DELAYED-HOOKING MORTALITY OF BLUE CATFISH *ICTALURUS FURCATUS* CAUGHT ON JUGLINES IN OKLAHOMA RESERVIORS

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INTRODUCTION

Angling harvest has the potential to alter population size structure and reduce the population size of fishes. To prevent this, managers often implement length restrictions and bag limits, forcing anglers to release fish. These restrictions assume, however, that a large proportion of these released fish will survive to further contribute to the population through reproduction or recreational opportunity. Although in some situations less than 1% post-release mortality is possible (Dotson 1982; Clapp and Clark 1989; Childress 1989a; Parks and Kraai 1991), under other conditions it is not uncommon to see 70-90% post-release mortality (Martin et al. 1987; Childress 1989b; May 1990; Siewert and Cave 1990). If post-release mortality is high, bag limits and/or length regulations may do more to irritate anglers than to benefit the fishery. However, with a better understanding of the conditions responsible for mortality, seasonal closures and gear restrictions could still be effective management tools, even when high post-release mortality occurs.

Many factors can increase post-release mortality in angled fish. Seasonality or water temperature can significantly affect mortality rates. In general, the likelihood of mortality increases during the summer months or with warmer temperatures. This has been demonstrated with spotted seatrout *Cynoscion nebulosus* (James et al. 2007), striped bass *Morone saxatilis* (Lukacovic and Uphoff 2007), brook trout *Salvelinus fontinalis* (Nuhfer and Alexander 1992), and largemouth bass *Micropterous salmoides* (Rutledge, 1975), among others species. Anatomical hooking location can also affect mortality and deeply-hooked fish (fish hooked in the esophagus or gills) are generally more likely to die. This has been shown to be the case with common snook *Centropomus undecimalis* (Taylor et al. 2001), striped bass (Lukacovic and Uphoff, 2007), red drum *Sciaenops ocellatus (*Aquilar et al. 2002*)*, spotted seatrout (James et al. 2007), largemouth bass (Cooke et al. 2003), white seabass *Atractoscion nobilis* (Aalbers et al. 2004), and striped marlin *Tetrapturus audax* (Domeier et al. 2003), to name a few. Additionally, fish captured from greater depths are more likely to suffer post-hooking mortality (Feathers and Knable 1983; Hubbard and Miranda 1991; John and Syers 2005; Stewart 2008) and fish captured with natural baits generally ingest the hook further into the esophagus thus increasing the probability of mortality (Clapp and Clark, 1989; Siewart and Cave 1990).

With circle hooks becoming more popular in recent years, there has been an increase in the number of studies pertaining to mortality rates associated with this alternative style of hook (Serafy et al. 2009). In theory, the mechanics of circle hooks should reduce instances of gut hooking, therefore reducing mortality. This has been confirmed with many species of marine and freshwater fish (Prince et al. 2002; Cooke and Suski 2004). However, this effect may be species-specific, therefore it has been suggested that fishery managers only promote the use of circle hooks when "appropriate scientific data exist" (Cooke and Suski 2004). No such data currently exists for blue catfish *Ictalurus furcatus*.

Blue catfish are a major sportfish native to the Mississippi, Missouri, and Ohio River basins and are commonly found in many of Oklahoma's rivers and impoundments. Although blue catfish are highly migratory and prefer riverine environments (Lagler

1961), they have been successful in large reservoirs, especially those with a gizzard shad *Dorosoma cepedianum* forage base (Graham 1999). Blue catfish are long-lived, often living in excess of 20 years (Graham 1999). In addition to being an important sportfish, blue catfish are an important food fish and are commercially harvested in 14 states (Graham 1999).

Angling for blue catfish has become increasingly popular over the past two decades (Boxrucker and Kuklinski 2008; Michaeletz and Dillard 1999; Mauck and Boxrucker 2004; Makinster and Paukert 2008), with many anglers being attracted to this species due to its large size (Arterburn et al. 2002). Blue catfish are the largest catfish and the 4th largest freshwater fish in North America, following white sturgeon *Acipenser transmontanus*, Atlantic sturgeon *A. oxyrhynchus*, and alligator gar *Atractosteus spatula*. Blue catfish can weigh in excess of 45 kg (Cofer 2000), and the current world record fish weighed nearly 65 kg. Although historically these fish often reached impressive sizes, individuals over 50 kg are less common today (Graham 1999). This is most likely caused by poor growth, which is often associated with aquatic habitat modification, increases in agricultural runoff, the construction of impoundments, and overharvest of large individuals (Graham 1999). While there has been a recent increase in nationwide catfish angling, most agencies are not emphasizing trophy catfish management. In fact, only 2% of the state agencies surveyed by Arterburn et al. (2002) emphasized trophy management for any of the three largest North American catfish species (channel catfish *Ictalurus punctatus*, blue catfish, or flathead catfish *Pylodictus olivaris*). This is in direct contrast to the 75% of the anglers surveyed who favored the development of trophy catfish fisheries (Arterburn 2002). It has been suggested the lack of management efforts is partially due to a scarcity of information on both the life history and general biology of blue catfish (Graham 1999; Mauck and Boxrucker 2004) and flathead catfish (Makinster and Pauckert 2008).

Growth of blue catfish in Oklahoma reservoirs is slow and highly variable (Mauck and Boxrucker 2004; Boxrucker and Kuklinski 2006), and, on average, it takes 13-16 years for a blue catfish to reach "preferred size" or 762 mm total length (Boxrucker and Kuklinski 2008; Gablehouse 1984; TL). Preferred-size fish are rare in Oklahoma; a recent electrofishing survey in nine major Oklahoma reservoirs found that only 0.7% of blue catfish sampled were preferred size (Boxrucker and Kuklinski 2006). Given the calculated growth and mortality rates, the researchers concluded that only 2-3% of Age-1 fish would ever reach preferred size, meaning even fewer would grow to memorable or trophy size (914 mm TL; 1143 mm TL; Gablehouse 1984).

As a result of increasing fishing pressure and limited numbers of large fish, the Oklahoma Department of Wildlife and Conservation (ODWC) implemented legislation in 2010 which only allows fisherman to keep one fish over 762 mm (30 inches) TL, per day. This management strategy, however, will only be successful if a large proportion of released fish survive to further contribute to the population through reproduction or recreational opportunity.

Whereas delayed hooking mortality has been well-studied in species such as largemouth bass (Rutledge 1978; Schramm et al. 1987; Kwak and Henry 1995; Wilde 1998) and Atlantic salmon (Warner and Johnson 1978; Warner 1979; Thorstad et al. 2003), very little research has addressed delayed hooking mortality of blue catfish. One trotline study in Texas reservoirs found an overall post-release mortality of 5.1% after a 72-h assessment period, though this study was done on one reservoir, did not standardize hook type or hooking duration, had limited replication (only 4 sampling dates and 82 fish) and lacked control fish (Muoneke 1991).

Although trotline studies have a prolonged hooking component, they may not accurately reflect mortality for fish caught on juglines. Trotlines are generally set horizontally whereas juglines are set vertically; this vertical component could result in fish being hooked below a thermocline in hypoxic conditions, presumably increasing mortality. Additionally, juglines are effective in deep water, particularly during the winter months, and fish captured from greater depth generally exhibit greater post-release mortality (Muoneke and Childress 1994). Juglines are the second most popular form of catfishing in Oklahoma (Boxrucker and Kuklinski 2008), following rod and reel, and ODWC allows anglers to leave jugs unattended for up to 24 hours. This means that hooked catfish could feasibly be struggling for the entire 24 hours; prolonged hooking can increase stress (Tomasso and Isely 1996); lead to poor condition (Thorstad et al. 2002) and increase the probability of mortality (Schisler and Bergersen 1996). Ultimately, high mortality of released catfish could negate the intended benefit of the new bag limit, necessitating the implementation of other regulations to assist in the development of trophy fisheries (i.e. gear or seasonal restrictions).

I conducted field trials to quantify the delayed-hooking mortality of blue catfish caught on juglines in three different Oklahoma reservoirs. More specifically, my objectives were to address the effects of hook type, water temperature, hook depth in the water column, and anatomical hooking location on the delayed hooking mortality of blue catfish.

SECTION II

STUDY AREA

Mortality was analyzed at Kaw, Keystone, and Sooner Lakes. Kaw Lake is an impoundment of the Arkansas River located near Ponca City, Oklahoma. At conservation pool, the reservoir impounds 0.53 km^3 of water and inundates a surface area of 6896 ha. Keystone Lake is an impoundment of Arkansas and Cimarron Rivers and is located downstream of Kaw Lake. At conservation pool, Keystone Lake impounds 0.62 km^3 of water and inundates a surface area of 9550 ha. Both Kaw Lake and Keystone Lake are heavily silted and have abundant shallow water habitat. Sooner Lake is a unique reservoir located just north of Morrison, Oklahoma. It was constructed in 1972 with the sole purpose of supplying cooling water for a coal-fired power plant. It is located on the top of a hill adjacent to the Arkansas River, so water must be actively pumped into the lake to maintain normal pool. It is deeper and generally less turbid than Kaw or Keystone Lakes, and is heavily infested with Asiatic clams *Corbicula fluminea* and zebra mussels *Dreissena polymorpha*. The discharge from the power plant provides a constant supply of warm water and creates a current throughout the reservoir. At normal pool, Sooner Lake holds approximately 0.18 km^3 of water and inundates a surface area of 2182 ha

SECTION III

METHODS

From May 2010 to March 2012, Blue catfish were captured using traditional jugline equipment at Kaw, Keystone, and Sooner Lakes. Trials were conducted seasonally so that mortality estimates could be made for the full range of water temperature. At a minimum, jugs were deployed at least five times per lake for water temperatures < 17°C and at least eight times per lake for water temperature > 17°C. More effort was directed towards warmer water temperatures because the probability of mortality generally increases with water temperature (Muoneke and Childress 1994). All juglines were baited with fresh gizzard shad, common carp *Cyprinus carpio*, or buffalo *Ictiobus spp*., depending upon bait availability. All hooks were baited with the same bait type during each replicate. Additionally, all bait types were used proportionally across all lakes and seasons.

Juglines were made using 295-lb test seine twine (#30) for the main line and 126-lb seine twine (#15) for the dropper lines. Dropper lines were attached to the main line at intervals of approximately 1-m using trotline clips. To quantify mortality of fish that were hooked in the hypolimnion, where hypoxic to anoxic conditions can exist, juglines were marked in 1-m increments and 2 hooks were set above the thermocline and 1 hook was set below.

Dropper lines were equipped with either 5/0 Mustad Biggun'® J-style hooks or 5/0 Diachii Circle-Chunk Light® hooks; both of which had non-offset points. All juglines had 3 hooks of the same design, either J-hooks or circle hooks. To quantify the effect of hook type on mortality, equal numbers of jugs with 5/0 J-hooks and 5/0 Circle hooks were set during each collection period. In order to intersperse the two hook styles and reduce bias, the juglines were deployed in series which alternated by hook type.

Jugs were allowed to soak for 24 h, which is the maximum time allowed by Oklahoma law. Because many fisherman would want to retrieve their hooks, all fish were unhooked upon capture, even though removing the hook from a deeply-hooked fish can increase the probability of mortality (Mason and Hunt 1967; Warner and Johnson 1978; Warner 1979; Weidlein 1989; Vincent-Lang et al. 1993, Aalbers et al. 2004). Additionally, blue catfish were not given any special treatment during handling (i.e., we tried to simulate the behaviors of typical anglers as much as possible).

All hooked fish were placed into separate field enclosures. Field enclosures were made from galvanized, 12.5-gauge fencing material with 51-mm x 102-mm openings. Each enclosure had dimensions of $1.25 m^3$. Each enclosure was suspended in close proximity to the location of capture with similar temperature and dissolved oxygen (DO). During the warmer months, when water column stratification had the potential to create hypoxic conditions, DO was monitored using a YSI 556 multi-probe system (Yellow Springs Instruments Inc., Yellow Springs, OH, U.S.A.) and cages were never suspending in areas with less than 5.8 mg/L DO, which is well above the minimum DO suggested for the culture of channel catfish (4.0 mg/L ; Tucker 1991).

Boat-mounted electrofishing equipment (either a Smith-Root Model 7.5 GPP or 5.0 GPP; 15 pps DC current; ≈4 amps) was used to collect control fish. One experimental and one control fish were placed within each field enclosure and mortality was quantified after 72 h. Because blue catfish can be cannibalistic (Schloesser et al. 2011), control and treatment fish in each enclosure were of similar size. Both the experimental and control fish were marked by clipping the soft portion of the pectoral fin: experimental fish had their left fins clipped; control fish had their right fins clipped.

Whereas most post-hooking mortality is expected to occur in the first 24 h (Muoneke 1992; Muoneke and Childress 1994; Schill 1996), all fish were placed in field enclosures and monitored for 72 h, because a substantial portion of death can occur after several days (Grover et al. 2002). A 72-h observation period is supported by the findings of several mortality studies (Muoneke 1991; James et al. 2007; Bettoli and Osborne 1998; Klein 1965; Mason and Hunt 1967; Hunsaker et al. 1970; Marnell and Hunsaker 1970; Warner and Johnson 1978; Stunz and McKee 2006), including a trotline study with channel catfish where the researchers found that the majority of the mortalities had occurred by 72 h (Ott and Storey 1991). To determine if significant mortality occurs after 72 h, 56 fish were observed at both 72 h and 7 d. These trials were conducted during the winter and summer at both Kaw and Sooner reservoirs, and no additional mortalities occurred after the initial 72-h assessment.

We modeled the binary probability (1=dead 0=alive) of survival using the Glimmix procedure in SAS with a logit link function and a binary probability distribution (SAS Institute, Carey, NC, 2009) Separate repeated-measures analyses, where lakes were treated as subjects, were used to test for significant differences in the 72-h mortality rate for each explanatory variable (temperature, hook type, fish size, and anatomical hooking location). Hook type, fish size (10-mm groupings), anatomical hooking location, and depth (above or below the thermocline) were treated as categorical variables; water temperature and was treated as a continuous variables. For significant tests with categorical variables, a Tukey's post-hoc test was used to test all pairwise combinations. Odds ratios were used to describe differences between levels of variables.

SECTION IV

RESULTS

A total of 97,200 hook-hours of effort were expended at Kaw, Keystone, and Sooner Lakes from May 2010 to March 2012. Water temperatures ranged from 2.3° C to 31.6° C. A total of 559 blue catfish were captured ranging in size from 310 mm to 1238 mm total length (Figure 1). Jugs were deployed on 54 separate occasions and, during most trials, mortality of control fish was very low (mean = 1.6%). However, in June and July of 2010, three trials were conducted at Kaw Lake during a high water event. During these trials, high mortality of jug-caught fish (40 – 50%) and control fish (30.0 – 37.5%) occurred, suggesting mortality may be related to environmental conditions during those replicates. Many control fish (*n*=12) were observed with malodorous lesions similar to those described by Meyer and Bullock (1973). This outbreak made it clear that mortality could no longer be solely attributed to hooking stress, so these trials were excluded from further analysis. Additional warm-water trials in Kaw Lake were conducted during June of 2011 and more typical mortality rates (5.9 %) suggested that the previous year's mortality rates were a result of isolated conditions during those replicates.

We attempted to quantify mortality rates for blue catfish captured beneath the thermocline at Kaw and Keystone Lakes. No trials were conducted on Sooner Lake because it is located in the prairie and has very few windbreaks. Strong winds result in large waves which thoroughly mix the water column and limit thermal stratification. A total of 11,680 hook-hours of effort were expended on Kaw and Keystone reservoirs, but no blue catfish were captured beneath the thermocline. Channel catfish were caught occasionally (n=6), several of which were dead upon retrieval of the jug, $n=3$. Field trials in the hypolimnion were abandoned after the first summer (2010).

Hooking mortality rates were similar across reservoirs so reservoir data were pooled (Kaw= 11.0%, Keystone= 9.9%, Sooner= 6.4%; $F_{2,511}$= 0.65; P=0.53). Mean mortality for both hooked fish and control fish was low at 8.54% and 1.64%, respectively. Subtracting mean control mortality from mean hooking mortality results in an overall adjusted mortality of 6.9%.

Although overall mortality was low, it was significantly related to several of the tested factors. Mortality rates increased with increasing water temperature ($F_{1,501}$ = 12.56, $P < 0.01$) and for every 1° C increase in temperature, catfish were 1.1 times more likely to die (odds ratio 1.1; Figure 2). Mortality also decreased significantly with increasing fish size ($F_{7,10}$ = 4.58, $P < 0.02$) and, for every 100-mm increase in total length, catfish were about 6 times less likely to die (odds ratio 0.16; Figure 3). Mortality of fish > preferred size was negligible at 2.5% (N=83). No mortality was observed in memorable or trophy-sized fish (N=16).

Hooking location also influenced mortality. Although the majority of fish (72.23%) were hooked in the corner of the mouth (Figure 4), many smaller fish that were hooked in the corner of the mouth also had damage to the eye due to its close proximity to the mouth. These “eye-hooked” fish were categorized separately and accounted for 20.6% of the fish caught. Fish that were hooked externally, usually the cheek, the bottom of the jaw, or the opercula, accounted for 4.79% of the fish captured. Only 15 fish (2.4 %) were hooked in the stomach or esophagus. Pair-wise comparisons of mortality by anatomical hooking location were made and significant differences in mortality were found across all ($P < 0.01$; Table 1), with the exception of externally hooked fish vs. eye hooked fish (P=0.28). Mortality was relatively high for esophagus-hooked fish (91%) and externally hooked fish (20%; Figure 5). Mortality of catfish hooked in other anatomical locations was comparatively low (<10%; Figure 5).

Circle hooks accounted for 75.5% of the total catch, despite equal effort with both hook types. Although circle hooks had slightly lower mean mortality (Figure 6), this effect was not statistically significant ($F_{1,510} = 0.24$, $P = 0.62$).

SECTION V

DISCUSSION

Mortality of blue catfish caught on juglines was very low. Mean mortality was less than 10% and, even during the heat of the summer, mortality rarely exceeded 20%. Therefore, managers should be able to effectively use length limits and/or bag limits as fish released under these regulations should have high survival under most conditions. However, although overall mortality was low, it was significantly related to several of the tested factors. This suggests that mortality could be problematic for some groups of fish, at least under specific conditions.

Large blue catfish had lower mortality rates than small blue catfish. No mortality was observed in memorable or trophy-sized fish (≥914 mm and ≥ 1143 mm TL, respectively; Gablehouse 1984) and mortality was 2.5% for preferred-size fish (≥762 mm TL; Gablehouse 1984). Higher mortality in smaller fish is consistent with Muoneke (1991), who found that 75% of the mortalities of blue catfish caught on trotlines were individuals <356 mm TL. Additionally, high post-hooking survival of larger individuals was found in lake trout *Salvelinus namaycush* (Loftus and Taylor 1988), rainbow trout (Schisler and Bergersen 1996), and dusky shark *Carcharhinus obscurus* (Romine et al. 2009), though the mechanisms causing this pattern are unclear. Damage caused by 5/0 hooks may be insignificant to larger fish but proportionally more severe to small fish, as there is less space between the mouth and vital organs, such as the eye or the esophagus, on these individuals. Hypothetically, smaller fish may be less resilient to hooking stress due to underdeveloped immune systems or limited energy reserves, making them more susceptible to post-hooking bacterial or viral infections. Whatever the mechanism, the high survival of large blue catfish implies that managers can effectively use maximum length limits or restricted bag limits to conserve large fish.

Mortality rates decreased significantly with decreasing temperature and, at temperatures cooler than 15° C, mortality decreased to 1.62%. This pattern of reduced mortality at cooler water temperatures is consistent with previous studies of brook trout (Dotson 1982), cutthroat trout *Oncorhynchus clarkii* (Marnell and Hunsaker 1970), largemouth bass (Rutledge 1975), striped bass (Childress 1989), tiger muskellunge *Esox masquinongy x E. lucius* (Newman and Storck 1986), and spotted seatrout (Matlock and Dailey 1981). Lower occurrences of mortality at cooler water temperatures likely result from decreases in metabolic rate, activity level, and bacterial concentrations (Muoneke and Childress 1994); however, the exact mechanism causing this pattern in blue catfish is unknown. Large blue catfish are more susceptible to capture during the cool months (Boxrucker and Kuklinski 2008), which is when this study found the probability of survival to be the highest. This further supports the idea that maximum length limits and/or restricted bag limits for large individuals may be useful tools when trying to manage for trophy fish.

Anatomical hooking location also had a significant effect on hooking mortality. While the majority of fish were hooked through the mouth, some fish were hooked externally, through the eye, or deep in the esophagus or stomach. Mortality was low for fish hooked in the mouth or through the eye but was over 90% for fish hooked in the esophagus. High mortality of esophagus-hooked fish is common with other fish species, especially when the hook is removed (Diggles and Ernst 1997; Butcher et al. 2006). Circle hooks significantly reduce instances of deep-hooking in several species of billfish (Prince et al. 2002), though this does not appear to be the case with blue catfish. In fact, 40% of the deeply-hooked catfish in this study were captured using circle hooks. Circle hooks cause less mortality than conventional hooks in many species (channel catfish, Ott and Storey 1991; striped bass, Caruso 2000; coho salmon *Oncorhynchus kisutch*, McNair 1997; Chinook salmon *Oncorhynchus tshawytscha*, Grover et al. 2002; and bluefin tuna *Thunnus thynnus*, Skomal et al. 2002), and, while circle hooks resulted in slightly lower mortality in this study, the difference was not statistically significant. Therefore, restrictions concerning hook type do not appear to be an effective management tool for this species. Restrictions that minimize deep hooking could be beneficial if it occurred more frequently, but in this study only 2.5% of the fish captured were hooked in the esophagus.

Although it is entirely possible that blue catfish may feed in the hypolimnion under certain conditions, no fish were captured beneath the thermocline in this study. It is feasible that blue catfish avoid these low-oxygen zones; Grist (2002) found that blue catfish in Norman Lake, North Carolina show a distinct preference for areas with much higher DO concentrations than the lake mean, particularly during the summer month, and were rarely found in areas with dissolved oxygen concentrations less than 7.0 mg/L. Even if a blue catfish were to get hooked beneath the thermocline, it still has a reasonable chance of escaping to more oxygen-rich zones. Most jug fisherman use bricks, bank sinkers, or homemade concrete weights to anchor their juglines, all of which typically weigh less than 1 kg. In this study, even medium-size fish (500-700 mm TL) were capable of towing juglines for several kilometers, so fish would not necessarily be trapped in the hypolimnion.

Mortality for blue catfish caught on juglines is quite low, and the probability of survival generally exceeded 90%. The probability of survival increased with fish size and no mortalities were observed in memorable or trophy-size fish. Mortality of preferred-size fish was negligible at 2.5%, and was very close to control mortality (1.6%). Large blue catfish are most vulnerable to capture during the winter months (Boxrucker and Kuklinski 2008), and our findings provide evidence of higher survival rates at colder water temperatures. These findings imply that managers can effectively use maximum length limits and/or more restrictive bag limits to conserve rare, larger fish. Density-dependent growth is a problem in Oklahoma reservoirs (Boxrucker and Kuklinski 2006), so it would be intuitive to restrict harvest of larger fish while encouraging liberal harvest of smaller fish.

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TABLES & FIGURES

Table 1 P-values from Tukey's pair-wise comparisons of mortality by anatomical hooking location for blue catfish caught on juglines during 2010-2012 at Kaw, Keystone, and Sooner Lakes, Oklahoma.

	External	Esophagus	Mouth	Eye
External	*			
Esophagus	0.002	*		
Mouth	0.003	0.001	*	
Eye	0.280	0.001	0.011	*

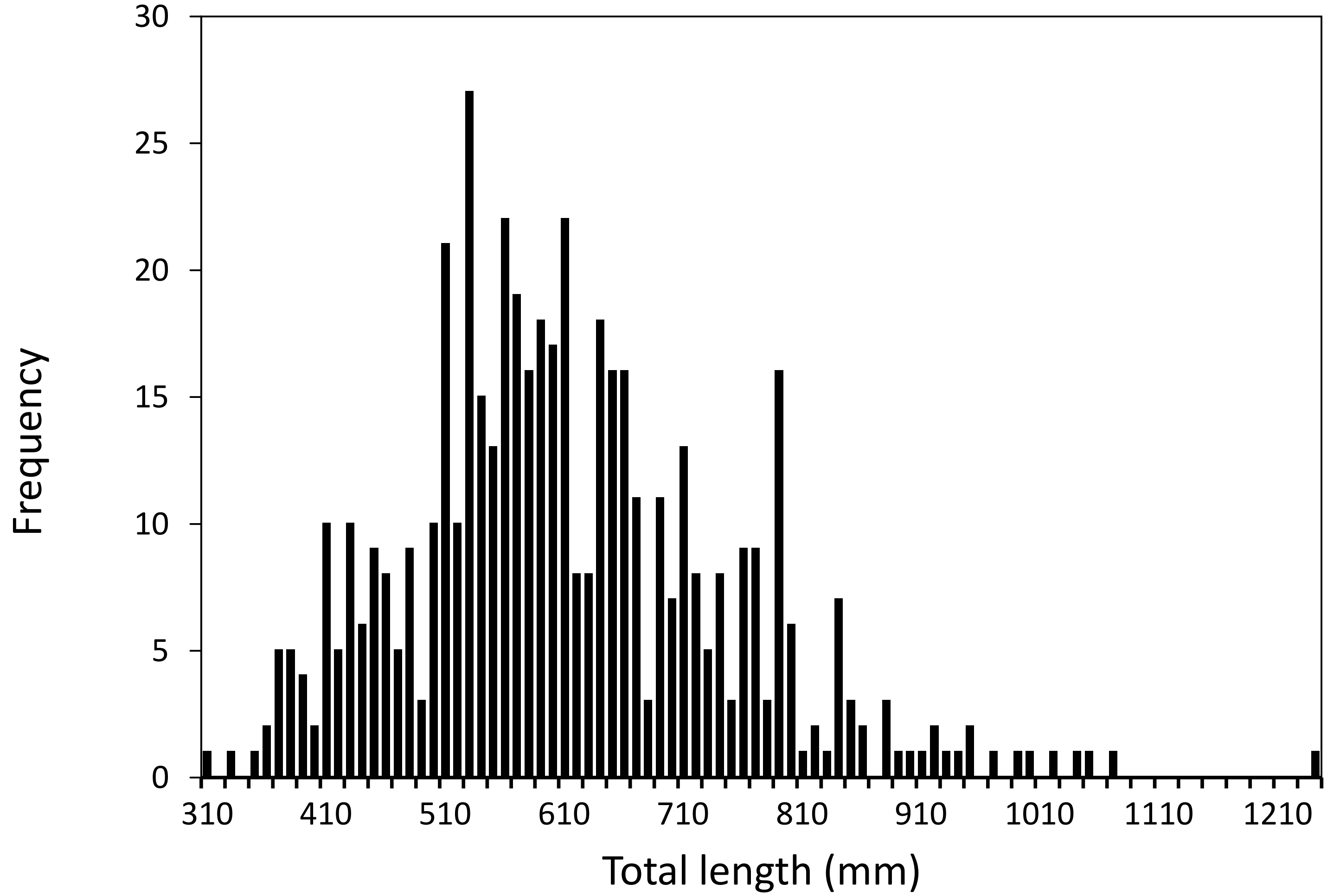

Figure 1 Length frequencies of blue catfish caught during 2010-2012 on juglines at Kaw, Keystone, and Sooner Lakes, *N* =559.

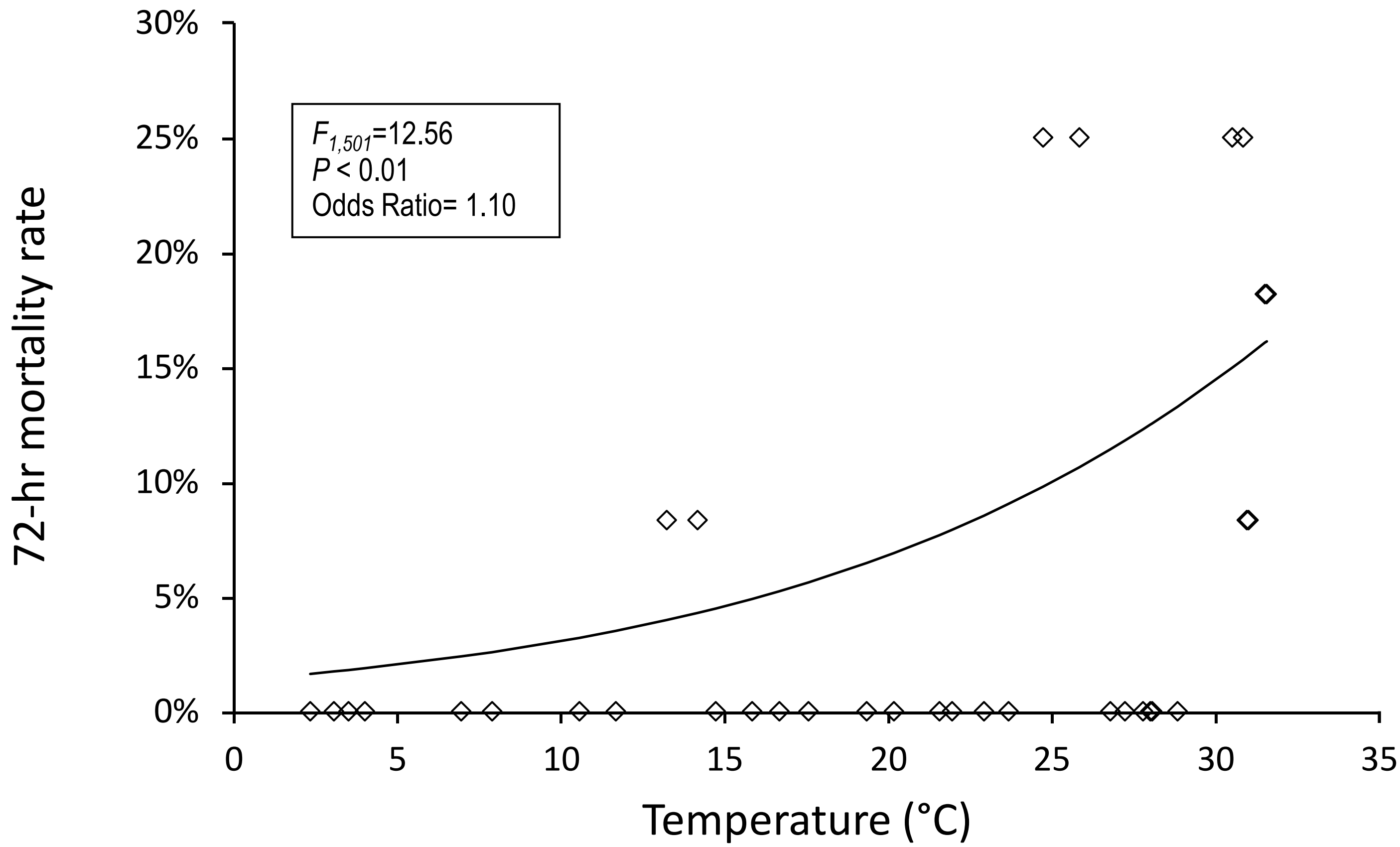

Figure 2 Relationship between temperature and 72-h post-hooking mortality of blue catfish caught during 2010-2012 on juglines at Kaw, Keystone, and Sooner Lakes, Oklahoma.

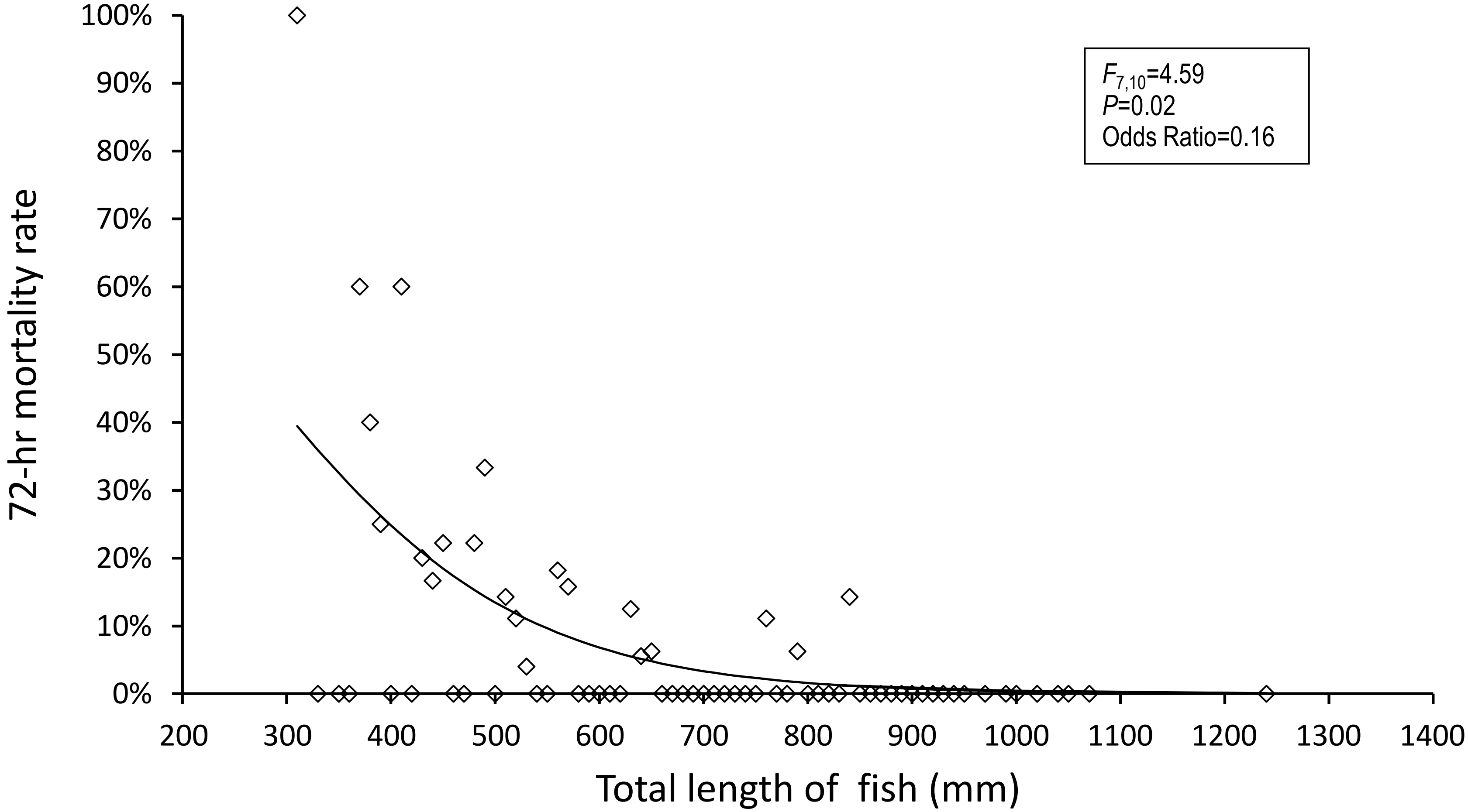

Figure 3 Seventy-two hour mortality rate as a function of total length (10-mm length classes) for blue catfish caught during 2010-2012 on juglines at Kaw, Keystone, and Sooner Lakes, Oklahoma.

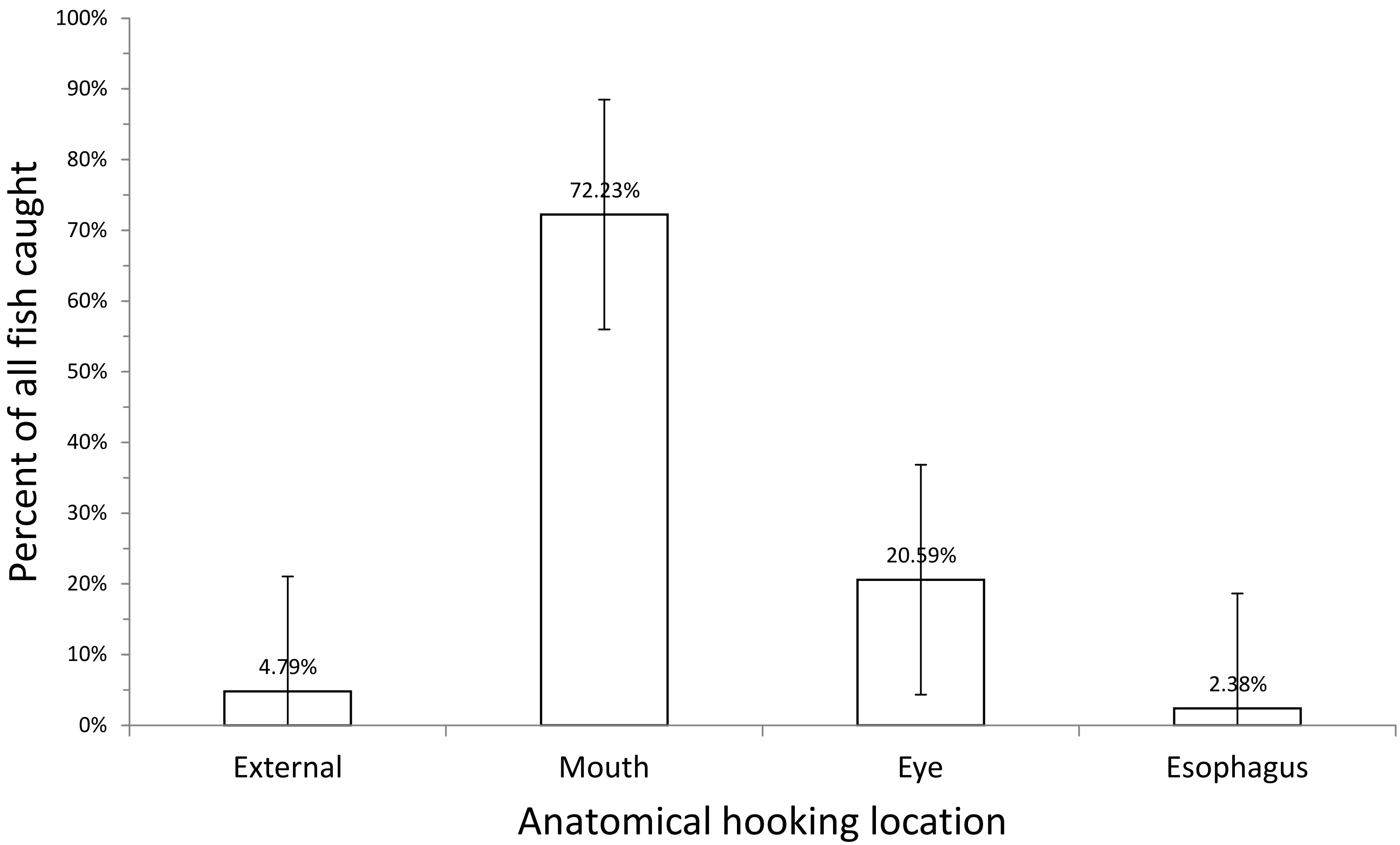

Figure 4 Total catch by anatomical hooking location for blue catfish caught during 2010-2012 on juglines at Kaw, Keystone, and Sooner Lakes, Oklahoma.

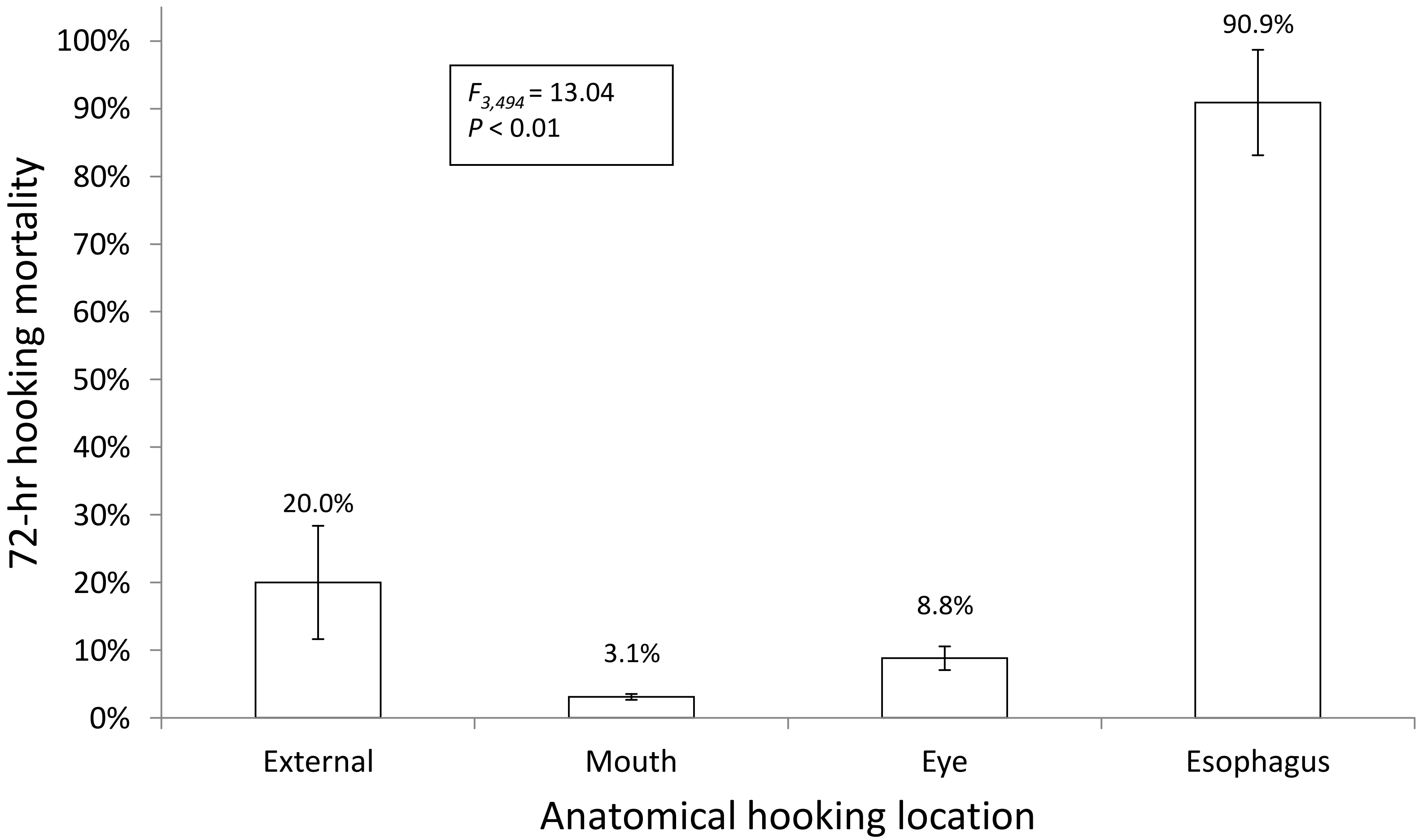

Figure 5 Effect of anatomical hooking location on 72-hr mortality rate for blue catfish caught on juglines at Kaw, Keystone, and Sooner Lakes, Oklahoma during N=54 sampling dates, 2010-2012.

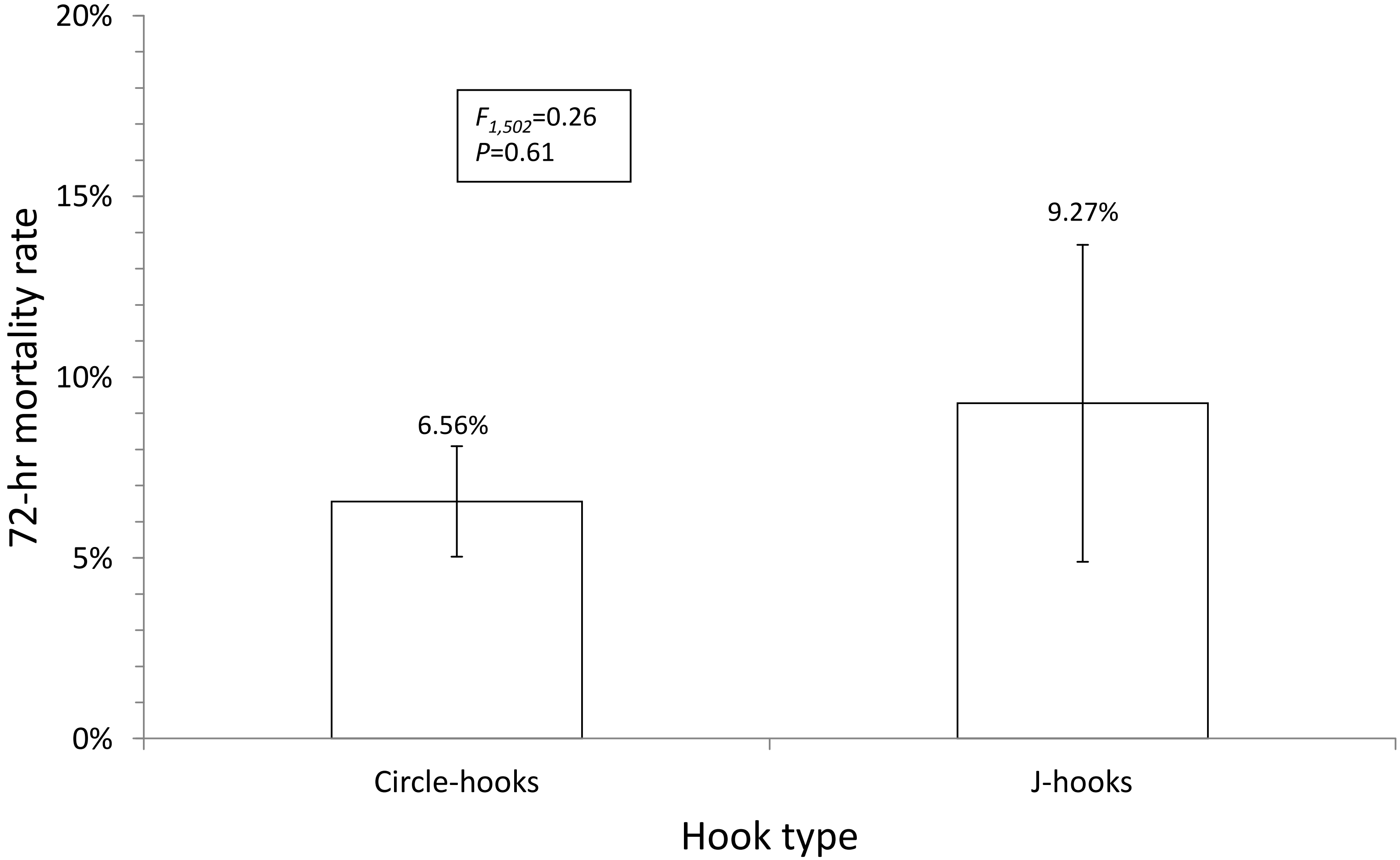

Figure 6 Effect of hook type on 72-hr mortality rate for blue catfish caught during 2010-2012 on juglines at Kaw, Keystone, and Sooner Lakes, Oklahoma

VITA

Joseph Daniel Schmitt

Candidate for the Degree of

Master of Science/Arts

Thesis: DELAYED HOOKING MORTALITY OF BLUE CATFISH *ICTALURUS FURCATUS* CAUGHT ON JUGLINES IN OKLAHOMA RESERVOIRS

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Major Field: Natural Resource Ecology and Management: Fisheries and Aquatic Ecology

Scope and Method of Study:

As recreational catfishing grows more popular, state agencies are beginning to emphasize trophy catfish management. Growth of blue catfish in Oklahoma reservoirs is typically slow, with only a small percentage of fish reaching preferred-size (762 mm). To prevent overharvest of larger fish, the Oklahoma Department of Wildlife Conservation recently implemented a law restricting harvest of fish over preferred size to one fish per person, per day. For this regulation to be effective, released fish must survive to further contribute to the population, but little is known concerning the delayed hooking mortality of blue catfish. We investigated the delayed hooking mortality for blue catfish caught on juglines. Blue catfish (N=559) were caught seasonally from three reservoirs on either 5/0 circle hooks or J hooks fished for 24-h sets. One experimental fish (jug fished) and one control fish (captured via pulsed DC electrofishing) were then placed in field enclosures and monitored for mortality after 72 h.

Findings and Conclusions:

We did not detect a significant difference across reservoirs ($P>0.05$), so data were pooled. Mean overall mortality was low at 8.54%. Mortality increased significantly ($P<0.01$) with water temperature, and for every 1°C increase in temperature, blue catfish were 1.1 times more likely to die. At temperatures lower than 15°C, mortality decreased to 1.62%. Hook type did not significantly affect mortality, nor did the depth in the water column where the fish was hooked. Larger fish were more resilient and less likely to suffer mortality due to hooking stress, which suggests that the new regulation limiting the harvest of preferred-size fish should be effective, even with 24-h jug-fishing sets.

ADVISER'S APPROVAL: Dr. Daniel E. Shoup