First Evidence of Blue Catfish Natural Reproduction in Canton Reservoir, Oklahoma

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Abstract: Blue catfish (*Ictalurus furcatus*) is the largest member of Ictaluridae and is the second largest fish in Oklahoma. Oklahoma Department of Wildlife Conservation (ODWC) has introduced Blue Catfish to many Oklahoma reservoirs due to their popularity among anglers. In 1983, Blue Catfish were stocked into Canton Reservoir in hopes of creating a self-staining population, but to date, no natural recruitment of Blue Catfish has been observed in Canton Reservoir. However, in 2016 seven juvenile Blue Catfish were collected in Canton Reservoir, Oklahoma. Fish were collected during electrofishing and experimental gill-net surveys. All of these fish were estimated to be age-1 using the lapilli otoliths (one of the three pair of ear stones that comprise the inner ear of fish), suggesting that Blue Catfish successfully spawned in Canton Reservoir in 2015. Blue Catfish spawn in late spring to early summer in Oklahoma. Conditions during spring 2015 consisted of high flow events from the North Canadian River resulting in an increase of pool elevation in Canton Reservoir. Prior to the increase in pool elevation, Canton Reservoir was experiencing low water levels due to an extended drought (2012-2015). During this drought, herbaceous and woody vegetation established in the dry reservoir bottom, however when inundated during spring 2015, it provided habitat which may have been utilized for spawning by adult Blue Catfish and as nursery habitat by juveniles. Understanding environmental conditions that lead to successful spawn and year-class formation of Blue Catfish in Canton Reservoir will aid in future management decisions for this species.

Introduction

Blue catfish (*Ictalurus furcatus*) are the largest member of Ictaluridae and are native to the Arkansas and Red River systems in Oklahoma. The Oklahoma Department of Wildlife Conservation (ODWC) has introduced Blue Catfish into many Oklahoma reservoirs outside their native river basins (Miller and Robinson 2004). Currently, they are found in reservoirs and river systems throughout Oklahoma. The accessibility and trophy potential of Blue Catfish has helped make this species popular among Oklahoma anglers (Kuklinski and Patterson 2011). Blue Catfish has gone from the ninth most preferred species in 1985 to the fourth most preferred species during 2001– present by anglers in Oklahoma (Summers 2009; Jager 2015).

Due to Blue Catfish popularity among Oklahoma anglers, ODWC wanted to create a sport fishery in Canton Reservoir by stocking Blue Catfish. A total of six stocking events

occurred over the span of 24 years (1983-2007) in repeated attempts to establish a Blue Catfish population in Canton Reservoir. However, Blue Catfish were never observed in sampling efforts following these stocking events (unpublished data ODWC). Despite not ever being caught in ODWC annual sampling, anglers have reported encounters with Blue Catfish in Canton Reservoir since the late 1980's, with recent accounts referencing large fish (John Stahl, Oklahoma Department of Wildlife Conservation, personal communication). For example, on September 28, 2015 a 27.7 kg Blue Catfish was harvested by an angler and is the current lake record for Canton Reservoir. However, there has never been reports of small Blue Catfish being caught until recently.

During an annual electrofishing survey in July 2016, ODWC northwest region fisheries staff collected four juvenile Blue Catfish. Then in October 2016 fall standardized gillnet surveys, three juvenile Blue Catfish were captured. The following year in May during a tagging event for the walleye rodeo fishing tournament, 5 more individuals were collect (via electrofishing). The purpose of this study is to estimate age of the Blue Catfish captured during these surveys and back-calculate spawning year to evaluate the environmental conditions which contributed to the first documented spawning success of Blue Catfish in Canton Reservoir.

Methods

Study area - Canton Reservoir is a 3,201-ha impoundment located in Blaine and Dewey Counties in northwest Oklahoma (Figure 1). Canton Reservoir has a maximum depth of 10.7 m and average depth of 4.6 m. It was built in 1948 to serve as flood control for the North Canadian River, which is the major tributary that flows into the lake. However, the reservoir also serves as a municipal water supply for the city of Oklahoma City.

Sampling - Blue Catfish were collected from Canton Reservoir in July of 2016, using

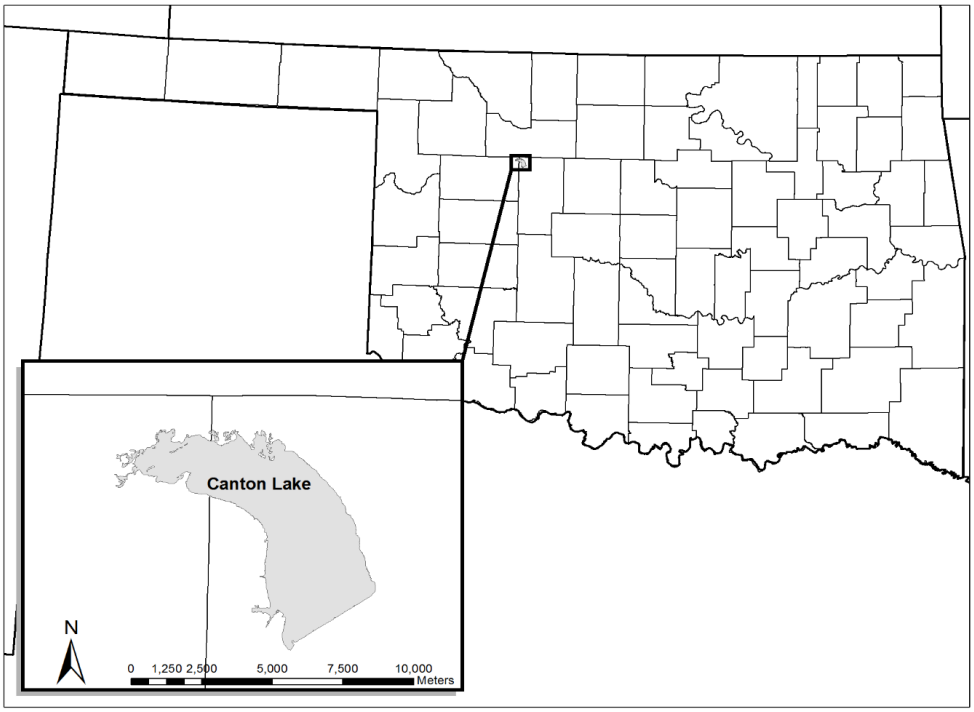

Figure 1. Canton Reservoir is located in Blaine and Dewey in northwest Oklahoma, near the towns of Longdale and Canton.

electrofishing (ETS MBS-1DP-SR-7200, 15 pulse/sec, set for optimal power; Miranda 2009, Bodine et al. 2011). Electrofishing sites were chosen at random and each site consisted of a five-minute unit of effort during daylight hours. In October of 2016, gillnetting was performed following standard protocols recommended by Miranda and Boxrucker (2009). Gillnets were bottom-set perpendicular to shore at depths ranging from 1.8 to 4.6 m. Experimental gill nets used were 61 m long x 1.8 m tall and constructed of eight 7.6 m panels (12.7, 15.9, 19.1, 25.4, 38.1, 50.8, 63.5, and 76.2 mm bar mesh).

Otolith aging - Following capture, each fish was measured for total length (TL; mm) and lapilli otoliths were removed for age estimation. Otoliths were dried for a period > 24 hours. After drying, lapilli otoliths were browned at 104°C on a hot plate to increase contrast between accretion and discontinuous zones (Secor et al.1992, Long and Snow 2016). After browning, otoliths were embedded in Loctite 349 (Mauck and Boxrucker 2004) and sectioned with a low speed IsoMet® saw (127 mm x 0.4 mm). To estimate age, the otolith was positioned sectioned-side up in modeling clay, covered with immersion oil to enhance annuli, and viewed with a dissecting microscope (4-45x) using a fiber optic light source. Annuli, which appeared as dark rings on a light background, were counted to assign an age estimate to each fish. Each otolith was evaluated by two independent readers (Hoff et al. 1997).

Descriptive statistics – Mean length-at-age was calculated to compare average growth rate from Canton Reservoir Blue Catfish to other Oklahoma Blue Catfish populations. The back-calculated spawning year was calculated for each Blue Catfish using age estimates from lapilli age estimates, and those spawning years were compared against lake condition for those years with pool elevation data for Canton Reservoir at (U.S. Army Corps of Engineers) and river discharge for the North Canadian River upstream of Canton Reservoir (USGS gage #07238000).

Results and Discussion

Seven juvenile Blue Catfish ranging from 220 – 291 mm in total length were collected in July and October 2016 with 5 addition fish collected in May of 2017. All fish were estimated to be age-1 in 2016 and age-2 in 2017 (Figure 2), suggesting that Blue Catfish successfully spawned in spring 2015. Because these fish are not age-0, back-calculation of spawning date is not possible as daily growth increments are no longer visible on otoliths. However, Blue Catfish spawn in late spring to early summer in Oklahoma (Miller and Robinson 2004). We surmise that spawning occurred in June 2015 in Canton Reservoir, because prior to the spawning event, Canton Reservoir was at its lowest pool elevation in recorded history. During this drought (November 2011 through April 2015) herbaceous and woody vegetation colonized the dry portion of lake bed and exposed shoreline. Then during April- July 2015, the pool elevation quickly increased by 2.74 m (Figure 3). By June, the terrestrial vegetation was entirely inundated. It is likely that Blue Catfish utilized this new habitat for spawning (Graham 1999) or as nursery areas for young fish.

Blue catfish are highly migratory, and have been found to move upstream in the spring in response to river flow (Garrett and Rabeni 2011) and water temperature increase (21 - 25ºC) in search of spawning sites (Graham 1999; Sublette et al. 1990). The North Canadian River that

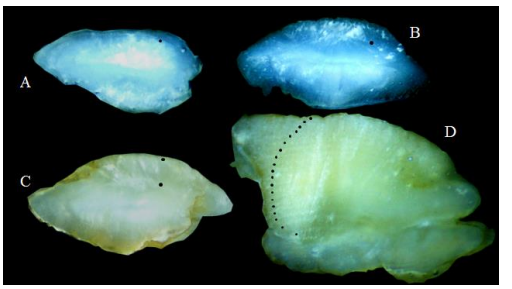

Figure 2. Photograph depicting annuli on lapilli otoliths of Blue Catfish from Canton Reservoir, Oklahoma A) Age-1 fish 228 mm TL collected July 2016; B) Age-1 fish 278 mm TL collected October 2016; C) Age-2 fish 282 mm TL collected May 2017; D) Age-19 fish 988 mm TL collected May 2017).

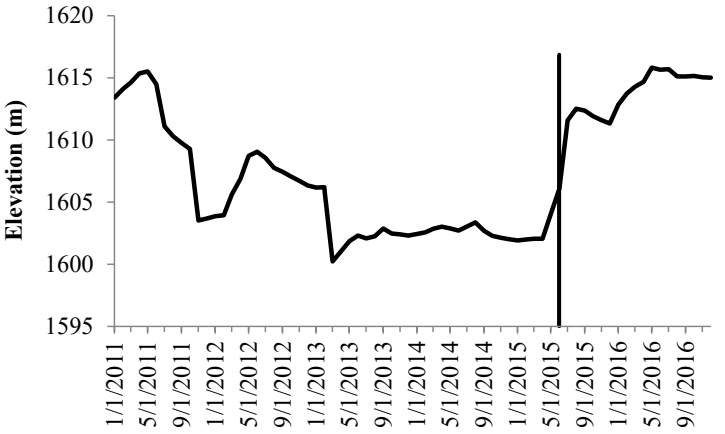

Figure 3. Canton Reservoir pool elevation from 2011 – 2016 using data from the U.S. Army Corps of Engineers. We speculate that spawning occurred in June based on knowledge of historical Blue Catfish spawning times in Oklahoma (Miller and Robinson 2004), which is represented by the vertical bar.

flows into Canton Reservoir is a shallow, prairie stream that on occasion will flood, but does not function like a large river system. High flow events starting in April 2015 and lasting through June 2015 (U.S. Geological Survey gage # 07238000), may have triggered a spawning run of Blue Catfish. By June, the pool elevation had almost returned the lake to normal pool conditions (Figure 4), which may have allowed Blue Catfish to find spawning sites in the newly established vegetation around the perimeter of the lake. Because daily increments have been validated for Blue Catfish (Sakaris et al. 2011), it is possible to back-calculate spawning dates of age-0 fish that are sampled in the future, which may allow us to better understand conditions leading to the timing of reproduction and the potential successful recruitment of Blue Catfish. Little information exists in the literature describing the environmental variables contributing to spawning success and recruitment of Blue Catfish and is a need of further research.

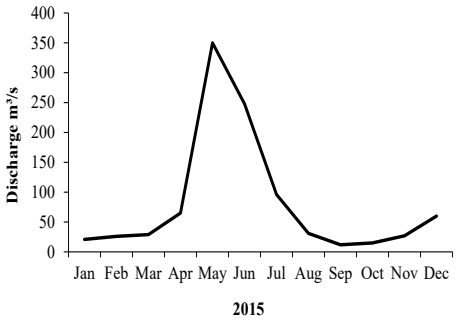

Figure 4. Spring river conditions of the North Canadian River (USGS gage #07238000) during 2015 when successful Blue Catfish reproduction occurred in Canton Lake.

A side effect of a flood event, especially after a prolonged dry period, is a large pulse of nutrients entering the system. This increased nutrient loading can lead to increased species richness, diversity and overall system productivity (Bayley 1995; Robertson et al. 2001). Blue Catfish populations in Texas have shown to be influenced by surface area, growing season, and productivity (Bartram et al. 2011). Furthermore, Bartram et al. (2011) found that stocking Blue Catfish into larger reservoirs with poor productivity yielded poor returns of stocked fish. Canton Reservoir is considered a hypereutrophic lake, however during the drought period (2011 – 2015) no runoff occurred from the agricultural land that dominates the watershed. Besides the increased spring flows and habitat abundance, it is possible that runoff from upstream agricultural sources increased productivity in Canton Reservoir assisting in conditions favorable to the formation of a Blue Catfish year class. However, without pre- and post-drought water quality data this is merely

speculation. Blue Catfish may have spawned annually with no observed recruitment due to comparatively low productivity. A long-term water quality monitoring program in Canton Reservoir would be beneficial to determine if reservoir productivity is critical to reproduction and recruitment of Blue Catfish.

Unfortunately, we could only speculate which Blue Catfish stocking event contributed to this reproduction event in Canton Reservoir. Only two adult Blue Catfish have been captured and verified by ODWC personnel from Canton Reservoir since stocking was initiated in 1983 (Table 1), although anglers have reported catching Blue Catfish through the years. The first fish is the current lake record, however the age is unknown preventing us the ability to back calculate the year of stocking. More recently, a large Blue Catfish was caught and weighed in at the Canton Lake Walleye Rodeo in May 2017. This fish measured 988 mm TL, weighed 13.7 k g, and the estimated age of this fish was 19 (Figure 2). This fish likely came from the 2007 stocking event when 163 fish from Ellsworth Lake were stocked into Canton Reservoir. These fish averaged 305 mm TL at stocking, and based on previous Blue Catfish age data, ranged in age from 7-9 years old (Kuklinski and Patterson 2011). The longevity of Blue Catfish in Oklahoma is around 20 years old, however fish have been estimated to be 32-year-old from R. S. Kerr Reservoir (Boxrucker and Kuklinski 2006; Kuklinski and Patterson 2011). Assuming that Blue Catfish longevity similar to R. S. Kerr Reservoir then Blue Catfish stocked after 1984 could have contributed to the reproduction success of Blue Catfish in 2015.

Table 1. Year, number of fish stocked, total length, and stocking rates of Blue Catfish stocked in Canton Reservoir, Oklahoma.

Year	Number Stocked	Length (mm)	Density (fish/ha)
1983	41,070	119	12.83
1989	74,889	79	23.39
1991	21,717	114	6.78
1992	27,200	152	8.49
1993	89	Adults	0.02
2007	163	305	0.05

Otolith analysis of Blue Catfish in Canton Reservoir reveals fast growth rates. Blue Catfish grew an average of 229 mm in the first year in Canton Reservoir. In comparison to other studied populations of Blue Catfish in Oklahoma, the Canton population growth rate was faster than 84.6% of other systems sampled during 2004 – 2007 (Boxrucker and Kuklinski 2006; Kuklinski and Patterson 2011; Table 2). Considerable growth continued as age-2 fish gained 45 mm in their second year (274 mm mean TL). Mean length at age of 2-year-old Blue Catfish was greater than 75% of Oklahoma populations, with similar growth rates to Arcadia, Keystone and Sardis Reservoirs (Table 2). Growth of Blue Catfish in reservoirs is dependent on several variables such as length of the growing season, lake fertility, fish density, forage density and water temperature (Graham 1999). Canton Reservoir is a hypereutrophic system with adequate forage, however the fish community is comprised of a high abundance of predators which could lead to interspecific competition and growth effects.

If Blue Catfish spawning coincides with increased spring flows and a rise in pool elevation that inundates terrestrial vegetation to provide spawning and nursery habitat, this information could be used by fisheries managers to predict when a Blue Catfish year class may be formed. It may be possible to manipulate pool elevation in reservoirs to attempt to produce a year class of Blue Catfish if the pool elevation was drawn down for an extended period to allow herbaceous vegetation to colonize the littoral areas of the reservoir. This is an unrealistic approach for Canton Reservoir since this is a municipal water source for downstream Oklahoma City, however it could be possible in other medium to small impoundments where establishing a Blue Catfish population is desirable. Furthermore, if no age-1 Blue Catfish are sampled in 2017 but age-2 individuals are, one could conclude that a pulse of water is more important in spawning success than just a rise in pool elevation that inundates spawning habitat. Conversely, if age-1 and age-2 Blue Catfish are collected and there was no extreme spring flow event or increase in pool elevation, then it is merely a function of habitat,

Table 2. Comparison of age 1 Blue Catfish mean total length (mm) and standard error from Oklahoma Reservoirs. Data from **Boxrucker and Kuklinski (2006) and *Kuklinski and Patterson (2011). Bold lettering represents study lake.

			Age 1		Age 2	
Lake	Year Sampled	Suface Acres (ha)	N	Length (mm)	N	Length (mm)
Arcadia	2006	737	45	205 (±5)	54	283 (±5)
Canton	**2016**	**3,201**	**4**	**229 (±3)**	**5**	**274 (±3)**
Ellsworth**	2004	2,258	2	166 (±18)	32	186 (±3)
Eufuala**	2005	45,540	48	156 (±4)	41	203 (±4)
Fort Gibson*	2005	8,053	7	174 (±7)	35	202 (±3)
Hugo**	2005	5,343	721	168 (±1)	212	223 (±2)
Kaw**	2004	6,871	21	174 (±2)	75	232 (±2)
Keystone**	2005	9,520	98	195 (±3)	57	277 (±5)
Oologah*	2006	11,736	283	188 (±1)	141	247 (±3)
R.S Kerr*	2006	17,401	172	185 (±2)	126	229 (±2)
Sardis*	2007	5,811	1	269	10	293 (±3)
Texoma**	2003	35,600	30	172 (±3)	21	253 (±10)
Waurika**	2004	4,073	22	184 (±3)	278	194 (±2)

which could be addressed by fishery managers. An electrofishing survey was conducted in July 2017 and resulted in 0 age-1 Blue Catfish being caught, however 38 age-2 (verified by aging 13 individuals) with a mean TL 342 mm (±3.4 SE) were captured, leading us to believe that the pulse of water experienced in spring 2015 queued fish to spawn, which resulted in a successful reproduction event of Blue Catfish in Canton Reservoir.

We will continue to monitor Blue Catfish in Canton Reservoir into the future in an attempt to determine which environmental factors (or combination of factors) lead to reproduction and recruitment of Blue Catfish. Because the adult Blue Catfish in Canton Reservoir are reaching the maximum longevity (~20 years) for this species in Oklahoma (Kuklinski and Patterson 2011), a stocking program may need to be developed and implemented to maintain a population of sexually mature adult Blue Catfish in this system if successful Blue Catfish reproduction does not continue.

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