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# Abundance, growth, and mortality of selected Oklahoma Blue Catfish Populations: Implications for Management of Trophy Fisheries

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*Abstract*: Blue catfish Ictalurus furcatus electrofishing samples were collected on nine Oklahoma reservoirs and age and growth estimates were made on seven of these reservoirs. Catch rates of blue catfish were high (up to 700/h) on all reservoirs sampled but catch rates of preferred-sized (≥762 mm total length) catfish were low (≤5/h). Growth rates varied widely both within and among reservoirs but were generally slow with blue catfish not reaching preferred size until ages 13-16. A negative relation between catch rates and growth was identified. Total annual mortality rates averaged 26% for the seven populations sampled. Given growth and mortality rates estimated in this study, only 2-3% of age-1 blue catfish reach preferred size in Oklahoma reservoirs. A management initiative stressing angler harvest of small individuals while restricting harvest of preferred-sized blue catfish is suggested.

Key words: blue catfish, age and growth, mortality

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Angler interest in the pursuit of "trophy-sized" catfish has increased in recent years. Most catfish anglers (71%) take at least one trip annually to pursue trophy catfish (Arterburn et al. 2001). Fishing for trophy-sized fish is more important for blue catfish Ictalurus furcatus and flathead catfish Pylodictis olivaris anglers than for anglers pursuing channel catfish Ictalurus punctatus (Wilde and Ditton 1999, Arterburn et al. 2002). However, the emphasis placed on managing catfish fisheries by agencies appears to be lagging behind angler interest to do so. Only 2% of agency experts surveyed by Arterburn et al. (2002) indicated that their agencies emphasized managing trophy catfish fisheries even though 75% of catfish anglers surveyed were in favor of developing trophy fisheries. Lack of biological information on catfish populations was the primary reason given for the low emphasis placed on managing catfish fisheries.

Lake Texoma has a reputation as a world-class blue catfish fishery; a former rod and reel world record blue catfish (55.2 kg) was caught in January 2004. The Oklahoma Department of Wildlife Conservation (ODWC) has been collecting abundance data since the early 1990's but concerns have arisen in recent years that increased fishing pressure on the largest individuals could jeopardize the trophy status of the fishery. Blue catfish growth data were collected on Texoma in 2003 (Mauck and Boxrucker 2005). Growth rates were relatively slow (blue catfish averaged 584 mm at age 10) and highly variable, making management of the fishery for trophy potential challenging. The need to collect growth and mortality information on additional blue catfish populations was recognized by ODWC staff. The objectives of this study were to: 1) collect abundance, age structure, growth rate, and mortality data on blue catfish populations in selected Oklahoma reservoirs; and 2) use this information to formulate management strategies to enhance and/or preserve the trophy potential of these fisheries.

## METHODS

Blue catfish abundance (catch rate) data were collected on nine Oklahoma impoundments (four mainstem and five tributary; Table 1). Age and growth samples were collected on seven of these impoundments (catch rate data only were collected on Ft. Cobb and Frederick reservoirs).

Low-frequency (15 pulses/sec), low amperage (4 amps), pulsed-DC electrofishing samples, targeting blue catfish, were collected in August 2003-05. Samples were collected in uplake portions of the reservoir on flats in depths of 3-5 m. The electrofishing boat was manned 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 and then moved slowly in the direction of surfacing fish. Eight units of effort (15 min each) were collected per reservoir for a total of 2 h of sampling effort. Total length (mm) and weight (g) were recorded from all blue catfish collected. Otoliths were removed from a subsample (20 fish/20 mm length group) and processed using methods described by Mauck and Boxrucker (2005). Annular rings were counted by two independent readers. Discrepancies in age determinations were rare but when they did occur, an age was assigned by both readers in concert. Ages were assigned to those fish in the electrofishing samples not aged using reservoir-specific age-length keys (Ketchen 1950).

Data Analysis

Catch per unit effort (CPUE) was calculated as number of blue catfish/15-min units of effort, multiplied by four and expressed as number/h. Catch data were partitioned by total catch and catch of blue catfish $\geq$762 mm (preferred size; Gablehouse 1984) (Table 2). Precision of the CPUE data was expressed as coefficient of variation of the mean ($CV_0$; Cyr et al. 1992). A $CV_0 =$ 0.20 was set as a target level of precision. Pearson correlation was used to compare specific conductance with CPUE ($\underline{P} \leq 0.05$).

Estimates of mean length at age, von Bertalanffy growth parameters, and total annual mortality (A) using catch curves were derived using the Fisheries Analysis Simulation Tools (FAST) model (Slipke and Maceina 2000). The von Bertalanffy growth curves for each reservoir were constrained ($L_{inf}$) by the largest fish in the respective sample (Table 3). Age classes not fully recruited to the gear were eliminated from the catch curve analysis. This varied by population as follows: age 1 eliminated-Eufaula, Hugo, Kaw, Keystone, and Waurika; ages 1 and 2 eliminated-Ellsworth; ages 1, 2, and 3 eliminated-Texoma. Simple linear regression was used to compare mean length at age 10 with CPUE ( $\underline{P} \leq 0.05$).

RESULTS

Electrofishing catch rates ($CPUE_{total}$) ranged from 124.0/h (Ft. Cobb) to 693.5/h (Ellsworth; Table 2). Precision of the $CPUE_{total}$ estimates was generally good with $CV_{0total} \leq 0.30$ on all lakes sampled with $CV_{0total} \leq 0.20$ (target level) on five of the nine reservoirs sampled (Table 2). Catch rates of preferred-size blue catfish ($CPUE_{\geq 762}$) ranged from 0/h (Eufaula) to 5.0/h (Waurika; Table 2). Precision of the $CPUE_{\geq 762}$ data was poor with $CV_{0\geq 762} > 0.40$ on all reservoirs sampled. No relations between specific conductance (Table 1) and total $CPUE_{total}$ (Pearson correlation; r = -0.49; $\underline{P}$ = 0.18) nor $CPUE_{\geq 762}$ (Pearson correlation; r = 0.34; $\underline{P}$ = 0.38) were found. Annual mortality estimates (A) ranged from 0.21 (Texoma) to 0.32 (Waurika; Table 2) and averaged 0.26.

Growth rates were highly variable, both within and among reservoirs (Table 3) Ranges in length at age often were as much as 50% of the mean (Table 3). Growth rates were poor on Ellsworth, Eufaula, and Hugo with age-10 fish averaging 384.4 mm, 427.3 mm, and 487.0 mm, respectively (Table 3). Growth rates on Kaw, Keystone, Texoma, and Waurika were higher with age-10 blue catfish averaging 610 mm, 636.8 mm, 583.7 mm, and 570.2 mm, respectively (Table 3). However, even on these “faster” growing lakes, it took 13-16 years for blue catfish to average 762 mm (preferred size) and a minimum of 10 years for the fastest growing individual in the sample to reach preferred size (Keystone; Table 3). However, it appears that the growth rates of some individuals in a given population greatly exceed the growth curves (Table 3). The largest fish in the Texoma sample measured 1164 mm, 1087 mm, and 1270 mm and were13, 16, and 19 years old, respectively. Growth appeared to be density related exhibiting a negative relation between mean length at age 10 and CPUE (Figure 1; simple linear regression; $r^2$ = 0.59; $\underline{P}$ = 0.045; N = 7). von Bertalanffy growth parameters for the seven populations are given in Table 4.

All year classes, ages 1-10, were represented in each of the seven reservoirs (Table 3). However, based on the catch curves, younger age classes (1-3) may not have been fully recruited to the sampling gear. Assuming a 26% annual mortality rate and given the growth rates listed in Table 3 (13-16 years to reach preferred size), only 2-3% of age-1 blue catfish survive long enough in Oklahoma reservoirs to reach preferred size (Figure 2).

## DISCUSSION

Although the use of low pulse-frequency electrofishing to sample flathead catfish is well documented (Gilliland 1988, Robinson 1994, Cunningham 1995, 2000), published accounts of the use of electrofishing to sample blue catfish are rare. Corcoran (1979) reported that low-frequency pulsed DC current was effective in immobilizing blue catfish and Justus (1996) used electrofishing to collect blue catfish for contaminant monitoring in Mississippi.

Catch rates in this study were high; approaching 700/h in two of the seven reservoirs sampled. Low-frequency electrofishing catch rates in the Rappahannock River, Virginia in 2006 were 4,698/h (Greenlee 2006). The results of this study coupled with the high catch rate reported from Virginia suggest that low-frequency electrofishing is highly effective for collecting large numbers of blue catfish. The precision of the CPUE data (Table 2) was comparable to what the agency obtains for its largemouth bass spring electrofishing data (Oklahoma Department of Wildlife Conservation, unpublished data). As such, we feel that our electrofishing protocol was adequate to compare annual trends in blue catfish abundance. $CPUE_{\geq 762}$ was low, ranging from 0-5 fish/h, suggesting that fish of this size are rare in all populations sampled. However, precision of the $CPUE_{\geq 762}$ data was poor (Table 2) making that data somewhat suspect. Negative bias toward large blue catfish in low-frequency electrofishing samples is also a concern in

Virginia (Greenlee 2006) and in Alabama (E.R. Irwin, Auburn University, pers. commun.). Some modification of the sampling protocol (e.g., time of year, habitat) may be warranted to decrease the variability in the $CPUE_{\geq762}$ data and to determine if that sample is representative of the population.

Growth rates reported in this study were moderate relative to those reported in Graham=s (1999) review of blue catfish growth rates. However, none of these studies 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 between spine-aged and otolith-aged populations may not be valid (Nash and Irwin 1999, Buckmeier et al. 2002). Otolith-based growth rates of the Rappahannock River, Virginia blue catfish population were similar to those observed in Oklahoma, averaging only 494 mm at age 10 (B. Greenlee, Virginia Department of Game and Inland Fisheries, pers. commun.). By contrast, otolith-based blue catfish growth estimates from the Santee-Cooper system in South Carolina indicate that age-10 blue catfish average 801 mm (Lamprecht and White 2006). A modified sampling protocol that is more effective in collecting large blue catfish would include an increased number of fast growing individuals in our samples which may increase the estimates of the average length of these older age classes.

The averaged total annual mortality rate estimated in this study (26%) was less than that previously reported for blue catfish populations (Kelley 1969, Hale 1987, Graham and DeiSanti 1999). However, these estimates may be biased. In our study, underestimation of the abundance of the larger fish in the sample would increase the slope of the catch curves and decrease estimates of A. Underestimation of the age of older fish in studies using spines as an aging method would have the same effect on estimates of A.

### Management Implications

The current blue catfish angler harvest regulation on blue catfish in Oklahoma is a 15-fish daily creel limit, in aggregate with channel catfish, with no length restriction. No commercial harvest of blue catfish is allowed. Given the high total abundance of blue catfish estimated in this study, consistent recruitment, and relatively slow growth, a liberal daily creel limit is warranted. Our evidence of a density dependent growth response also suggests the need for a liberal creel limit.

The low abundance of preferred-sized blue catfish in all reservoirs in this study, suggests the need for management efforts aimed at increasing $CPUE_{\geq 762}$. Reducing harvest of preferred-size blue catfish has the potential of increasing abundance of large individuals in the population. Restricting angler harvest to one preferred-sized fish daily, while maintaining or even increasing the existing liberal daily limit of smaller fish should meet the harvest desires of catfish anglers (Wilde and Ditton 1999), reduce the abundance of small fish thereby improving growth rates, and increase the “trophy-potential” of the state’s blue catfish fisheries.

Angler surveys conducted in other states have indicated desires to increase management efforts to preserve/enhance the trophy-potential of blue catfish fisheries (Arterburn et al. 2002, Reitz and Travnicek 2005). ODWC biologists have been contacted by a number of individual anglers expressing similar desires, but a scientific survey of the demographics and desires of catfish anglers in Oklahoma is needed prior to implementing any regulation change aimed at increasing the numbers of large blue catfish in Oklahoma waters.

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Table 1. Physical and chemical characteristics of nine Oklahoma reservoirs sampled for blue catfish. *mainstem impoundment; **tributary impoundment.

| Lake | Year sampled | Surface area (ha) | Mean depth (m) | Sechhi (cm) | Conductivity (µS/cm) |
|---|---|---|---|---|---|
| Ellsworth** | 2004 | 2,258 | 6 | 61 | 475 |
| Eufaula* | 2005 | 42,540 | 8 | 36 | 752 |
| Frederick** | 2005 | 373 | 4 | 15 | 480 |
| Ft. Cobb** | 2005 | 1,653 | 7 | 38 | 470 |
| Hugo** | 2005 | 5,343 | 4 | 36 | 90 |
| Kaw* | 2004 | 6,871 | 9 | 30 | 450 |
| Keystone* | 2005 | 9,520 | 9 | 86 | 3300 |
| Texoma* | 2003 | 35,600 | 11 | 38 | 2717 |
| Waurika** | 2004 | 4,073 | 7 | 64 | 450 |

Table 2. Catch per unit effort (N/h) of all blue catfish in the sample ($CPUE_{total}$) and of preferred-sized blue catfish ($CPUE_{\geq 762}$) with respective precision estimates [coefficient of variation of the mean ($CV_{0\ total}$ and $CV_{0\geq 762}$)] and total annual mortality rates (A) of blue catfish from selected Oklahoma reservoirs.

| Reservoirs | $CPUE_{total}$ | $CV_{0total}$ | $CPUE_{\geq 762}$ | $CV_{0\geq 762}$ | A |
|---|---|---|---|---|---|
| Ellsworth | 693.5 | 0.24 | 0.5 | 1.00 | 0.26 |
| Eufaula | 390.0 | 0.15 | 0 | | 0.21 |
| Frederick | 330.5 | 0.22 | 0.5 | 1.00 | |
| Ft. Cobb | 124.0 | 0.28 | 3.4 | 0.54 | |
| Hugo | 633.5 | 0.11 | 0.5 | 1.00 | 0.28 |
| Kaw | 294.0 | 0.15 | 2.0 | 0.53 | 0.30 |
| Keystone | 224.0 | 0.28 | 3.0 | 0.42 | 0.23 |
| Texoma | 225.0 | 0.09 | 3.0 | 0.83 | 0.23 |
| Waurika | 490.5 | 0.09 | 5.0 | 0.45 | 0.32 |

Table 3. Mean length (mm) at age and range of lengths for blue catfish from seven Oklahoma reservoirs.

| Age | N | Length | Range | N | Length | Range | N | Length | Range | N | Length | Range |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ellsworth | | | Eufaula | | | Hugo | | | Kaw | | |
| 1 | 2 | 165.5 | 148-183 | 48 | 156.0 | 132-191 | 721 | 168.4 | 92-225 | 21 | 174.2 | 157-194 |
| 2 | 32 | 185.5 | 144-205 | 41 | 202.8 | 145-243 | 212 | 222.7 | 138-276 | 75 | 232.4 | 182-255 |
| 3 | 227 | 222.2 | 127-269 | 60 | 256.4 | 204-309 | 167 | 272.9 | 172-382 | 259 | 272.0 | 227-365 |
| 4 | 243 | 235.8 | 169-288 | 65 | 295.1 | 217-365 | 20 | 320.4 | 298-348 | 129 | 324.9 | 269-438 |
| 5 | 419 | 253.2 | 189-311 | 117 | 272.5 | 252-456 | 45 | 330.7 | 254-390 | 39 | 400.9 | 344-502 |
| 6 | 141 | 273.6 | 226-322 | 93 | 350.5 | 256-420 | 44 | 371 | 338-418 | 22 | 480.7 | 392-544 |
| 7 | 116 | 297.9 | 225-371 | 71 | 356.6 | 259-454 | 46 | 411.5 | 360-498 | 12 | 511.2 | 339-610 |
| 8 | 109 | 320.9 | 267-367 | 39 | 374.7 | 296-492 | 4 | 449.8 | 424-492 | 6 | 543.7 | 505-592 |
| 9 | 12 | 339.2 | 313-465 | 32 | 414.5 | 340-552 | 2 | 474.0 | 474 | 9 | 614.1 | 572-682 |
| 10 | 22 | 384.4 | 341-465 | 83 | 427.3 | 350-566 | 3 | 487.0 | 442-512 | 1 | 610 | |
| 11 | 57 | 393.7 | 355-470 | 28 | 472.7 | 402-579 | | | | 6 | 673.2 | 625-754 |
| 12 | 32 | 413.5 | 360-481 | 34 | 479.0 | 384-604 | | | | 1 | 737 | |
| 13 | 13 | 382.0 | 308-487 | 27 | 490.6 | 423-664 | | | | | | |
| 14 | 3 | 554.7 | 484-670 | 16 | 498.1 | 438-560 | | | | 5 | 701.8 | 633-789 |
| 15 | 2 | 591 | 456-726 | 12 | 486.2 | 397-622 | | | | | | |
| 16 | 1 | 822 | | 7 | 505.4 | 440-576 | | | | 1 | 830 | |
| 17 | | | | 1 | 531 | | | | | 1 | 853 | |
| 18 | 4 | 600.3 | 455-783 | 1 | 462 | | | | | | | |
| 19 | | | | | | | 1 | 926 | | | | |
| 20 | | | | 1 | 504 | | | | | | | |
| 21 | 1 | 898 | | 2 | 531.0 | 496-566 | | | | | | |
| 23 | 1 | 896 | | | | | | | | | | |
| 24 | 1 | 493 | | | | | | | | | | |

Table 3 (continued). Mean length (mm) at age and range of lengths for blue catfish from seven Oklahoma reservoirs.

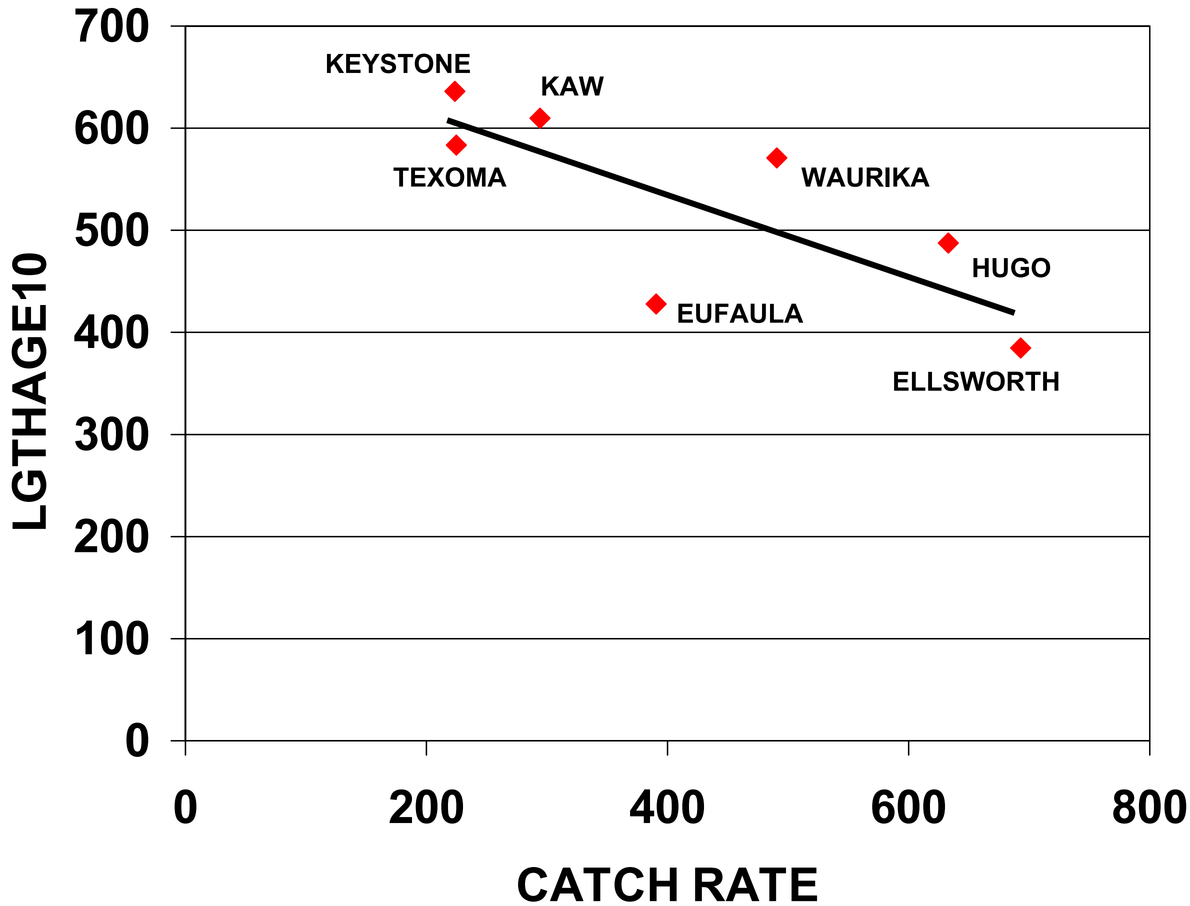
| Age | N | Length | Range | N | Length | Range | N | Length | Range |
|---|---|---|---|---|---|---|---|---|---|
| | Keystone | | | Texoma | | | Waurika | | |
| 1 | 98 | 194.5 | 143-306 | 30 | 171.3 | 138-220 | 22 | 184.4 | 132-198 |
| 2 | 57 | 276.5 | 185-383 | 21 | 252.8 | 133-304 | 278 | 194.2 | 138-277 |
| 3 | 29 | 356.2 | 290-427 | 23 | 315.3 | 250-375 | 196 | 262.4 | 166-369 |
| 4 | 36 | 422.0 | 353-504 | 42 | 369.7 | 319-464 | 195 | 292.0 | 223-389 |
| 5 | 39 | 454.6 | 351-550 | 32 | 401.9 | 335-482 | 66 | 321.2 | 206-488 |
| 6 | 62 | 516.3 | 440-642 | 35 | 439.3 | 311-555 | 48 | 380.8 | 290-513 |
| 7 | 24 | 564.3 | 467-673 | 19 | 459.5 | 394-529 | 66 | 457.6 | 329-558 |
| 8 | 26 | 575.6 | 487-665 | 47 | 496.5 | 400-645 | 41 | 468.4 | 340-587 |
| 9 | 12 | 611.7 | 464-660 | 26 | 535.9 | 436-712 | 35 | 537.9 | 424-641 |
| 10 | 10 | 636.8 | 524-857 | 17 | 583.7 | 488-719 | 10 | 570.2 | 383-737 |
| 11 | 5 | 666.4 | 596-709 | 18 | 572.8 | 461-829 | 5 | 646.4 | 516-756 |
| 12 | 11 | 714.4 | 596-860 | 12 | 685.7 | 477-995 | 2 | 750.0 | 725-775 |
| 13 | 1 | 793 | | 6 | 881.0 | 555-1164 | 4 | 936.3 | 864-1050 |
| 14 | | | | 1 | 696 | | 3 | 631.3 | 502-885 |
| 15 | 2 | 765 | 717-813 | 4 | 851.8 | 720-994 | 2 | 862.0 | 860-864 |
| 16 | | | | 4 | 933.0 | 540-1087 | | | |
| 17 | | | | 1 | 954 | | | | |
| 18 | | | | | | | 1 | 903 | |
| 19 | | | | 1 | 1270 | | | | |
| 20 | | | | | | | | | |
| 21 | | | | | | | | | |
| 22 | | | | | | | | | |
| 24 | | | | | | | | | |

Table 4. von Bertalanffy growth parameters from blue catfish populations from seven Oklahoma reservoirs. $L_{inf}$ = maximum theoretical length (mm) that can be obtained; k = growth coefficient; $t_0$ = time in years when length would theoretically be equal to 0.

| Lake | $L_{inf}$ | k | $t_0$ |
|---|---|---|---|
| Ellsworth | 898 | 0.063 | -0.665 |
| Eufaula | 622 | 0.091 | -2.526 |
| Hugo | 512 | 0.214 | -0.677 |
| Kaw | 853 | 0.136 | -0.151 |
| Keystone | 860 | 0.133 | -0.919 |
| Texoma | 964 | 0.077 | -1.843 |
| Waurika | 1050 | 0.095 | 0.114 |

Figure 1. Relation of mean length at age 10 (LGTHAGE10) and electrofishing catch rates (CPUE) from blue catfish populations from seven Oklahoma reservoirs. LGTHAGE10 = 691.56-0.3869 * CPUE ($r^2 = 0.59$; $P = 0.045$; N = 7).

Figure 2. Progressive decline in numbers of fish assuming a 26% annual mortality rate and average growth rates of blue catfish in Oklahoma. Ages at which blue catfish reach preferred size.



700
600
500
400
300
200
100
0
LGTHAGE10
KEYSTONE
KAW
TEXOMA
WAURIKA
HUGO
EUFAULA
ELLSWORTH
0
200
400
600
800
CATCH RATE


MORTALITY RATE = 26%
NUMBER (Thousands)
12
10
8
6
4
2
0
1
3
5
7
9
11
13
15
17
19
AGE (Years)