Comparison of Florida, Northern, and Intergrade Juvenile Largemouth Bass in a Virginia Reservoir

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Abstract: Briery Creek Lake was stocked with both the Florida and northern subspecies of largemouth bass (*Micropterus salmoides floridanus* and *M. s. salmoides*, respectively) at a ratio of 3 Florida to 1 northern bass following impoundment in 1986. Progeny of these stockings in the 1989 and 1990 year classes were sampled in October as age-0 and again the following May and electrophoretically assayed to assign phenotypes for comparison of overwinter survival, first-year growth, and relative weight. Subspecies as well as intergrade (F_1 and F_x) phenotypes were present in both year classes. First-generation hybrids dominated the 1989 cohort, but F_x and F_1 bass were equally prominent in the 1990 year class. Approximately 50% of examined alleles were of Florida bass origin in both year classes. Differential overwinter mortality occurred among phenotypes in both year classes, with the percentage of the Florida subspecies declining by two-thirds while intergrade bass proportionally increased. First-year growth and relative weight did not vary consistently among phenotypes. The Florida subspecies of largemouth bass is likely to provide at best only a small and short-term direct contribution when stocked in waters experiencing winter thermal regimes like that of Briery Creek Lake (≥100 days <10 C water temperature, >1,900 heating degree days). Potential benefits of Florida largemouth bass introductions to Virginia and states with similar climates may be outweighed by the consequences of persistent contamination of northern largemouth bass gene pools.

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The Florida subspecies of largemouth bass (FLMB) is endemic to peninsular Florida (south of 30°37' N latitude) but it has been widely stocked elsewhere to establish trophy bass fisheries. In most of these waters, FLMB soon hybridize with native northern largemouth bass (NLMB), producing intergrade hybrids (F_1 and F_x). Stockings of FLMB have produced trophy bass fisheries in some states, presumably as the result of superior growth and/or longevity of FLMB and intergrades, but success appears to be climate-dependent. The Florida subspecies has poorer cold tolerance than the northern subspecies (Cichra et al. 1982); it as well as intergrades experienced poor overwinter survival and growth relative to NLMB in central Illinois at 40°10' N latitude (Philipp and Whitt 1991). However, FLMB and intergrades experienced better growth and survival than did NLMB in Aquilla Lake, Texas (31°55' N; Maceina et al. 1988). A survey of Oklahoma reservoirs stocked with FLMB indicated that they persisted better at latitudes south of 35°30' N (Gilliland and Whitaker 1989). Gilliland (1992) refined that assessment on the basis of climate, recommending that FLMB stockings in Oklahoma be discontinued in that part of the state where heating degree days (HDD, the sum of all days fall to spring when the mean air temperature is below 18.3 C times the difference between mean temperature on those days and 18.3 C) exceeded 1,870. However, the relationship between HDD and survival to age 1 of FLMB was not statistically significant in this Oklahoma assessment.

Collectively, these studies demonstrate that FLMB and intergrade bass perform satisfactorily south of 35°N latitude and fare poorly north of 40°N. At latitudes between 35°N and 40°N, local climate may determine success of FLMB introductions; more research is necessary to define these climatic influences.

This study assessed the performance of juvenile FLMB, NLMB, and intergrade bass in Briery Creek Lake, Virginia (37°12N'), which was stocked with FLMB and NLMB following its impoundment in 1986. We sampled the age-0 progeny of these fish in the 1989 and 1990 year classes and compared phenotypes for overwinter survival, first-year growth, and relative weight.

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Methods

Briery Creek Lake is a 342-ha mesotrophic reservoir in south-central Virginia with a mean depth of 4 m and large stands of both submerged and emergent timber. The principal tributary, Briery Creek, was treated with rotenone prior to dam closure in 1985. The lake was stocked with approximately 64,000 fingerling FLMB (Florida origin) and 20,000 NLMB (Indiana origin) fingerlings in 1986 and again in 1987. Largemouth bass reproduction was first observed in 1988. Overwinter (December through March) water temperature in Briery Creek Lake was measured by a continuous recording thermograph suspended at a depth of 3 m in 1989–90 and 1990–91.

Approximately 100 largemouth bass juveniles (75–140 mm total length) were collected by boat electrofishing at night on 4 dates, 1 each in October 1989, May and October 1990, and May 1991. Bass were collected from throughout the reservoir to minimize the influence of potential habitat segregation among phenotypes. Specimens were stored on ice, then returned to the laboratory for length and weight measurements and excision of livers for electrophoretic analysis.

Horizontal starch-gel electrophoresis was used to categorize individual largemouth bass as NLMB, FLMB, or intergrades (F_1 or F_x). Fixed allelic differences between FLMB and NLMB at 2 loci (sAAT-2*, IUBNC 2.6.1.1 and sIDHP-2*, IUBNC 1.1.1.42) were used to discriminate among the 4 phenotypes (Philipp et al. 1983). Homozygous bass were assigned to the appropriate subspecies, while double heterozygotes were classified as F_1 and single heterozygotes as F_x. A third polymorphic enzyme, GALT-2* (IUBNC 1.7.7.12), was assayed to provide confirmation of phenotypic assignments. Allelic overlap between FLMB and NLMB for GALT-2* has been reported to be 1%–4% (Williamson and Carmichael 1986, Maceina et al. 1988). Inclusion of GALT-2* resulted in a reclassification rate of 4%, within the range of reported allelic overlap; the original phenotypic assignment was retained for all fish. The percentages of Florida bass alleles in each cohort were estimated by dividing the number of Florida alleles expressed in the data set by the total number of alleles examined (N fish $\times$ 6).

Relative overwinter survival was examined by comparison of the frequency distributions of largemouth bass phenotypes between October and May samples using Chi-square tests of homogeneity. Comparisons among phenotypes for length at age 1 (May samples) and relative weights (W_r; calculated with the equation of Wege and Anderson 1978 in all 4 samples) were made with 1-way ANOVA and Duncan's multiple range test. All tests were assumed to indicate statistical significance at the P = 0.05 level for Type I error.

Results and Discussion

Both the 1989 and 1990 year classes of largemouth bass in Briery Creek Lake were dominated by FLMB and intergrade phenotypes (Table 1). The presence of the F_x phenotype in both year classes indicates that the founding stock did not consist only of the pure northern and Florida subspecies. Contaminated brood sources have plagued comparative studies of FLMB vs. NLMB (Maceina et al. 1988, Gilliland and Whitaker 1989) and illustrate the need for confirmation of genetic status prior to stocking. Some degree of misclassification of F_x individuals as subspecies of F_1 phenotypes may have occurred. However, agreement with the original 2-loci phenotype assignments by using a third diagnostic locus (GALT-2*) was 96%, indicating that misclassification was minimal.

The NLMB phenotype was poorly represented in both cohorts. Bass were stocked at a ratio of 3 FLMB to 1 NLMB, which may account for some of the disparity. Phenotypic composition differed significantly between the 1989 and 1990 cohorts in both October and May samples. The F_1 hybrid phenotype accounted for the

Table 1. Percentage phenotypic composition of the 1989 and 1990 year classes of largemouth bass in Briery Creek Lake, Virginia at age 0 (October) and age 1 (following May).

Year class	Phenotype[a]	Oct	May
1989	NLMB	4	4
	FLMB	17	4
	F_1	60	75
	F_x	19	17
1990	NLMB	8	8
	FLMB	39	12
	F_1	22	39
	F_x	31	40

a. NLMB = northern largemouth bass; FLMB = Florida largemouth bass; F_1 = first-generation hybrid between NLMB and FLMB; F_x = second-or later-generation hybrid between NLMB and FLMB.

majority of 1989 year-class bass, but F_x hybrids were equally abundant in the 1990 year class at age 1. Domination of the largemouth bass population by F_x hybrids within a few generations is a predictable consequence of FLMB stockings because the northern and Florida subspecies of largemouth bass do not effectively segregate in spawning (Isely et al. 1987, Maceina et al. 1988, Philipp 1991).

The distribution of phenotypes also differed significantly within both year classes between October and May (Table 1). The proportional contribution of FLMB dropped by two-thirds over the first winter in each instance; this loss was made up by proportionally higher survival of F_1 (both year classes) and F_x hybrids (1990 year class). In both winters, water temperature was <10 C for >100 days. In 1989–90, water temperature ranged between 3 and 5 C for 31 consecutive days, and HDD totaled 2,178. The winter of 1990–91 was somewhat less severe; water temperature never declined below 6 C, and HDD totaled 1,982. The HDD metric is not totally definitive of first-winter survival potential for FLMB, but results of this and similar field studies generally concur. At Aquilla Lake, Texas, HDD averaged 1,210 during a 4-year study by Maceina et al. (1988), and differential overwinter mortality of FLMB did not occur. However, FLMB experienced very poor overwinter survival in central Illinois ponds where HDD averaged 2,906. Gilliland (1992) recommended discontinuance of FLMB stockings in that part of Oklahoma which exceeded 1,870 HDD because of generally poor survival. This study substantiates that recommendation. More specifically, differential first-winter mortality of FLMB may be expected to occur in waters which drop to ≤10 C for at least 2 months, a thermal regime characteristic of most Virginia waters.

Although the direct contribution of FLMB to mid-latitude sport fisheries may be slight, the enduring legacy of their stocking is likely to be introgression of Florida genes into the native northern largemouth bass genome. In Briery Creek Lake, the percentage contribution of Florida bass alleles at 3 loci was 50% for the 1989 year class at age 1 and 49% for the 1990 year class. Philipp et al. (1983) surveyed 3 other

Virginia reservoirs that had received FLMB introductions several years earlier and reported allelic contributions of 19%, 46%, and 80%. Florida bass alleles should also persist in the Briery Creek Lake population.

Total length at capture in the May samples (age 1) did not vary significantly among phenotypes in the 1989 and 1990 cohorts, with the exception that F_1 hybrids of the 1989 year class were significantly longer than FLMB (Fig. 1). Relative weight showed similar inconsistency among phenotypes over the 4 samples. Statistically significant differences in W_r occurred only in the May 1991 sample of the 1990 year class; mean W_r values were significantly greater for FLMB (97.9) and F_x (97.4) than for NLMB (89.8).

Other studies show a general pattern of slower or equivalent first-year growth of FLMB relative to NLMB or intergrades in the southeastern United States and in California (Moyle and Holzhauser 1978, Regier and Summerfelt 1978, Maceina et al. 1988). In Oklahoma reservoirs, FLMB were generally longer than NLMB at age 1 but were in poorer condition (Gilliland 1992). For the Briery Creek Lake population, no early growth advantage is apparent for FLMB and intergrades. However, lifespan growth potential of largemouth bass with Florida alleles has not been compared to NLMB where both stocks were present. Maceina et al. (1988) observed that FLMB first outgrew NLMB at age 3 in Aquilla Lake. Other studies (cited by Philipp 1991) have found no evidence of a "late blooming growth advantage" for FLMB or intergrade phenotypes.

Briery Creek Lake established a reputation as a trophy largemouth bass fishery in the 1990s. From 1992 through 1996, 91 citation (>3.6 kg) bass were reported by Briery Creek anglers to the VDGIF. Whether this production of trophy bass was due to genetic attributes, environmental conditions, or a combination of these factors cannot be determined. New reservoirs in Virginia and elsewhere experience a "boom" phase in their fisheries as fertility is high and fish density is expanding (Kimmel and Groeger 1986). The trophy bass fishery in Briery Creek Lake now appears to have peaked; citation reports declined in both 1996 and 1997, and annual growth rates of largemouth bass have dropped 20% since 1990 (D. Wilson, VDGIF, pers. commun.). Four citation specimens we were able to electrophoretically analyze proved to be F_x intergrades.

This study documents poor first-year survival of the Florida subspecies of largemouth bass in a new mid-latitude reservoir. In such systems, contributions of FLMB to the adult, harvestable population will be limited and short-term. Stocking of FLMB should, however, result in a generation of F_1 hybrids which will soon be replaced by F_x progeny. The second and later-generation intergrades appear to lack the attributes to sustain a trophy fishery, as evidenced by widespread stockings of FLMB in the 1970s into Virginia reservoirs which then failed to establish trophy fisheries (VDGIF, unpubl. data), despite the persistence of FLMB alleles in some populations (Philipp 1983). The best opportunity to develop a trophy fishery even briefly by stocking FLMB will likely be limited to new impoundments that experience moderate climatic conditions. Latitude and HDD are imperfect thermal criteria, as overwinter FLMB survival may depend more on short-term temperature extremes (Gilliland

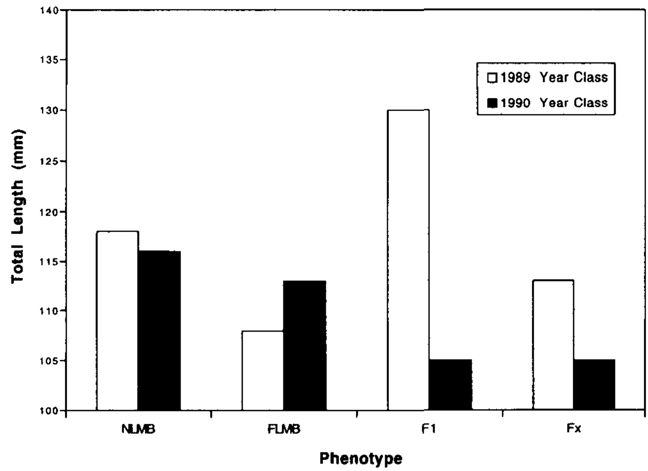

Figure 1. Mean total length at age 1 (May samples) of largemouth bass phenotypes of the 1989 and 1990 year classes in Briery Creek Lake, Virginia. NLMB = northern largemouth bass; FLMB = Florida largemouth bass; F_1 = first-generation hybrid between NLMB and FLMB; F_x = second- or later-generation hybrid between NLBM and FLMB.

1992), but waterbodies >37°N that experience HDD >1,900 appear to be poor candidates for FLMB introductions.

Where even some FLMB survive their first winter, introgression between FLMB and NLMB will likely occur. The stocking of FLMB beyond its indigenous range has been controversial (Maceina and Murphy 1992, Philipp 1992), representing a trade-off between the risks of contaminating the native NLMB genome with maladaptive genes versus the benefits of producing bigger bass. In mid-latitude reservoirs, the benefits of FLMB introductions are likely to be ephemeral while the long-term consequences of genomic contamination remain unknown.

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