Abundance, Growth, and Mortality of the Lake Texoma Blue Catfish Population: Implications for Management

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Abstract: The blue catfish *Ictalurus furcatus* fishery at Lake Texoma has been increasing in popularity. Guides that typically seek striped bass *Morone saxatilis* switch to blue catfish, particularly during the winter months when the largest individuals are most vulnerable. Low frequency electrofishing samples, collected since the early 1990s by the Oklahoma Department of Wildlife Conservation, indicate that population abundance is stable but concerns have been raised over the long term viability of the fishery in the face of increased angling pressure on the largest individuals. Baseline age and growth data, using otoliths, were collected from both the Red River arm and Washita River arm in 2003 (N = 333). Mortality rates were estimated using the Fishery Analysis Simulation Tools model. Growth rates, particularly of fish age ≥ 6, were highly variable. The oldest fish collected was age 16 and weighed 20.43 kg. Growth rates of the smaller individuals (ages 1, 3, 4, 5) were higher in the Red River arm than in the Washita River arm. No differences were found in growth rates of older fish, likely due to the high variation in mean length at age. Blue catfish from Lake Texoma reach 762 mm (4.5 kg) in approximately 12 years. Total annual mortality estimates (A) from the Red River arm and Washita River arm were 13.5% and 17.0%, respectively (A = 18.8% for both arms combined). Even though these mortality estimates are low relative to that of other freshwater sport fishes, given the length of time it takes to reach a size being targeted by guides and their clients, options to limit harvest of large blue catfish may need to be considered in the future.

Key words: blue catfish, age and growth, mortality

Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 58:57–65

Lake Texoma has a nationally-renowned striped bass *Morone saxatilis* fishery. The striped bass fishery brings in US$25 million annually to the local economy and supports around 200 full and part-time guides. Lake Texoma is also gaining a reputation as a world-class blue catfish *Ictalurus furcatus* fishery. A previous rod and reel world record blue catfish (55.2 kg) was caught in January 2004. In recent years, guides and their clients have increasingly targeted large blue catfish, particularly in winter when the largest individuals are most vulnerable. The Oklahoma Department of Wildlife Conservation has been collecting abundance trend data since the early

1990s but information on age and growth and mortality is lacking. This information is vital to making informed management decisions.

Jenkins (1956) published length at age information on blue catfish up to age 11 from Lake Texoma. This study is the only known published age and growth data on blue catfish from Oklahoma. No mortality information on blue catfish is available from Oklahoma. The objective of this study was to establish baseline age and growth and mortality data for future management strategies of the blue catfish fishery on Lake Texoma.

Study Area

Lake Texoma is a 35,600-ha flood control and hydropower reservoir on the Oklahoma-Texas border. The lake, impounded in 1944 on the Red and Washita rivers, drains approximately 103,000 km^2 of agricultural land in southwest Oklahoma and north Texas. The Red and Washita arms of the lake are relatively shallow (18 m maximum depth) with the main basin reaching depths of 22–26 m (Matthews et al. 1985). In the Red River, conductivities greater than 4,000 μS/cm are common within 50 km upstream from the reservoir, whereas conductivities on the Washita River are typically 400–1000 μS/cm (Matthews et al. 1985). Lake Texoma is moderately turbid with Secchi disk visibility approximately 1.0–1.5 m in the Red River arm and 1.5–1.8 m in the main basin (Matthews 1984). Fluctuating water levels deter the growth of aquatic macrophytes.

Methods

Sampling Methods

Low-frequency (15 pulses/sec), low amperage (4 amps), pulsed-DC electrofishing samples, targeting blue catfish, were collected in August 2003. Samples were collected in uplake portions of the reservoir on flats in depths of 3–5 m. The electrofishing boat was operated with a driver and two dippers. In addition, two chase boats, each equipped with a driver and two dippers, assisted in collecting fish. Due to the distance that fish surface from the electrofishing boat, chase boats were essential to maximize collections. The electrofishing boat remained stationary until fish began to surface, then moved slowly in the direction of surfacing fish. A unit of effort was defined as 15 minutes of electrofishing. Four units of effort were collected in each the Red River arm and the Washita River arm. All fish were measured (mm TL) and weighed (g). Catch per unit effort (CPUE) data were assessed by total catch and catch of blue catfish ≥762 mm (i.e., trophy size in the fishery). Historical electrofishing samples targeting blue catfish, using methods described above have been collected on Lake Texoma, but no age information was gathered during these samples (Table 1). Samples from each arm of the lake were kept separate for comparison.

Table 1. Effort (h) and catch per unit effort (CPUE; *N*/h) of blue catfish collected in summer electrofishing from Texoma Reservoir, Oklahoma, 1993–2003.

	Red River arm			Washita River arm			Arms combined		
Year	Effort (h)	$CPUE_{total}$	$CPUE_{\geq 762}$	Effort (h)	$CPUE_{total}$	$CPUE_{\geq 762}$	Effort (h)	$CPUE_{total}$	$CPUE_{\geq 762}$
1993	1.25	148.7	3.8						
1994	1.0	261.0	4.0						
1995	1.0	188.0	4.0	1.67	161.7	0.0	2.67	162.9	2.3
1999	1.0	211.0	7.0	1.0	449.0	7.0	2.0	330.0	7.0
2002	1.0	185.0	8.0						
2003	1.0	245.0	5.0	1.0	215.0	1.0	2.0	230.0	3.0

Aging Techniques

Sagittal otoliths were removed from all fish collected using methods described by Buckmeier et al. (2002) for channel catfish. Otoliths were placed in flat embedding molds (Electron Microscopy Sciences) and filled with Loctite 349. The embedding medium was cured under ultraviolet light (350 nm wavelength) for six hours. A transverse cut, through the nucleus, was made with an Isomet low-speed saw (Buehler LTD). The sectioned surface was viewed using a dissecting scope under 5X–15X magnification. Polishing the surface, using 12.0µ polishing sheets, was occasionally necessary to facilitate annulus identification. A single strand fiber-optic cable was used as a light source. The first 100 otoliths were co-read by two experienced readers (>10,000 otoliths of various species aged per reader). Ages assigned by the two readers were consistent so the remaining otoliths were read by a single reader. The age of the fish was determined by total annuli count. Given that fish were collected in August, growth beyond the last annulus was evident.

Data Analysis

Mean length at age, von Bertalanffy growth parameters, and total annual mortality (A) for blue catfish from the Red River arm and the Washita River arm were determined using the Fishery Analysis Simulation Tools (FAST) model (Slipke and Maceina 2000). Comparisons of mean length at age (ages 1–12) between arms were made using a one-way ANOVA ($P \leq 0.05$). Only ages with multiple fish/age were tested for statistical significance.

Results

Historical electrofishing catch rates of blue catfish from the Red River arm of Lake Texoma have been relatively consistent over time (approximately 200/h; Table 1). $CPUE_{\geq 762}$ from the Red River arm ranged from 1.5%–4.3% of the total catch, with no increasing or decreasing trend in abundance over time (Table 1). Catch rates of blue catfish from the Washita River arm have been less consistent than from the Red River arm but fewer samples have been collected (Table 1). It appears that the

Table 2. Mean length (mm) at age, along with sample size *(N)* and range of lengths, for blue catfish from Lake Texoma, Oklahoma, 2003. Lengths within the same row with different superscripts are significantly different (one-way ANOVA; $P \leq 0.05$).

	Red River arm			Washita River arm			Arms combined		
Age	*N*	Length	Range	*N*	Length	Range	*N*	Length	Range
1	11	186.3[a]	163–220	19	163.0b	138–185	30	171.5	138–220
2	8	259.3[a]	180–304	13	248.8a	133–303	21	252.8	133–304
3	10	344.4[a]	318–375	13	292.9b	250–333	23	315.3	250–375
4	26	381.7[a]	340–464	16	350.1b	319–406	42	369.7	319–464
5	10	419.6[a]	387–472	22	393.8b	335–482	32	401.9	335–482
6	17	444.9[a]	398–505	18	433.9a	311–555	35	439.3	311–555
7	9	455.8[a]	424–485	10	462.8a	394–529	19	459.5	394–529
8	16	489.8[a]	400–542	31	500.0a	426–645	47	496.5	400–645
9	18	530.7[a]	462–638	8	547.5a	436–712	26	535.9	436–712
10	12	577.9[a]	488–719	5	597.4a	535–678	17	583.7	488–719
11	9	596.6[a]	461–829	9	549.1a	488–690	18	572.8	461–829
12	6	730.8[a]	540–995	5	613.0a	477–851	11	677.3	477–995
13	4	955.3	555–1164						
14	1	696							
15	2	846.5	823–870	1	720		3	804.3	823–870
16	3	1064.0	1025–1087	1	540		4	933.0	540–1087

relative abundance of large blue catfish (≥762 mm) was lower in the Washita River arm than in the Red River arm ($CPUE_{\geq 762}$ ranged from 0%–1.6% of $CPUE_{total}$ in the Washita River arm; Table 1). No evidence of increasing or decreasing trends in abundance of $CPUE_{total}$ and $CPUE_{\geq 762}$ was observed when data from both arms were combined (Table 1).

There was a large amount of individual differences in growth rates of blue catfish from Lake Texoma, as evidenced by the wide range in mean length at age for all age classes (Table 2). On the average, blue catfish from Lake Texoma reach 300 mm at age 3, 400 mm at age 5, and 500 mm at age 8 or 9. Blue catfish do not reach “trophy size” (762 mm) on Lake Texoma until age 12 or older. Unrealistic growth increments and small sample sizes from blue catfish age > 12 make the length at age data suspect. The von Bertalanffy growth parameters for ages 1–12 are:

$$L_{inf} = 1032 \text{ mm TL}$$

$$K = 0.068$$

$$t_0 = -2.029$$

where: L_{inf} = maximum theoretical length (length infinity) than can be obtained; K = growth coefficient; and t_0 = time in years when length would theoretically be equal to 0. The length-weight relationship of this population is:

$$\log_{10} W = -5.787 + 3.264 \cdot \log_{10} L; \; r^2 = 0.99$$

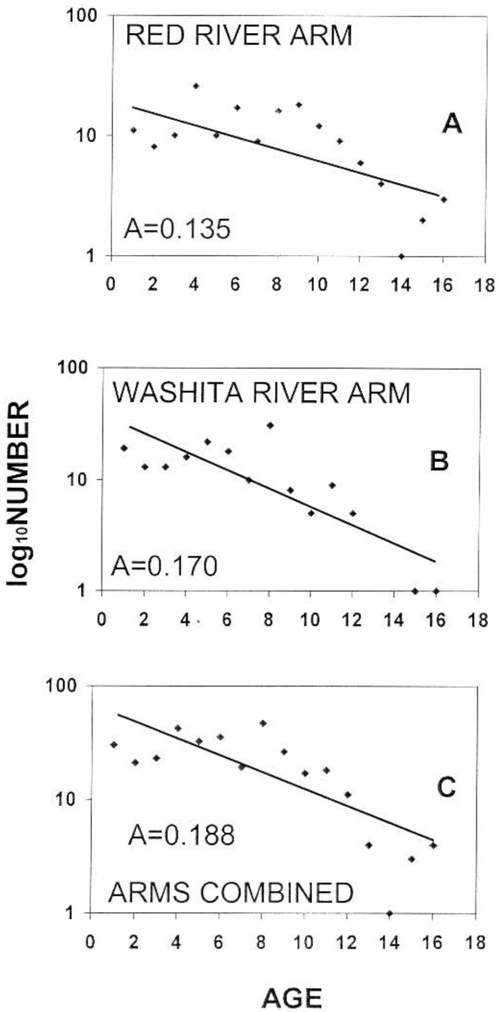

Figure 1. Catch curves of blue catfish from the Red River arm (A), the Washita River arm (B), and from arms combined (C) of Lake Texoma, Oklahoma, 2003. A = total annual mortality estimate.

Consequently, an average "trophy size" individual weighs approximately 4.5 kg.

Growth rates from the Red River arm exceeded those from the Washita River arm for ages 1, 3, 4, and 5 (one-way ANOVA; $P \leq 0.05$; Table 2). No differences in mean length at age for other ages were observed.

Total annual mortality (A) of the Red River arm and Washita River arm samples were 0.135 (Fig. 1A) and 0.170 (Fig. 1B), respectively. A = 0.188 when data from both arms were combined (Fig. 1C).

Discussion

Low pulse-frequency electrofishing has been used to successfully sample flathead catfish populations (Gilliland 1988, Robinson 1994, Cunningham 1995, Cunningham 2000). However, the use of electrofishing to sample blue catfish is not well documented. Corcoran (1979) reported that low-frequency pulsed DC current was effective in immobilizing blue catfish. Justus (1996) used electrofishing to collect blue catfish for contaminant monitoring in Mississippi rivers. Given the paucity of published information on sampling blue catfish with electrofishing, comparisons of CPUE data for the Lake Texoma blue catfish population with that of others are not possible. However, published CPUE data from electrofishing for flathead catfish are available for comparison. By expanding CPUE data from Gilliland (1988) to *N*/h, catch rates of flathead catfish from several Oklahoma reservoirs were generally <30/h. Catch rates reported by Cunningham (1995) for Oklahoma reservoirs were generally less than those reported by Gilliland (1988) although Cunningham (1995) did not report all sizes of flathead catfish captured. This information seems to suggest that the abundance of the Lake Texoma blue catfish population is relatively high (CPUE ~200/h; Table 1).

Mean lengths at age of blue catfish from Lake Texoma reported in this study are less than those reported by Jenkins (1956). However, Jenkins (1956) reported that blue catfish growth rates at Lake Texoma were declining at that time as a result of interspecific competition resulting from the fish community coming to equilibrium as the reservoir aged. Graham (1999) provided an overview of blue catfish growth rates from the literature. Growth rates reported in this study were moderate relative to those reported in Graham's review. However, none of the studies reported by Graham (1999) used otoliths to age blue catfish. Given that aging catfish with spines tends to underestimate the age of older individuals (Mayhew 1969, Muncy 1969) direct comparisons of mean length at age information between spine-aged and otolith-aged populations may not be valid. Growth rates of populations aged using spines were likely overestimated which might make the growth rates of the Lake Texoma population higher relative to those reported by Graham (1999).

Even though we found significant differences in growth rates between the two arms of the reservoir for a few age classes (1, 2, 4, 5), the high degree of overlap in length at age confers little biological meaning to these differences. Furthermore, it would be unlikely that different management options would be considered for separate regions of Lake Texoma. Consequently, for management purposes growth differences between the Red River arm and the Washita River arm will be considered nonsignificant.

Gender of individual fish was not determined so gender-related differences in growth rates could not be used to explain the wide range in lengths of individuals of the same age (Table 2). If growth rates of both genders are divergent, catch curves by gender may need to be determined to get a more accurate measure of annual mortality rates. This question should be addressed in future research.

Assumptions on which catch curve analysis of mortality rates are based are rarely met by the populations being sampled; i.e., constant recruitment, equal survival among year classes, constant survival from year to year, natural and fishing mortality are consistent among age classes and years, and age structure of the sample is representative of that of the population. Stable recruitment of most species being managed would be a welcomed plus by those doing the management, yet is seldom realized. Long-lived species, such as blue catfish, are exposed to a larger degree of environmental variation over the course of their lives than short-lived species. Consequently, constant survival among age classes and years is less likely to occur. We stated early in this paper that angling pressure appears to be increasing with the largest individuals being sought disproportionately. Yet in spite of the shortcomings of catch curves to estimate mortality, the method is commonly used in the scientific literature (Maceina 1997, Maceina et al. 1998, Boxrucker 2002, Isermann et al. 2002).

Total annual mortality estimated in this study (18.8%) is less than that previously reported for blue catfish populations. Published accounts of blue catfish mortality estimates were 39% from the Tombigbee River, Alabama (Kelley 1969), 12% to 32% from Lake of the Ozarks, Missouri (Graham and DeiSanti 1999) and 36% to 63% from Kentucky Lake, Kentucky (Hale 1987). Mortality estimates of blue catfish populations reported previously in the literature were estimated using spine-aged fish. Underestimating ages of older individuals in a population can lead to artificially high estimates of mortality. In fact, Winkelman (2003) reported lower mortality estimates for the Lake Carl Blackwell, Oklahoma flathead catfish population (16% to 17%) aged using otoliths than was reported by Summerfelt et al. (1972) for the same population aged using spines (31% to 49%). Of course, the length of time between studies (approximately 30 years) could also contribute to the difference in these estimates.

Management Implications

Our CPUE data for blue catfish does not indicate that the abundance of large blue catfish is declining in Lake Texoma. However, given the increasing angler pressure on the fishery, continued monitoring of the trends in abundance (CPUE) is warranted.

Based on current estimates, blue catfish reach "trophy size" (762 mm and 4.5 kg) in approximately 12 years. Even given the relatively low annual mortality rate estimated in this study (18.8%), only 8% of age-1 recruits reach age 12. The size designated as "trophy" in this study may be conservative. A survey of biologists and catfish anglers in the Mississippi River basin indicated that 72% of respondents consider 838 mm to be a "trophy" blue catfish (Arterburn et al. 2001). Seventy-two percent of Santee Cooper, South Carolina blue catfish anglers would prefer catching one 9-kg fish over four 2.3-kg fish and only 1% of those anglers considered 4.5 kg to be "trophy size" (S. Lamprecht, South Carolina Department of Natural Resources, pers. commun.).

Managing long-lived, slow-growing species as "trophy fisheries" is challenging. The only viable means of reducing total annual mortality is reducing exploitation. We do not know what the exploitation rate on blue catfish is on Lake Texoma.

However, given recent trends in targeting large blue catfish by guides and their clients, we would expect fishing pressure to increase. Currently, the daily creel on blue catfish is 15 with no size restrictions. More restrictive harvest regulations may need to be considered in the future to preserve this "world-class" fishery. In the mean time, continued monitoring of abundance and growth rates is warranted. A creel survey to determine fishing pressure, size distribution of the harvest, and the proportion of anglers practicing catch and release and a human dimensions survey to determine angler preferences would be invaluable to making informed management decisions.

Acknowledgments

We wish to thank the South central and Southeast Regional management staff and the staff of the Oklahoma Fishery Research Laboratory for assistance with field collections and otolith removal. We particularly wish to acknowledge Troy Hatfield for his expertise in otolith aging. This project was funded through Sport Fish Restoration Project F-44-D, Grant 5. This manuscript is Contribution No. 238 of the Oklahoma Fishery Research Laboratory.

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