Evaluation of a Trophy Bass Length Limit on Lake Fuqua, Oklahoma

Larry M. Cofer, *Oklahoma Department of Wildlife Conservation, HC 32, Box 580, Lawton, OK 73501*

Abstract: Changes in largemouth bass (*Micropterus salmoides*) and forage populations were analyzed in Lake Fuqua, Oklahoma, following its designation as a Trophy Bass Lake. A 356–558 mm slot limit for bass was established in 1990 after anglers reported catching many large bass, including a state record. The electrofishing catch-per-hour (C/f) of bass >355 mm in 1993 (C/f = 24) was significantly higher than in 1989 (C/f = 7). The abundance of bass >508 mm also increased significantly from 1989 (C/f = 1.4) to 1993 (C/f = 5.0). The electrofishing C/f of trophy bass (>558 mm) did not change. Relative weight values declined for bass in the slot range and gizzard shad (*Dorosoma cepedianum*) became rare by 1993. A recommendation was made to raise the slot range (to 406–585 mm) to allow harvest of abundant bass and further protect potential trophies. Certified Florida bass (*M. s. floridanus*) stockings at Lake Fuqua in 1990 and 1992 increased the percentage of sub-adult bass with Florida alleles by 1993.

Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 47:702–710

Length limits on largemouth bass have been used to increase angler catch rates, to improve forage population structures, or to maintain quality fishing in new lakes (Redmond 1986). Several high minimum and slot length limits were established in the late 1980s to provide trophy bass fishing in Texas and Oklahoma, but published results have been preliminary or abbreviated (Luebke 1987, Dean and Wright 1992).

Public interest in trophy bass fishing in Oklahoma was stimulated by the success of Florida bass stockings that began in 1970. The 42-year-old state record for bass (5.4 kg) was broken in 1983 by a first-generation (F_1) Florida × northern bass (*M. s. salmoides*) cross. Lake Fuqua in southwest Oklahoma was among the first in the state to be stocked with Florida bass in the mid-1970s. The lake subsequently produced state record bass in 1989 and 1990 and many more trophy-class fish as a result of the early introductions (E. Gilliland, Okla. Dep. Wildl. Conserv., pers. commun.).

Despite those angling results, fish sampling indicated that Lake Fuqua had a low predator/prey ratio and habitat sufficient to support additional adult bass. Bass

recruitment at Lake Fuqua was adequate, and overharvest was considered the limiting factor to higher bass abundance (Cofer 1989). No length limit was in effect prior to 1990.

A history of trophy bass production and the potential for even better fishing led the Oklahoma Department of Wildlife Conservation (ODWC) to propose Lake Fuqua as Oklahoma's second Trophy Bass Lake. Anglers enthusiastically supported the recommendation at a public hearing in 1989. A slot length limit of 356–558 mm was mandated at Lake Fuqua by the City of Duncan beginning in January 1990. The creel limit of 5 bass daily could include only 1 trophy (>558 mm). A slot limit was chosen in this case because minimum length limits have resulted in stockpiling of bass in populations where recruitment is not limiting (Rasmussen and Michaelson 1974, Summers 1988).

The program's objectives were to improve bass angling overall, but particularly to maintain or increase the chances of catching trophy bass. This paper documents the changes in bass and forage fish populations after implementation of the length limit. The frequency of Florida alleles in Lake Fuqua's sub-adult bass population was also assessed after a change in stocking strategy.

The assistance provided by the staff at the Oklahoma Fishery Research Laboratory in Norman, Oklahoma, is greatly appreciated. This work was funded by the Sport Fish Restoration Act, Oklahoma project F-44-D.

Methods

Lake Fuqua impounds Black Bear Creek, a tributary of the Washita River, approximately 25 km northeast of Duncan, Oklahoma. Constructed in 1962 by the U.S. Department of Agriculture Soil Conservation Service, Lake Fuqua is owned by the City of Duncan and is used occasionally as a water supply reservoir. The lake covers 600 ha, has a maximum depth of 15 m and a mean depth of 4.5 m. Secchi disc measurements in the lower pool in August average 1 m, and turbidity is primarily from phytoplankton.

Eurasian watermilfoil (*Ceratophylum demersum*) dominated the shoreline habitat to a depth of 4 m in the early 1980s. Grass carp (*Ctenopharyngodon idella*) were stocked at 17.5/ha to reduce the vegetation and improve boating access. To date, substantial watermilfoil beds remain and grass carp over 15 kg are occasionally sampled. Water usage in 1990 appeared to eliminate the vegetation in the 0–1 m zone. No attempt was made to quantify these changes.

Standardized electrofishing surveys of bass and forage populations were conducted at Lake Fuqua in 1986 and 1989, prior to implementation of the 356–558 mm slot limit in 1990. Post-length limit surveys were taken in 1991 and 1993 to evaluate the regulation. A 7.5-kw boat-mounted Smith-Root GPP electrofisher (340 V pulsed-DC) was used to collect bass, bluegill (*Lepomis macrochirus*), and shad in April and May of 1986, 1989, 1991, and 1993. Daytime, 15-minute sampling units were standard, but catch-per-unit-effort (C/f) results are reported here as hourly catch rates for comparative convenience. A sample size of 150 bass recommended

by Gilliland (1985) has been achieved since 1989; 104 bass were collected in 1986. Yearly mean C/f's were stratified by the total number of bass captured, bass <356 mm, bass >355 mm, bass >508 mm, and trophy bass, herein defined as those above the slot range (>558 mm).

Bluegill, gizzard shad, and largemouth bass <1 kg were weighed to the nearest gram and measured (total length) to the nearest millimeter. Larger bass were weighed to the nearest ounce and weights were later converted to grams. Mean relative weights (W_r, Anderson and Gutreuter 1983) were calculated for bass below (<356 mm) and within (356–558 mm) the slot range, bluegill >100 mm, and shad >180 mm.

Analysis of variance was used to determine differences ($P < 0.05$) among mean C/f's for bass by year, and for W_r values for each species within the selected size ranges. If significant differences were found, Tukey's pairwise comparison test was used to identify where the differences occurred ($P < 0.05$).

Because bluegill and gizzard shad C/f variances were high, collection of sufficient replicates to detect differences in forage abundance was not practical. Alternatively, W_r and Proportional Stock Density (PSD, Anderson and Gutreuter 1983) values for forage species were used as indices of population changes.

Sub-adult (150–250 mm) bass, originally from Florida-strain broodstock, were stocked annually in Lake Fuqua by the City of Duncan from 1975 through 1989 (stocking rates unavailable). Hatchery broodstocks of bass were not evaluated genetically until 1985, and the potential for northern bass introgression at the hatcheries involved was considered high (E. Gilliland, ODWC, pers. commun.). Certified Florida bass (3,000) were stocked as sub-adults in 1990, and 30,000 certified fingerlings (75 mm) were stocked in 1992.

Samples of small bass (<200 mm) were collected in 1986, 1987, 1991, and 1993 for genetic analysis. Electrophoretic tests (Philipp et al. 1983) determined whether bass were northern (NLMB), Florida (FLMB), F_1 crosses, or subsequent-generation intergrades (F_x).

Results

Bass Catch Rates

Total electrofishing C/f's for bass at Lake Fuqua rose from a low of 34/hour in 1986 to 66/hour in 1993 (Table 1). Bass recruitment, estimated as the C/f of fish <356 mm, was virtually unchanged from 1989 to 1993. Most of the change in total bass abundance was therefore attributable to an increase in bass that were protected by the slot limit.

The C/f for bass >355 mm did not improve significantly by 1991, after 1 year of harvest restrictions. However, a significant increase over all previous samples was found for slot bass in 1993. The C/f estimate for 1993 (24/hour) was 3 times higher than the low in 1989 (7/hour).

The abundance of bass >508 mm also improved under the slot limit. The C/f rose from a pre-slot average of 1.6/hour to 5.0/hour in 1993. Electrofishing catch

Table 1. Mean electrofishing catch rates and mean relative weights for largemouth bass before and after imposition of a trophy bass slot limit (356–558 mm) at Lake Fuqua, Oklahoma. Values within a column with a letter in common are not significantly different ($P > 0.05$).

Year	Effort (hours)	*N*	Mean catch per hour					Mean relative weight	
			Total	<356 mm	>355 mm	>508 mm	>558 mm	<356 mm	356–558 mm
1986	3.25	104	34 A	24 A	10 A	1.8 AB	1.0 A	92 A	100 AB
1989	4.00	182	47 AB	40 A	7 A	1.4 A	0.6 A	89 B	103 A
1990	Trophy slot limit imposed								
1991	3.00	153	53 AB	42 A	11 A	2.6 AB	1.7 A	88 B	97 B
1993	3.00	199	66 B	42 A	24 B	5.0 B	1.0 A	88 B	96 B

rates for trophy bass (>558 mm) remained low (<2.0/hour) and did not change significantly through the study period.

Bass Relative Weights

Mean W_r's for bass under the slot (<356 mm) remained stable but below 100 from 1986 to 1993 (Table 1). For bass protected by the slot limit, the mean W_r declined from a high of 103 in 1989 to 96 in 1993. The 1993 value was significantly lower that the 1989 W_r, but not the 1986 value. The decline from 1989 to 1993 was consistent for most 20-mm size groups in the slot (Fig. 1).

Forage Indices

The bluegill PSD was low in the first 3 samples, then fell to 0 in 1993 (Table 2). Bluegill W_r values varied from 94 to 100, but the changes were not significant. Electrofishing estimates of bluegill abundance varied from 58/hour in 1991 to 106/hour in 1993, with no apparent trend.

Gizzard shad PSDs varied between a high of 32 in 1986 to a low of 7 in 1989, with no trend. Shad W_r values generally declined from the 1986 figure of 97,

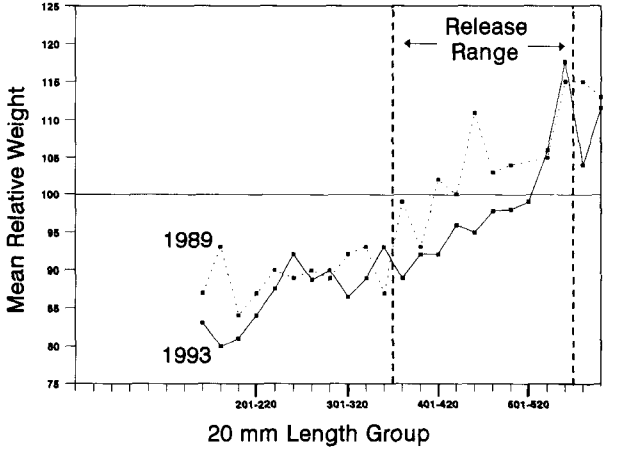

Figure 1. Mean relative weight values by 20-mm groups for largemouth bass at Lake Fuqua, Oklahoma, before (1989) and after (1993) imposition of a trophy bass slot limit (356–508 mm) in 1990.

Table 2. Total electrofishing catch rate (C/f), proportional stock density (PSD), and mean relative weight (W_r) values for bluegill and gizzard shad before and after imposition of a trophy bass slot limit (356–558 mm) at Lake Fuqua, Oklahoma. Values within W_r columns with a letter in common are not significantly different ($P > 0.05$). Catch rates and PSD's were not evaluated statistically.

	Bluegill				Gizzard shad			
Year	Effort (hours)	C/f	PSD	Mean W_r[a]	Effort (hours)	C/f	Mean PSD	W_r[b]
1986	1.50	100	2	95 A	2.00	59	32	99 A
1989	1.75	77	3	100 A	4.00	27	7	94 AB
1990	Trophy slot limit imposed							
1991	2.50	58	6	95 A	2.50	31	18	91 B
1993	2.00	106	0	94 A	2.00	4	13	93 AB

[a] Bluegill ≥ 100 mm.
[b] Gizzard shad ≥ 180 mm.

with a significant difference detected between the 1986 and 1991 samples. Shad abundance in electrofishing samples declined steadily from 58/hour in 1986 to only 4/hour in 1993. Only 8 shad were captured in 2 hours of effort in 1993.

Bass Genetics

Prior to 1991, only 50% of the bass <200 mm from lake Fuqua contained Florida alleles (Table 3). Of these fish, none were pure FLMB, and only 13% were F_1 crosses. Half of the remaining individuals were pure NLMB, and the others were F_x intergrades.

After stockings of certified FLMB in 1990 and 1992, pure FLMB were still absent from the 1991 and 1993 samples. However, the frequency of F_1 bass in the 1993 sample rose to 26%, and the percentage of bass with Florida alleles increased 87%.

Discussion

Catch Rates

In 1991, the ODWC Bass Management Plan (unpubl.) established criteria for designation of Quality Bass Lakes and High Quality Bass Lakes based on historic statewide C/f's from standardized electrofishing samples. For the Quality category, a minimum total bass C/f of 40/hour and a least 10/hour of bass >355 mm are required. For High Quality designation, the minimums are 60/hour for total bass and 15/hour for >355 mm bass.

Under this index, Lake Fuqua would not have been considered a quality bass lake prior to slot limit implementation (Fig. 2). By 1991, after only 1 year under the slot regulation, Lake Fuqua was considered a Quality Bass Lake. After 3 years, C/f's were sufficient to categorize Lake Fuqua as a High Quality Bass Lake. The

Table 3. Percentages of northern largemouth bass (NLMB), Florida largemouth bass (FLMB), first-generation crosses (F_1), and subsequent-generation intergrades (F_x) from electrophoresis testing of <200 mm bass from Lake Fuqua, Oklahoma.

Year	*N*	NLMB %	FLMB %	F_1 %	F_x %	FLMB + F_1+F_x %
1986	34	50	0	18	32	50
1987	40	48	0	13	40	53
1991	29	41	0	7	52	59
1993	38	13	0	26	61	87

substantial increase in abundance of bass in the slot range fulfilled the objective of improving C/f's for bass overall.

The Bass Management Plan also set target C/f's for Trophy Bass Lakes where the minimum C/f of bass >533 mm was 2/hour. Lake Fuqua's C/f for bass >533 mm was below 2/hour until 1993, when the C/f met the Trophy Bass Lake criteria. The C/f of bass above Lake Fuqua's slot limit (>558 mm) did not differ significantly from samples collected prior to 1990, however.

Sampling inefficiency may have been the reason for the inability to detect changes in trophy bass abundance. Few lakes yield significant numbers of bass >558 mm in electrofishing in Oklahoma. Anglers frequently catch trophy bass at Lakes Konawa, Dripping Springs, and Sardis, but electrofishing C/f's for >558 mm bass average only 1/hour, as they did at Lake Fuqua.

Radio-telemetry studies on the movements of large bass indicate that most inshore activity occurs during night-feeding (Knopf 1982, Manns and Hope 1992). This behavior should make big bass more vulnerable to sampling at night. However, night-electrofishing also yields C/f's near 1/hour at Lakes Fork, Texas (B. Lyons, Texas Parks and Wildl. Dep., pers. commun.), and Tohopekaliga, Florida

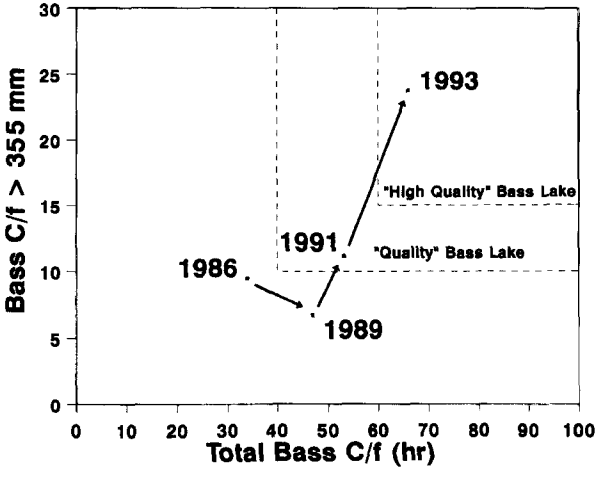

Figure 2. Electrofishing catch rate (C/f) of largemouth bass (total and >355 mm) from Lake Fuqua in relation to minimum values established for "quality" or "high quality" bass Populations in Oklahoma lakes. A trophy bass slot limit (356–558 mm) was imposed in 1990.

(E. Moyer, Fla. Game and Freshwater Fish Comm., pers. commun.), 2 premier trophy bass lakes. Bass >558 mm at Fuqua and elsewhere may only be vulnerable to electrofishing gear during brief trips to shallow water during the spring spawning period.

Current sampling methods are unlikely to detect changes in trophy bass abundance. Angler Recognition Programs (ARP) that rely on public reporting may be valuable supplements to electrofishing (Quinn 1987, Forshage et al. 1989). Oklahoma's ARP was established after the trophy bass designation at Lake Fuqua, but it may be useful in documenting future accomplishments.

Bass Genetics

Pure-strain FLMB and F_1 intergrade bass are credited with producing trophy bass fisheries in states outside their native range (Botroff and Lembeck 1978, Forshage et al. 1989, Gilliland 1992). All of the trophy bass reported from Lake Fuqua to the Oklahoma ARP of known-heredity were FLMB or F_1 phenotypes (R. Horton, ODWC, pers. commun.).

The percentage of pure FLMB stocked in Oklahoma may have declined over the period from 1975 to 1989 as hatchery broodstocks were contaminated with northern bass. The frequency of small F_1 bass in Lake Fuqua did in fact decline steadily from 1986 through 1991. Consistent introductions of certified stock should increase the proportion of bass with trophy potential (FLMB and F_1), as it did in 1993.

Bass Growth

Declines in bass growth rates and forage availability have been a concern when minimum length limits are applied to bass fisheries (Hackney 1974). Slot length limits are generally expected to prevent forage deficiencies, but W_r's were poor for bass under a 356–533 mm slot limit in Lake Dripping Springs, Oklahoma's first trophy bass lake (Bowen and Wright 1991). These problems prompted an evaluation of W_r trends at Lake Fuqua.

Mean W_r's for slot bass declined by 5% from the pre-limit years to 1993. This decline may have been more severe if a high minimum length limit had been used at Lake Fuqua, rather than the slot. In itself, the slight reduction in slot bass W_r's observed so far would not be notable. However, the situation demands attention given forage population changes.

Generally, as predator abundance increases in fish communities, edible forage numbers decrease. In traditional circumstances (where predators accumulate under a minimum size limit), forage reductions would be concurrent with increases in PSD and W_r values for the remaining large prey. In contrast, as bass accumulated in the slot range (but not below it) at Lake Fuqua, the bluegill PSD declined to 0 and their W_r's did not improve. As gizzard shad became scarce, their W_r's and PSD's did not rise.

Large bass accumulated in the slot may have selected for the larger, more energy-efficient prey items. Maceina and Murphy (1988) found that prey size se-

lection was positively correlated to bass length, particularly for sunfish and gizzard shad. Two other studies found that bass select for the largest prey available for their size (Tarrant 1960, Howick and O'Brien 1983), while another found no relationship (Wright 1970). Unmonitored changes in aquatic vegetation density may also have accounted for forage population changes.

In lakes managed primarily for trophy bass fishing, low bluegill PSD's may be beneficial. An abundance of stock-size bluegill (75–150 mm) could be optimal, providing that bass recruitment is not impaired severely by sunfish crowding. However, the sharp decline in gizzard shad abundance at Lake Fuqua could be adverse to the program. An abundance of edible shad (<275 mm) is advantageous to maintain the growth of slot-size bass.

If fish in below-optimal condition are more vulnerable to anglers, a decline in W_r's could improve fishing for bass in the slot. However, a substantial decline in slot bass growth would reduce their chances of survival to trophy size and impede the program's primary objective. Considering this potential problem, the ODWC will recommend that the City of Duncan raise the lower limit of the slot to 406 mm. This change should improve W_r's if anglers keep legal-size bass. The higher slot should also remove protection from a sizable portion of male bass that are incapable of becoming trophy bass due to dimorphic growth limitation (Schramm and Smith 1987).

A change in the upper end of the slot limit from 558 mm to 585 mm will also be recommended to protect even larger bass. The state record has increased to 6.6 kg, possibly raising the subjective definition of trophy bass in Oklahoma. The slot change at Lake Fuqua would protect bass to about 3.2 kg, or nearly half the current record weight.

Some bass tournament organizers opposed the original slot regulation at Lake Fuqua, and a decline in tournaments was noted. Competitive anglers should have incentive to return to the lake, since bass up to 1 kg (and trophy bass) could be kept for weigh-ins under the revised slot limit. The trophy bass potential may improve further at Lake Fuqua if growth rates are maintained through harvest of sub-slot fish, and as bass genetics are altered with certified Florida stockings.

Literature Cited

Anderson, R. O. and S. J. Gutreuter. 1983. Length, weight, and associated structural indices. Pages 283–300 *in* L. A. Nielsen and D. L. Johnson, eds. Fisheries techniques. Am. Fish. Soc., Bethesda, Md.

Botroff, L. J. and M. E. Lembeck. 1978. Fishery trends in reservoirs of San Diego County, California, following the introduction of Florida largemouth bass, *Micropterus salmoides floridanus*. Calif. Fish and Game 64(1):4–23.

Bowen, D. and G. Wright. 1991. Fish management survey and recommendations for Dripping Springs Lake. Okla. Dep. Wildl. Conserv. Perf. Rep., Fed. Aid Proj. F44-D-5. Oklahoma City, Okla. 22pp.

Cofer, L. M. 1989. Fish management survey and recommendations for Lake Fuqua. Okla. Dep. Wildl. Conserv. Perf. Rep., Fed. Aid Proj. F44-D-5. Oklahoma City, Okla. 14pp.

Dean, J. and G. Wright. 1992. Black bass length limits by design: a graphic approach. North Am. J. Fish. Manage. 12:538–547.

Forshage, A. A., P. P. Durocher, M. A. Webb, and D. G. Lewis. 1989. Management application of angler recognition program data. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 43:36–40.

Gilliland, E. R. 1985. Evaluation of Oklahoma's standardized electrofishing in calculating population structure indices. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 39:277–287.

———. 1992. Evaluation of genetic status of Oklahoma largemouth bass populations. Okla. Dep. Wildl. Conserv. Perf. Rep., Fed. Aid Proj. F39-R-14, Job 12. Oklahoma City, Okla. 11pp.

Hackney, P. A. 1974. Largemouth bass harvest in the midwest, an overview. Pages 114–116 *in* J. L. Funk, ed. Symposium on overharvest and management of Largemouth bass in small impoundments. Am. Fish. Soc. Spec. Publ. 3, Bethesda, Md.

Howick, G. L. and W. J. O'Brien. 1983. Piscivorous feeding behavior of largemouth bass: an experimental analysis. Trans. Am. Fish. Soc. 112:508–516.

Knopf, R. R. 1982. The diel activity, habitat observations and the effects of light intensity on radiotagged largemouth bass. M.S. Thesis, Cent. Mich. Univ. Mount Pleasant. 123pp.

Luebke, R. W. 1987. Preliminary results of a 21-inch largemouth bass minimum length limit on angler catch and harvest in a south Texas urban impoundment. Pages 253–267 *in* R. A. Barnhart and T. D. Roelofs, eds. Catch-and-release fishing, a decade of experience. Calif. Coop. Fish. Unit, Arcata.

Maceina, M. J. and B. R. Murphy. 1988. Florida, northern, and hybrid largemouth bass feeding characteristics in Aquilla Lake, Texas. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 42:112–119.

Manns, R. E. Jr. and J. Hope. 1992. Revelations in big bass behavior. In-Fisherman 109:50–57.

Philipp, D. P., W. F. Childers, and G. S. Whitt. 1983. A biochemical genetic evaluation of northern and Florida subspecies of largemouth bass. Trans. Am. Fish. Soc. 112:1–20.

Quinn, S. P. 1987. The status and usefulness of angler recognition programs in the United States. Fisheries 12(2):10–16.

Rasmussen, J. L. and S. M. Michaelson. 1974. Attempts to prevent largemouth bass overharvest in three northwest Missouri lakes. Pages 69–83 *in* J. L. Funk, ed. Symposium on overharvest and management of largemouth bass in small impoundments. Am. Fish. Soc. Spec. Publ. 3, Bethesda, Md.

Redmond, L. C. 1986. Management of reservoir fish populations by harvest regulation. Pages 186–195 *in* G. E. Hall and M. J. Van Den Avyle, eds. Reservoir fisheries management: strategies for the 80's. Am. Fish. Soc., South. Div., Reservoir Comm., Bethesda, Md.

Schramm, H. L. and D. C. Smith. 1987. Differences in growth rate between sexes of Florida largemouth bass. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 41:76–84.

Summers, G. L. 1988. Largemouth bass population changes following implementation of a slot length limit. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 42:209–217.

Tarrant, R. M. 1960. Choice between two sizes of forage fish by largemouth bass under aquarium conditions. Prog. Fish Cult. 22:83–84.

Wright, L. D. 1970. Forage size preference of the largemouth bass. Prog. Fish Cult. 32:39–42.