Effects of Minimum Length Limits on Smallmouth Bass in Meredith Reservoir, Texas

Joseph E. Kraai, *Texas Parks and Wildlife Department, Fisheries and Wildlife, Box 835, Canyon, TX 79015*

Abstract: The minimum length limit for smallmouth bass *Micropterus dolomieu* in Meredith Reservoir, Texas, was increased from 254- to 305-mm TL in 1986 and to 356 mm TL in 1988. Population assessments indicated these limits contributed to an abundance of 178- to 280-mm bass which displayed low condition indices and slow growth. Angler catch rates of smallmouth bass increased but harvest rates and yield decreased following implementation of length limits. A 305- to 381-mm slot length limit was recommended to improve population structure and increase growth, condition, and harvest.

Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 47:695–701

Smallmouth bass *Micropterus dolomieu* were introduced into Meredith Reservoir in the Texas Panhandle during the mid-1970s. This 6,447-ha reservoir provides abundant rocky habitat and a temperature regime suitable for good reproduction and recruitment of smallmouth bass. By the early 1980s, a self-sustaining smallmouth bass population and fishery developed (Kraai 1991).

From 1945 to 1975, Texas had a 178-mm minimum length limit for all black bass with a 15 fish per day bag limit of which no more than 10 could be ≥280 mm. In 1975 the length limit for black bass was changed to 254 mm and the daily bag limit reduced to 10 fish. The length limit for smallmouth bass for Meredith Reservoir was increased to 305 mm on 1 September 1986 and then further increased to 356 mm on 1 September 1988 to conform with changing statewide regulations. The bag limit was reduced to 5 black bass per day in the aggregate in 1986 and remained so through 1991.

Length limits are commonly employed to manage *Micropterus sp.* fisheries. Minimum size limits can affect the dynamics and structure of fish populations and impact anglers. Cox (1975) and Novinger (1984) cautioned researchers to carefully monitor fish populations for each body of water to which minimum size limits are applied. Many studies have documented the effects of size limits on largemouth bass *M. salmoides.* Considerably less information is available for smallmouth bass. Most of these studies on length limits have examined populations in streams and rivers (Fleener 1975, Fajen 1981, Kauffman 1983, Paragamian 1984, Austen and Orth 1988, Smith and Kauffman 1991) or natural lakes (Forney 1972, Marinac-Sanders and Coble 1981, Serns 1984, Bryant and Smith 1988). No studies were found that evaluated smallmouth bass minimum length limits in reservoirs. This study assessed changes in smallmouth bass relative abundance, size structure, condition, growth, and angler catch and harvest rates in Meredith Reservoir after imposition of minimum length limits.

Partial funding for this study was provided by the Federal Aid in Sport Fishing Restoration Act, Project F-30-R of the Texas Parks and Wildlife Department. The author acknowledges Gene Wilde (Texas Parks and Wildl. Dep., Austin) for assistance with statistical analysis, Mike Reed and Mike Costello (Texas Parks and Wildl. Dep., Mathes) and Dick Luebke (Texas Parks and Wildl. Dep., Mountain Home) for editorial assistance. Special thanks are due to Jim Hoy, Charlie Munger, and David DeLeon (Texas Parks and Wildl. Dep., Canyon) for assistance in all field collections.

Methods

Smallmouth bass were collected by electrofishing to determine relative abundance, population structure indices, condition indices, and age and growth. The electrofishing unit had 2 bow-mounted electrodes and multiple electrodes suspended from a boom extending approximately 1 m in front of a boat. The unit was powered by a portable 5-kwatt generator that produced 110 volt AC output. We sampled 8 fixed stations during late September or early October 1986–1991 between sunset and sunrise. Approximately 15 minutes of actual shocking (when current entered the water) was made at each station each year.

Smallmouth bass were measured (to the nearest mm TL) and weighed (to the nearest g). Catch per unit effort (CPUE) was calculated as catch per hour of actual shocking time. Individual length-weight data were used to calculate Relative Weight (Wr) according to Childers (1989), and Proportional Stock Density (the number of quality-size and larger fish divided by the number of stock-size and larger fish $\times$ 100 = PSD) and Relative Stock Density (the number of target-size, i.e., preferred, fish divided by the number of stock size and larger fish $\times$ 100 = RSD) according to methods described by Wege and Anderson (1978). Length range criteria used for smallmouth bass of stock ($\geq$178 mm), quality ($\geq$280 mm), and preferred sizes ($\geq$356 mm) were according to Gabelhouse (1984*b*).

Scales were examined to determine age and growth; scale images were enlarged using a microfiche viewer. Annuli were counted to determine age. Length at annuli formation was estimated using the direct-proportional expansion method. Weighted mean back-calculated lengths were determined from scales (Gutreuter 1987).

Catch and harvest rates were estimated by roving creel surveys on 5 weekend days and 4 week days randomly selected during spring (1 April through 30 June) periods from 1986 through 1991. Angler counts (for pressure estimates) and interviews (for catch estimates) were conducted during 2 randomly selected 3-hour time periods between sunrise and sunset. The number of anglers in each party, number of hours fished, the number and total lengths of fish harvested, and the number of fish caught and released were recorded. Data were expanded to estimate catch, harvest, and yield.

For statistical analysis untransformed data were used for CPUE, growth, harvest, yield, and catch. For PSD, data were normalized using an arscine-square root transformation. Linear regression was used to test differences across years. One-way analyses of variance were used to test for before-after differences.

Results and Discussion

Smallmouth bass length regulations at Meredith Reservoir were implemented to increase relative abundance of stock, quality and preferred size fish without adversely impacting fish condition and growth. Density estimates, structural and condition indices, and growth and fishing statistics indicated that these regulations did not achieve all the desired objectives.

Relative abundance of stock-to-quality size fish did not increase in 1987, 1 year after implementation of the 305-mm limit (Fig. 1). CPUE of stock-to-quality size fish increased following implementation of the 356-mm limit in 1988. There was a significant linear (across years) increase in CPUE for total ($P = 0.003$), and for stock-to-quality size fish ($P = 0.0006$). Fajen (1981) reported an increase in smallmouth bass abundance following the implementation of a 305-mm limit in Missouri streams. Substantial increases in smallmouth abundance in Nesbish Lake, Wisconsin, occurred after the imposition of a 203-mm limit. Increasing the limit should increase the relative abundance of preferred-size smallmouth bass. CPUE of preferred-size fish increased 1 year after implementation of the 305-mm limit, increased again 2 and 3 years after the 356-mm limit was imposed, and then declined through 1991.

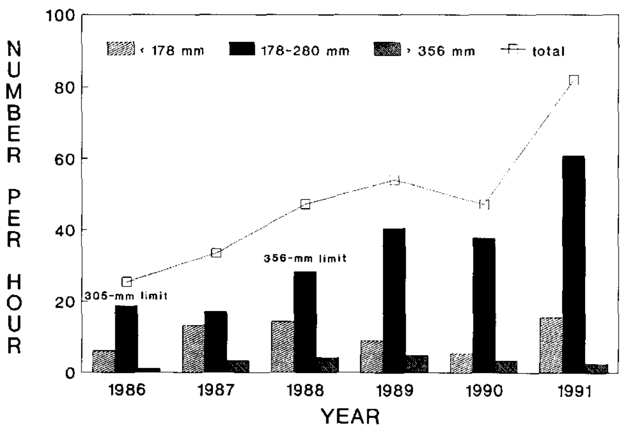

Figure 1. Smallmouth bass catch per unit effort from fall electrofishing collections.

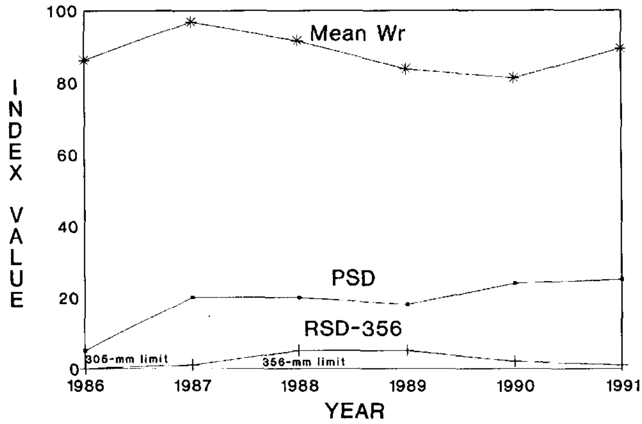

Figure 2. For smallmouth bass, weighted mean relative weight (Wr) values (for fish ≥178 mm), proportional stock density (PSD) values, and relative stock density for preferred-size fish (RSD-P) values from fall electrofishing collections.

PSD values rose from 5 in 1986 to 25 in 1991, indicating improved recruitment to quality size (Fig. 2). Although the increase in PSD across the study period was nonsignificant ($P = 0.0710$), the before (1986) and after (1987–1991) increase was significant ($P = 0.0055$). Paragamian (1984) found the PSD of smallmouth bass increased from 14 to 35 in the Maquoketa River, Iowa, after a 305-mm limit had been imposed. Bryant and Smith (1988) determined an increase in abundance of adult smallmouth bass occurred after the limit was raised from 254 to 305 mm in Anchor Bay, Lake St. Clair, Michigan.

Although smallmouth bass relative abundance increased and PSD values improved, there was no apparent increased recruitment of smallmouth bass to preferred size (356 mm). RSD of preferred-size fish increased slightly following implementation of the 305-mm limit but declined to near pre-change levels after the 356-mm minimum length limit was imposed (Fig. 2). Similarly, a 305-mm limit did not improve population size structure for smallmouth bass in New River, Virginia and West Virginia (Austen and Orth 1988).

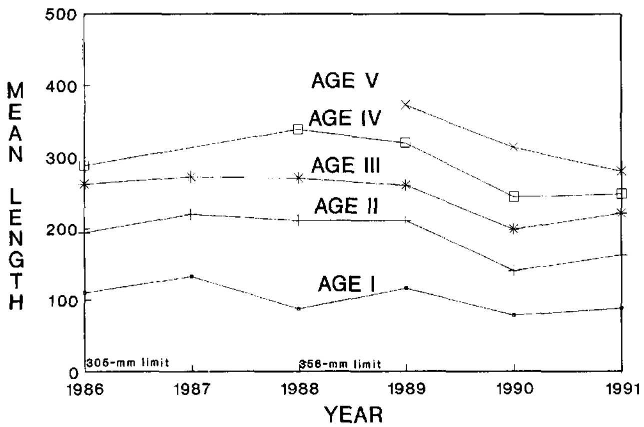

Figure 3. Back-calculated mean length (mm) at age for smallmouth bass.

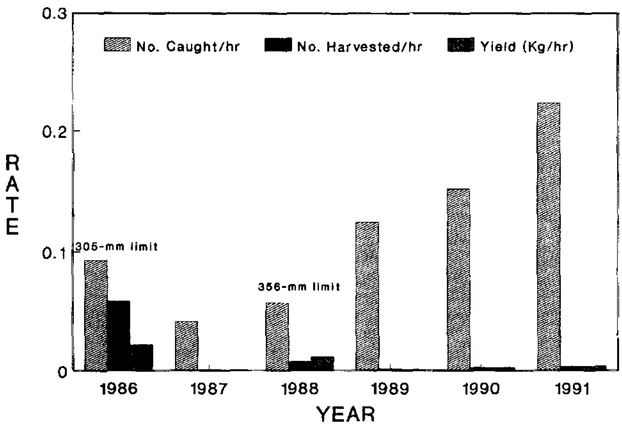

Figure 4. Angler catch, harvest, and yield of smallmouth bass, for April, May, and June.

Condition indices for smallmouth bass following implementation of both limits were consistently low (Fig. 2). Low Wr values can indicate crowding and may reflect the observed increased abundance of stock-to-quality size bass. Wege and Anderson (1978) found relative abundance of stock-to-quality size largemouth bass was a major factor related to the condition of all bass <381 mm.

Mean length at age remained stable through 1989 and declined during 1990 and 1991, 2 and 3 years after the 356-mm limit was imposed (Fig. 3). There were no significant difference in growth rates for Age I–V smallmouth bass across years ($P = 0.0727$ to 0.3495) or before and after implementation of the limits ($P = 0.6486$ to 0.9966). Similarly, Fajen (1981), Kauffman (1983), Paragamian (1984), and Serns (1984) reported growth was essentially unchanged following implementation of length restrictions for smallmouth bass.

Angler harvest and yield decreased after imposition of the 305-mm limit (Fig. 4). By 1991, 3 years following implementation of the 356-mm limit, harvest and yield had still not recovered to 1986 levels. Although the number of smallmouth bass harvested did not change significantly ($P = 0.6804$) across years, there was a significant before-after decrease ($P = 0.0228$). There were no significant across years ($P = 0.6409$) or before-after ($P = 0.0785$) changes in yield. Catch rates (harvested fish plus fish caught and released) decreased following initiation of the 305-mm limit, then increased in 1989 1 year after imposition of the 356-mm limit (Fig. 4). This probably reflects increased relative abundance of the 178 to 280-mm smallmouth bass as seen in electrofishing collections. There was a significant (P=0.0210) across years change in number of fish caught plus those released although there was no significant before-after change ($P = 0.9983$). Fleener (1975), Kauffman (1983), and Paragamian (1984) reported decreased harvest but increased catch rates of smallmouth bass following implementation of 305-mm limits in streams. However, Fajen (1981) found catch rates increased without a significant decrease in harvest with a 305-mm minimum length limit. Austen and Orth (1988) determined that a 305-mm minimum length limit did not improve smallmouth bass fishing in a river as measured by catch rates or population size structure.

One year after imposition of the 305-mm limit total CPUE increased, PSD increased, and harvest and yield declined. Three years after imposition of the 356-mm limit total CPUE increased, CPUE for stock size fish increased substantially, PSD increased, RSD-P decreased, growth declined, and angler catch increased while harvest and yield declined. Considering these changes in the smallmouth bass population and fishery at Meredith Reservoir, imposition of a slot length limit would seem appropriate. Johnson and Anderson (1974) predicted a 305- to 381-mm slot length limit for largemouth bass in Missouri impoundments would reduce overabundant sublegal size fish, increase growth rates, and result in increased survival to legal size. Eder (1984), Gabelhouse (1984*b*), and Novinger (1990) found anglers could restructure largemouth bass populations in impoundment if they harvest bass <305 mm. Smith and Kauffman (1991) found catch, harvest, and growth rates increased substantially after the implementation of a 279- to 330-mm slot length limit for smallmouth bass in the Shenandoah River.

A 305- to 381-mm slot length limit was enacted for smallmouth bass in Meredith Reservoir beginning 1 September 1992. Expected results include increased relative abundance of preferred size fish, improvements in condition indices and growth rates, and increased harvest and yield.

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