after stocking, and that significant differences did not occur after this time. The relatively higher survival of hybrid bass was possibly due to hybrid vigor. The reason for the higher relative mortality of northern bass is not known, but may have been due to delayed handling mortality. Inman et al. (1977) attributed similar findings as a response to handling, electrofishing, or other unknown factors.

During this study, Oklahoma experienced record cold winters. The lake was ice-covered for about 6 weeks during the winter of 1978-79. Even with these adverse conditions, high overwinter mortality of Florida bass as reported by Johnson and Anderson (1974), Johnson and Graham (1978), and Reiger and Summerfelt (1976) was not noted.

Catchability

No significant differences in vulnerability to angling among the 3 strains were found in this study. This finding was contrary to those of Reiger et al. (1978), Smith (1971), and Zolczynski and Davies (1976), but did agree with that of Inman et al. (1977). However, it should be noted that this was a new lake which had not been previously fished. Bass were very susceptible to angling under these conditions as illustrated by the catch rate of 4.06 per angler-hour for native and stocked bass combined.

CONCLUSIONS

From the results of this study, it appears that Florida bass may be suitable for introduction into new Oklahoma impoundments. In Dripping Springs, their growth was found to be superior to that of the northern subspecies at older ages. Overall, survival of Florida bass was at least equal to that of northern bass despite adverse winter conditions. Superior growth of Florida bass should allow a more rapid development of a quality bass fishery in a new lake. Also, it appears that a trophy fishery may be provided by their introduction. Hybrid bass also showed excellent potential in terms of growth and survival indicating that there may be no problems due to hybridization when Florida bass are introduced into lakes containing populations of northern bass.

LITERATURE CITED

- BOTTRUFF, L. J. 1967. Intergradation of Florida bass in San Diego County, California. M.S. Thesis, San Diego State College, San Diego. 135pp.
- BOTTRUFF, L. J., and M. G. LEMBECK. 1978. Fishery trends in reservoirs of San Diego County, California, following the introduction of Florida largemouth bass, *Micropterus salmoides floridanus*. Calif. Fish Game 64:4-23.
- CHILDERS, W. F. 1975. Bass genetics as applied to culture and management. Pages 362-372 in R. H. Stroud and H. Clepper, eds. Black bass biology and management. Sport Fishing Institute, Washington, D.C.
- CLUGSTON, J. P. 1964. Growth of the Florida largemouth bass and the northern largemouth bass in subtropical Florida. Trans. Am. Fish. Soc. 93:146-154.
- HOUSER, A., and M. G. BROSS. 1963. Average growth rates and length-weight relationships for fifteen species of fish in Oklahoma waters. Okla. Fish. Res. Lab., Norman. Report No. 85. 75pp.
- INMAN, C. R., R. C. DEWEY, and P. P. DUROCHER. 1977. Growth comparisons and catchability of three largemouth bass strains. Fisheries. 2(5):20-25.
- JOHNSON, D. L., and R. O. ANDERSON. 1974. A comparison of Florida and northern largemouth bass in Missouri. Abstracts, Midwest Fish and Wildl. Conf. 36:82.
- JOHNSON, D. L., and L. K. GRAHAM. 1978. Growth, reproduction, and mortality factors affecting the management of largemouth and smallmouth bass. Pages 92-103 in G. D. Novinger and J. G. Dillard, eds. New approaches to the management of small impoundments. N. Central Div., Am. Fish. Soc., Spec. Publ. No. 5.
- MARASCUILO, L. A., and M. McSWEENEY. 1977. Nonparametric and distribution-free methods for the social sciences. Brooks/Cole Publ. Co., Monterey, Calif. 556pp.
- MILLER, L. W. 1965. A growth study and blood protein analysis of the two subspecies of largemouth bass; the Florida bass, *Micropterus salmoides floridanus* (Le Suer), and the northern bass, *Micropterus salmoides salmoides* (Lacepede), in San Diego County, California. Calif. Dept. Fish and Game, Inland Fish. Adm. Rep. No. 65:15-18.
- NIEMAN, D. A. 1978. Some aspects of the ecology of Florida and northern largemouth bass in a thermally enriched reservoir. M.S. Thesis, Okla. State Univ., Stillwater. 97pp.
- REIGER, P. W., R. C. SUMMERFELT, and G. E. GEBHART. 1978. Catchability of northern and Florida largemouth bass in ponds. Prog. Fish-Cult. 40:94-97.
- REIGER, P. W., and R. C. SUMMERFELT. 1976. An evaluation of the introduction of Florida largemouth bass into an Oklahoma reservoir receiving a heated effluent. Proc. Ann. Conf. S.E. Assoc. Fish & Wildl. Agencies 30:48-57.
- ROSCOE, J. R. 1975. Fundamental research statistics for the behavioral sciences. Holt, Rinehart and Winston, Inc., Dallas. 483pp.
- SASAKI, S. 1961. Introduction of Florida largemouth bass into San Diego County. Inland Fish. Adm. Rep., Calif. Dept. Fish and Game No. 61-11. 6 pp. (Mimeo).
- SMITH, G. 1971. Florida largemouth bass in southern California. Florida Wildlife. September:30.
- WEGE, G. W., and R. O. ANDERSON. 1978. Relative Weight (W): A new index of condition for largemouth bass. Pages 79-91 in G. D. Novinger and J. G. Dillard, eds. New approaches to the management of small impoundments. N. Central Div., Am. Fish. Soc., Spec. Publ. No. 5.
- ZOLCZYNSKI, S. J., and W. D. DAVIES. 1976. Growth characteristics of the northern and Florida subspecies and their hybrid, and a comparison of catchability between the subspecies. Trans. Am. Fish. Soc. 105: 240-243.