Effects of a Slot Length Limit on Largemouth Bass in a Newly-opened Texas Reservoir

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Abstract: The effects of a slot length limit of 381–533 mm and a daily bag limit of 3 fish on largemouth bass (*Micropterus salmoides*) catch and harvest, abundance, and size structure in Gibbons Creek Reservoir, Texas, a newly-opened heated impoundment, were monitored for 3 years, 1985–1988. Randomized creel surveys conducted from March through May each year were used to evaluate angler catch and harvest. Spring and fall electrofishing provided abundance and population structure data. Initial overharvest did not occur because 94% of all largemouth bass caught during the first 5 days of angling were protected from harvest by the restrictive limit. Total spring and fall electrofishing CPUE (catch per hour) increased from 1985 to 1988. CPUE increased for most length groups below and within the slot. The proportion of slot-length largemouth bass did not change after angling commenced although CPUE increased. The high slot limit was effective at preventing initial overharvest in a newly-opened impoundment and for maintaining a bass population structure dominated by large (>381 mm) individuals.

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Slot length limits are a modification of the minimum length limit concept and have been imposed mostly on existing largemouth bass populations to correct problematic population structures (Anderson 1976, Eder 1984). They are designed to reduce mortality of largemouth bass in a protected length range and allow harvest of those outside the range. Novinger (1984) stated harvest of smaller largemouth bass would maintain satisfactory growth and recruitment into and through a protected length range. In a new reservoir, a slot length limit tailored to protect a dominant age or length group could be used to prevent initial overharvest of that group while also allowing limited harvest.

Gibbons Creek Reservoir was impounded in 1981 but remained closed to angling until March 1985. Texas Municipal Power Agency owns and operates the 1,012-ha impoundment located approximately 29 km east of Bryan, Texas, as a cooling reservoir for a 400-megawatt, lignite-fueled electric generating plant. Upon impoundment, the reservoir was stocked with Florida largemouth bass (*M. s. floridanus*) to increase the maximum size of largemouth bass harvested.

Qualitative electrofishing surveys conducted at Gibbons Creek Reservoir in September and October 1984 indicated largemouth bass >381 mm were abundant. Most (74%) of these fish were 381–483 mm. As early as 1983, poachers were apprehended with largemouth bass weighing up to 4.1 kg from Gibbons Creek Reservoir (Cox 1985). Game wardens caught some of the intruders with numerous largemouth bass. Anglers became aware of the largemouth bass population through outdoor writers and television fishing show hosts that were allowed to fish prior to the reservoir being opened to the public.

Gibbons Creek Reservoir was opened to public angling on 11 March 1985. To prevent initial overharvest and maintain or increase the abundance and proportion of largemouth bass >381 mm, a slot length limit of 381–533 mm and a daily bag limit of 3 fish were imposed. Statewide regulations at that time were a 254-mm minimum length limit and 10 fish daily bag limit for largemouth bass. The objectives of this study were to monitor the largemouth bass fishery after Gibbons Creek Reservoir was opened to angling under the restrictive harvest limits to determine if initial overharvest had occurred and to characterize changes in population abundance and structure for the first 3 years.

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Methods

Creel surveys were conducted from March through May 1985–1987 to determine angling effort, catch, and harvest for largemouth bass anglers. In 1985, surveys were conducted on 12 days during the 3-month period (4 holiday/weekend days and 8 weekdays). The first 5 days the reservoir was opened for angling were sampled to more closely monitor "opening-day" effects, and after the first week, 7 randomly-selected days were sampled. In 1986 and 1987, creel surveys were conducted on 9 randomly-selected days (5 holiday/weekend days and 4 weekdays) each year. Length of the creel survey day (period when interviews were conducted) in 1985 coincided with opening and closing times for the reservoir (0630 to 1830 hours). In 1986 and 1987, survey day length was 6 hours. Start time in 1986 was 1200 hours and in 1987 was randomly selected from available daylight hours. Each party of anglers returning to the single access point was interviewed. Information from angler interviews included length of time each party of anglers fished, number of anglers in each party, and number of largemouth bass harvested and caught and released. Anglers who caught and released largemouth bass were asked to estimate how many of those bass were within and outside the slot. Harvested largemouth bass were counted and measured. Angling effort was determined by direct count in 1985 (the entire fishing day was surveyed). In 1986 and 1987, angling effort was calculated for bank anglers using instantaneous counts, and for boat anglers, using the mean number of anglers per interviewed party multiplied by the number of boat trailers from instantaneous counts.

Estimates of total angling effort, catch, and harvest were determined by expanding the mean daily estimates in each day type by the total number of each day type in the creel period. Total ratio estimators and standard errors were calculated according to Cochran (1977). Differences in catch rates (both harvest and catch-and-release) among years were tested using a 2-tailed t-test for comparison of independent populations having unknown variances (Freund and Walpole 1980) with the following modifications. Mean catch rates and their standard errors were estimated using a stratified ratio estimator with a separate ratio in each stratum (Cochran 1977). The standard deviation of catch rates for fishing parties was approximated as the product of the standard error and the total number of parties. The degrees of freedom was the total number of parties minus 2. Significance was set at $\alpha = 0.05$.

Largemouth bass were sampled with a boat-mounted electrofishing unit equipped with a 4-kw, 230-VAC generator converted to pulsed, DC by a Coffelt model VVP-15 pulsator. Sampling was conducted after sunset in November 1985–1987, February 1986, and March 1987 and 1988. Electrofishing was conducted for intervals of 0.25 hours of actual shocking time at each of 11–14 stations selected to obtain a representative sample of habitats in the reservoir. Sampling was conducted when water temperatures were 14°–23° C. Individual total lengths and weights were recorded for all largemouth bass collected. The number of largemouth bass captured per hour of electrofishing (CPUE) was calculated for specific length groups (<203, 203–204, 305–380, 381–532, and ≥533 mm) to examine changes in largemouth bass abundance among years. Length data also were used to calculate Relative Stock Density (RSD) for the aforementioned length groups (except <203 mm) according to methods described by Anderson (1980) and Gabelhouse (1984*a*). Confidence intervals (95%) for RSD values were approximated according to Snedecor and Cochran (1980) to evaluate population structure.

Results

Angler Surveys

The number of largemouth bass caught and released greatly exceeded harvest when Gibbons Creek Reservoir opened to angling (Table 1). Most largemouth bass caught and released (95%) were within the slot. Among largemouth bass harvested, 82% were <381 mm, 5% were within the slot (either just >381 mm or <533 mm), and 13% were >533 mm. Daily catch rates declined substantially after the first 3 days of angling.

Table 1. Summary of angling pressure, catch, and harvest for largemouth bass anglers the first 5 days of angling and 7 randomly-selected days, Gibbons Creek Reservoir, March–May 1985. Slot denotes fish within the 381–533-mm slot length limit and non-slot denotes fish <381 mm or ≥533mm.

				Number released	
Date	Angler-hours	Catch rate[a]	Number harvested	Slot	Non-slot
11 Mar	2,917	0.40	31	1,094	30
12 Mar	2,529	0.40	27	963	28
13 Mar	2,124	0.46	32	906	49
14 Mar	1,622	0.27	11	419	15
15 Mar	2,111	0.17	11	336	16
23 Mar	1,821	0.17	10	272	21
30 Mar	845	0.23	15	164	12
5 Apr	1,867	0.15	27	240	18
23 Apr	1,068	0.24	11	210	37
12 May	916	0.13	8	102	13
18 May	1,113	0.15	6	129	29
30 May	862	0.14	1	105	15
Total	19,795		190	4,940	283

[a] Number harvested and caught and released per angler-hour.

Catch for anglers seeking largemouth bass was 29 times greater than harvest in 1985 (Table 2); catch rates were also substantially greater than harvest rates in 1986 and 1987. Catch and harvest rates in 1986 and 1987 were not significantly different from rates in 1985 ($P > 0.05$). More slot-length than non-slot-length largemouth bass were caught and released in 1986 (311 and 173, respectively), but numbers of both groups caught and released in 1987 were similar (72 and 81, respectively).

Table 2. Catch and harvest rates (largemouth bass per angler-hour) for anglers seeking largemouth bass, Gibbons Creek Reservoir, March–May 1985–1987. Standard errors are in parentheses.

Year	Catch rate	Harvest rate
1985	0.265 (0.040)	0.009 (0.001)
1986	0.183 (0.029)	0.011 (0.003)
1987	0.184 (0.039)	0.010 (0.003)

Table 3. Electrofishing total catch (*N*) and CPUE (catch per hour) of largemouth bass for 5 length groups (total length in mm), Gibbons Creek Reservoir.

		Catch rate per length group					
Sample date	*N*	<203	203–204	305–380	381–532	≥533	Total
Fall							
Nov 85	71	1.7	8.0	4.3	6.0	0.3	20.3
Nov 86	143	5.8	20.0	5.2	12.3	0.6	43.9
Nov 87	217	16.4	28.4	15.3	18.2	0.7	79.0
Spring							
Feb 86	182	11.1	15.7	5.1	18.6	1.4	51.9
Mar 87	196	7.3	17.3	9.0	28.7	3.0	65.3
Mar 88	236	2.9	23.3	21.8	36.4	1.5	85.8

Abundance and Population Structure

Total electrofishing CPUE for largemouth bass increased annually each fall and spring (Table 3). Generally, CPUE for most length categories below and within the slot increased. The CPUE for fish above the slot was always low (0.3–3.0 fish per hour). Annual differences in total catch rate were more pronounced in fall than spring due to annual increases in the <203 and 203- to 304-mm length groups.

Increases in CPUE for inch groups within the slot were not concentrated within a particular length group (e.g., just below the upper end of the slot; Fig. 1). Increases in CPUE over time were apparent among most length groups within the slot.

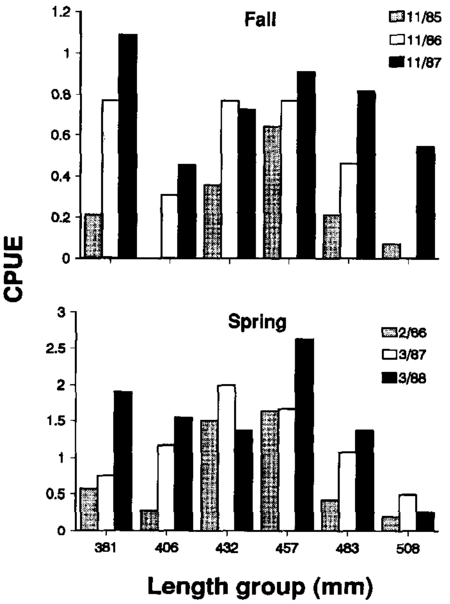

Figure 1. Electrofishing CPUE (catch per hour) of largemouth bass for 5 length groups (381–405, 406–431, 432–456, 457–482, 483–507, and 508–532) within the 381–533-mm slot length limit for fall and spring, Gibbons Creek Reservoir, 1985–1988.

Table 4. Incremental Relative Stock Density (RSD) and 95% confidence intervals for 4 length categories (total length in mm) of largemouth bass collected by electrofishing, Gibbons Creek Reservoir.

Sample date	RSD 203–304	RSD 305–380	RSD 381–532	RSD 533
Fall				
Nov 85	43±12.0	23±10.2	32±11.3	2[a]
Nov 86	52±8.7	14±6.1	32±8.2	2±2.5
Nov 87	45±7.4	24±6.4	29±6.8	1±1.5
Spring				
Feb 86	38±8.0	13±5.5	45±8.2	3±2.8
Mar 87	30±6.9	16±5.4	49±7.4	5±3.2
Mar 88	28±5.8	26±5.7	44±6.4	2±1.8

[a] N = 1.

Proportions of slot-length largemouth bass (RSD 381–532) remained relatively constant after angling commenced (Table 4) even though CPUE increased annually (Table 3). Spring RSD 381–532 values were always higher than fall values. The RSD-533 values also were higher in spring, but differences were not as great and sample sizes were small. Among length categories below the slot, the RSD 203–304 category comprised a larger proportion of the population than the RSD 305–380 category.

Discussion

Initial overharvest did not occur as harvest rates during the first 3 months Gibbons Creek Reservoir was open to angling were similar to harvest rates in the same 3 months during the following 2 years. Without the slot limit, harvest could have been much higher, and based on angler catch rates, most of the harvest would have occurred in the first weeks of angling. In Lake Nacogdoches, Texas, anglers reported substantial declines in harvest success after being very successful during the first 3 weeks the reservoir was opened to angling (Seidensticker 1985). Similarly, exploitation of largemouth bass populations was from 40% to 69% during the first 4 days of angling on new lakes in Missouri (Redmond 1972).

As expected, use of a highly restrictive slot length limit resulted in low harvest. Catch-and-release angling for largemouth bass was a more important component of the fishery than harvest. The slot limit maintained abundance of 381- to 532-mm largemouth bass allowing anglers the opportunity to catch more, larger fish than would probably be available in a reservoir without restrictive limits.

The slot length limit also was instrumental in the increased abundance of slot-size largemouth bass. The slot limit afforded bass below the slot (<381 mm), which also increased in abundance, protection when these fish recruited into the slot. Increased abundance of largemouth bass <381 mm was indicative of increased recruitment throughout the study. This increased abundance of bass <381 mm may have also been benefited by the reluctance of anglers to keep bass below a slot (Eder 1984, Gabelhouse 1984*b*).

The substantial decline in daily catch rates during the first days Gibbons Creek Reservoir was opened suggested vulnerability of largemouth bass to angling decreased over time. Other studies have shown a decline in vulnerability of largemouth bass after initiation of angling. Anderson and Heman (1969) observed that after 2 weeks of angling, largemouth bass that had not previously been fished for became as difficult to catch as fish previously exposed to angling. In Ridge Lake, Illinois, catch declined rapidly from the morning to afternoon on the first day of the season and on the succeeding 4 days (Bennett 1954).

The slot limit rather than bag limit was probably more instrumental in reduction of initial harvest. If the 381- to 533-mm slot limit and the statewide bag limit (10) had been in effect and all fish outside the slot range had been harvested, 94% (3,718) of all largemouth bass caught during the first 5 days of angling (3,968) would still have been protected. Without a slot length limit, all largemouth bass caught during the first 5 days could have been potentially harvested. All largemouth bass caught were >305 mm and statewide length limit at that time was 254 mm. Redmond (1984) also noted reduction of the daily bag limit from 10 to 4 fish would have saved only 10% of largemouth bass harvested from Little Dixie Lake, Missouri.

Abundance of largemouth bass >381 mm tended to increase annually reflecting increases in total abundance. RSD 381–532 for fall and spring were similar from year to year and were indicative of a population that had low mortality of quality-length and larger largemouth bass (≥305 mm). Catch and release of slot-length fish probably contributed to this low mortality. The population structure approximated RSD standards suggested by Gabelhouse (1984*a*) for a largemouth bass population with a slot length limit that has the upper limit near 508 mm and where largemouth bass are the single most important species, recruitment is moderate or high, and large individuals are desired.

Even though abundance of slot-length largemouth bass increased, abundance of fish above the slot did not change. Growth of fish within the slot appeared adequate to allow growth above 533 mm (Kurzawski and Luedke 1988). No buildup of largemouth bass <533 mm was detected that would have indicated failure of fish to grow beyond the upper end of the slot. Novinger (1984) observed abundance of largemouth bass above a minimum length limit will not increase as much as anticipated because anglers remove a high percentage as fish grow beyond the protection of the limit. Largemouth bass in or above the upper end of the slot may have experienced high rates of natural mortality as reported by Bennett et al. (1969) or most largemouth bass in this study (maximum age 7+) may have been too young to attain lengths >533 mm.

Hooking mortality did not appear to be a substantial factor as abundance increased for the length groups most exposed to repeated catch and release. Plumb et al. (1988) noted survival of largemouth bass released within 30 minutes of capture by angling was 99%. Initial mortality for largemouth bass caught in tournaments, which involves more handling stress than immediate catch and release, ranged from 11% to 25% (Zagar and Orth 1986).

Management Implications

A slot length limit of 381–533 mm was an effective management tool for prevention of initial overharvest in a new impoundment. When length limits for other new reservoirs are being formulated, population structure should be considered, and a slot limit can be tailored to protect a particular length or age class so the goal of preventing initial overharvest is achieved. Much of the angling for largemouth bass under such a slot length limit will be catch and release; however, many of the fish caught and released will be >381 mm. Anglers may not desire to harvest fish <381 mm when fish >381 mm are abundant and readily caught. Eder (1984) noted the reluctance of anglers to keep largemouth bass below the lower end of a slot. In these instances, the slot limit will function more like a minimum length limit. Rapid growth of fish below the slot, recruitment of those fish into the slot, and low angling mortality of slot-length fish are all necessary to insure continued abundance of larger fish. Because the effect of a daily bag limit was probably minimal, selection of a bag limit appears less crucial than delineating the boundaries of the slot length limit. When the upper end of a slot limit or minimum length limit is set high (≥508 mm), males may not grow beyond this limit (Porak et al. 1986). The effect of this reduction of angling mortality of adult males on largemouth bass population dynamics is unknown.

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