AN EVALUATION OF THE EFFECTIVENESS OF A TROPHY BLUE CATFISH REGULATION IN OKLAHOMA

By

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Abstract: Growing interest in trophy Blue Catfish *Ictalurus furcatus* angling has resulted in implementation of trophy regulations by some natural resource agencies. On January 1, 2010, the Oklahoma Department of Wildlife Conservation adopted a regulation that only one Blue Catfish over 760 mm can be harvested per day to redirect angler harvest towards smaller fish, control harvest of large fish, and improve the overall size structure of these populations. This study evaluates whether the 762 mm length regulation has resulted in improved size structure of Blue Catfish in Oklahoma reservoirs. We compared pre- (2003-2006) and post- (2017-2018) regulation population parameters from seven Oklahoma reservoirs and found significant differences in length frequencies in all sampled reservoirs and age frequencies on the three reservoirs where otoliths were collected, although not necessarily congruent with expectations from the trophy regulation. Two lakes, for example Texoma and Ellsworth, exhibited significant increases in PSD, indicating a greater abundance of larger fish, but the other five lakes exhibited opposite or no clear trend. As of 2018, it appears the regulation change has been ineffective at meeting its stated goals, at least on a state-wide basis.

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CHAPTER I

AN EVALUATION OF THE EFFECTIVENESS OF A TROPHY BLUE CATFISH REGULAION IN OKLAHOMA

Introduction

Creating trophy fisheries is often an objective of fisheries managers (Paukert et al. 2001, Dreves et al. 2014). Trophy fishing is a relatively new focus for fisheries managers, which arose after anglers expressed a desire for a diverse selection of fishing opportunities (Bennett et al. 1978, Chen et al. 2003). Managing a diversity of fisheries, which includes trophy fisheries, creates high satisfaction among anglers as a whole, thus maintaining high numbers of license holders (Hayes et al. 1999, Chen et al. 2003). In the late 1970s, only 18% of state agencies in the United States were actively developing trophy fisheries, but 28% were interested in their development in the future (Bennett et al. 1978). Since the 1970s, managers have developed trophy fisheries for a number of fish species.

Blue Catfish *Ictalurus furcatus* is a sportfish with a growing percentage of anglers targeting them for their trophy potential. Nationally, 75% of catfish anglers were in favor of developing trophy fisheries for catfish at the beginning of the decade and 71% took at least one trip a year in pursuit of trophy catfish (Arterburn et al. 2002). In contrast, only 2% of managers surveyed indicated their agency managed for trophy catfish (Arterburn et al. 2002). Since 2002, some state agencies have developed regulations to promote trophy catfish (Kuklinski and Paterson 2011, Stewart et al. 2012) and prevent overharvest of larger Blue Catfish (Dorsey et al. 2011). Using maximum size limits is one way of allowing harvest of smaller fish while protecting larger fish, which can increase trophy opportunities (Carlson and Isermann 2010, Pierce 2010, Neely and Dumont 2012). In 2003, Tennessee became the first state to implement a maximum size limit on Blue Catfish (Stewart et al. 2009). Since, four other states (Alabama, Ohio, Oklahoma, and Virginia) have implemented statewide length limits limiting harvest of trophy-size Blue Catfish (Dickinson 2013, SDAFS 2019). Additionally, seven states (Kentucky, Louisiana, Mississippi, Missouri, North Carolina, South Carolina, and Texas) have regulations restricting the harvest of larger Blue Catfish on at least one water body (Dickinson 2013, SDAFS Catfish Committee 2017). Results from these management changes have not been reported, but simulation models have indicated that minimum and maximum length regulations may not be effective at increasing the abundance of larger Blue Catfish (Dorsey et al. 2011, Stewart et al. 2016), although large minimum length limits have improved size structure in some systems (e.g., Holley et al. 2009). These models indicate the need to evaluate the effectiveness of trophy Blue Catfish regulations already in place so managers can verify if management objectives are being met.

After conducting research evaluating Blue Catfish in multiple waterbodies across the state (Mauck and Boxrucker 2004, Boxrucker and Kuklinski 2006, Kuklinski and Paterson 2011), Oklahoma implemented their own “trophy” Blue Catfish regulation in 2010 (Kuklinski and Paterson 2011). Creel data in Oklahoma indicated that the proportion of Blue Catfish ≥760 mm TL (preferred-sized (Gablehouse 1984)) harvested by anglers was 10x greater than the relative abundance of this size class in fishery samples. Furthermore, 55.4% of anglers that caught a Blue Catfish preferred-sized or larger harvested multiple preferred-sized Blue Catfish in their daily limit (Kuklinski and Boxrucker 2008). However, Blue Catfish in Oklahoma grow slowly, taking roughly 12 years to reach preferred size, and live up to 32 years (Mauck and Boxrucker 2005; Boxrucker and Kuklinski 2006), suggesting that multiple years are necessary to increase abundance of these large-sized fish. Effective January 1, 2010, Blue Catfish in Oklahoma were subjected to a 15-fish limit with only one Blue Catfish over preferred-size per day. Whether this decade-old regulation change has increased the relative abundance of preferred-size fish is unknown.

Evaluating post-regulation changes is critical in order to determine if managers' desired effects have been achieved. Regulations may not work for a variety of reasons including, for example, noncompliance, resulting in overharvest of fish by anglers. Additionally, anglers may be catch-and-release oriented and regulations that support liberal harvest of fish to reduce fish numbers may be ineffective due to lack of harvest (Noble and Jones 1999). Blue Catfish anglers who target trophy-size fish are more likely to prefer catching fewer, but larger fish (Wild and Riechers 1994, Graham 1999, Arterburn et al. 2002, Mauck and Boxrucker 2004), than harvest oriented anglers who prefer catching smaller fish in greater numbers (Reitz and Travnichek 2006, Hunt et al 2012, Hyman et al 2017). Evaluating regulations allows modifications to be made if populations are not responding in the desired way (Noble and Jones 1999). Using data from multiple lakes in Oklahoma that were previously assessed (Boxrucker and Kuklinski 2006, Kuklinski and Patterson 2011), and have been sampled by ODWC since, will allow for a comparison between pre and post- regulation implementation.

Study Area

Seven study lakes were chosen to represent broad geographic coverage across the state, encompass a large range in size, and that had comparable Blue Catfish data from before the regulation change in 2010 (Figure 1; Table 1). Lake Ellsworth is located in Caddo and Comanche counties within the Central Great Plains ecoregion (Woods et al. 2005) in southwestern

Oklahoma. Impounded along the East Cache Creek in 1962, it is managed by the City of Lawton for water supply, recreation opportunities, and fish and wildlife propagation (OWRB 2016). Lake Eufaula is the largest lake in Oklahoma in terms of surface area and is located in the Arkansas Valley, Central Irregular Plains, and Cross Timbers ecoregions (Woods et al. 2005) as an impoundment of the Canadian River in 1964. It is managed by the United States Army Corp of Engineers for flood control, hydropower, recreation, water supply, and fish and wildlife propagation (OWRB 2016). Kaw Lake is an impoundment of the Arkansas River located in the Central Great Plains and Flint Hills ecoregions (Woods et al. 2005). The lake was completed in 1976 and is managed by the United States Army Corps of Engineers for flood control, hydropower, water supply, water quality control, and fish and wildlife conservation (OWRB 2016). Keystone Lake is impounded at the confluence of the Arkansas River and the Cimarron River in the Cross Timbers ecoregion (Woods et al. 2005) and was completed in 1968. Keystone Lake is managed by the United States Army Corps of Engineers for flood control, hydropower, recreation, water supply, and fish and wildlife propagation (OWRB 2016). Oologah Lake was completed in 1963 and is operated by the United States Army Corps of Engineers for flood control, navigation, recreation, water supply, and fish and wildlife propagation (OWRB 2016). It is located in the Central Irregular Plains (Woods et al. 2005) and fed by the Verdigris River. Lake Texoma is located in the Cross Timbers and East Central Texas Plains ecoregion (Woods et al. 2005). The lake was impounded at the confluence of the Red River and the Washita River and completed in 1944. Texoma is managed by the United States Army Corps of Engineers for flood control, hydropower, recreation, water supply, and fish and wildlife propagation (OWRB 2016). Waurika Lake is a 4,092-ha reservoir impounded along Beaver Creek in the Central Great Plains ecoregion (Woods et al. 2005), when the dam was completed in 1977. Waurika is managed by United States Army Corps of Engineers for flood control, recreation, water supply, and fish and wildlife propagation (OWRB 2016).

Methods

Evaluation of the study lakes was done by using two groups of data: pre (2003-2006) and post (2017 and 2018) regulation change. Data from Boxrucker and Kuklinski (2006) and Kuklinski and Patterson (2011) were the primary data sources used for the pre-regulation population dynamics of Blue Catfish. These pre-regulation data were collected using low-pulse (15/sec), low current (<4 amp) boat electrofishing with samples taken in 8 locations from upper portions of the reservoirs in depths ranging from 3-5 m. Each sample site had 15 min of effort, using one electroshock boat and two chase boats each with two dippers. Blue Catfish collected were measured (TL mm) and weighed (g). Otoliths were collected from a subsample of fish (20 fish/ 20 mm length group) and used to determine age.

In summer 2017 and 2018 (June-September), I conducted post-regulation Blue Catfish sampling using low-pulse (15/sec), low current (<4 amp) boat electrofishing with 20 sample sites randomly selected in the upper portions of 6 study lakes (Mauck and Boxrucker 2004, Bodine and Shoup 2010, Bodine et al. 2011). The seventh lake (Ellsworth) included for sampling only had 10 random sites due to its smaller size (ODWC 2016). There, sites ranged in depth from 3-13m and were randomly chosen within a 300m x 300m grid overlay stratified to the upper 50% of the length of the reservoir. For all lakes, electrofishing was conducted between sunrise and sunset at each site for 5 minutes, using two chase boats and one electrofishing boat each with one dipper (Buckmeier and Schlechte 2009). Differences between pre- and post-regulation sampling methodologies reflect differences in standardized sampling that is conducted by ODWC at the time. The primary difference is duration of sampling, which does not affect abundance or size-structure metrics (Shoup and Bodine *In Press*) and would not bias my results for comparison. Blue Catfish at all study lakes were collected, measured (TL mm), and weighed (g). At three lakes (Ellsworth, Kaw, and Waurika), lapilli otoliths (Long and Stewart 2010) were collected from a subsample of fish (20 fish/ 20 mm length groups) for age estimation (Boxrucker and

Kuklinski 2006). Otoliths were processed by embedding in epoxy resin (Stewart et al. 2009), allowed to dry for two days, and making a single cut along the transverse plane just anterior of the edge of the nucleus using a Buehler low speed isomet saw (Buckmeier et al. 2002, Stewart et al. 2009). Otoliths were then sanded using 1500-grit sand paper until the nucleus was exposed and readable. Ages were estimated independently by two readers and disagreements between estimates were resolved by concert age assignment (Buckmeier et al. 2002). Age estimates were applied to the whole lake sample of Blue Catfish using an age-length key before additional age-based metrics of growth, age frequency, and mortality were estimated.

I used the Oklahoma Fisheries Analysis Application (OFAA) to analyze data from both before and after the regulation change. The OFAA was designed to allow ODWC fisheries workers to quickly analyze standardized samples and use the output for management decisions and it houses previous standardized sample data across the state. The OFAA is able to use chosen sampling data to produce easy to read results for a wide array of fisheries metrics (e.g., CPUE, PSD, length and age frequencies) including measures of uncertainty. In addition, the OFAA stores the historic fisheries data allowing one to compare with newly obtained data. Catch per unit effort (CPUE; #/hr), CPUE of fish ≥760mm TL (CPUE ≥760), proportional size distributions (PSD), PSD of preferred size fish (PSD-P), relative weight (Wr), relative weight of fish ≥762mm TL (Wr ≥762), mean total length (mm) at age (years), and annual mortality (A) were calculated for pre- and post-regulation periods using the OFAA. Significant differences for each of these metrics were determined using the 95% confidence intervals that were produced by the OFAA. Length frequencies and age frequencies were compared with Kolmogorov-Smirnov tests (K-S tests) using the ksTest() function of the FSA package in Program R (Ogle 2016).

The fishery statistics chosen represented expected changes if the regulation change had been effective at meeting its goals of limiting harvest of larger fish and shifting existing harvest to smaller size classes (Table 2). In this scenario, several results would be expected to occur if the regulation achieved those objectives. Namely, significant increases in metrics related to shifts in abundance of large fish (CPUE ≥760, PSD – P, length-at-age). Increases in Wr would suggest better food availability due to decreased abundance of smaller Blue Catfish because of higher harvest on those size classes. Changes in metrics for the population as a whole (CPUE, PSD, mortality) may change either direction depending on the nature of the fishery response, but I retained these measures because any change could aid interpretation of other results. For example, if larger fish were harvested less, but the harvest on smaller fishes also decreased, then overall CPUE may increase, whereas if harvest was also shifted to the smaller size classes, then overall CPUE may decrease.

Results

Blue Catfish were collected from 2004 – 2006 (results previously published by Boxrucker and Kuklinski (2006) and Kuklinski and Patterson (2011)). For post- regulation data, a total of 3,933 Blue Catfish were collected from 2017-2018. (Ellsworth – 874 fish, Eufaula – 513 fish, Kaw – 741 fish, Keystone – 298 fish, Oologah – 677 fish, Texoma – 376 fish, and Waurika – 454 fish). Electrofishing catch rates ranged from 178 fish/hr at Keystone to 1,048.8 fish/hr at Ellsworth. Catch rates of fish ≥762mm ranged from 0 fish/hr at Eufaula to 7.42 fish/hr at Kaw. Among the lakes studied, only Waurika exhibited any significant difference to pre- regulation, with declines in CPUE (Figure 2).

Length frequencies and associated measures of size-structure (PSD and PSD-P) exhibited some differences between the pre- and post- samples of each lake, but changes were inconsistent across lakes and, at times, not in the direction hypothesized. Length frequencies were all significantly different, but the differences were subtle in many cases and did not indicate a dramatic change in size distribution (Table 3; Figure 3). Eufaula and Kaw lakes had noticeably smaller proportions of fish < 250 mm and a greater proportion larger than this size after the regulation. Keystone had a similar proportion of large fish, but noticeably fewer fish < 300 mm after the regulation change. Other lakes had subtle changes to the length frequency, but still had modes and ranges of lengths that were similar before and after the regulations. Only two lakes (Ellsworth and Texoma) exhibited significant changes in PSD (both increased after the regulation), while PSD-P did not significantly change in any lake (Figure 4). Relative weights (Wr) for Blue Catfish displayed significant changes in four of the seven lakes (Figure 5) with Ellsworth, Eufaula, and Texoma exhibiting significant increases, and Oologah with a significant decrease. The relative weights of Blue Catfish ≥762mm showed no significant changes in any lake.

Otoliths were collected from a total of 848 Blue Catfish across three lakes and estimated ages ranged from 0 to 27 years (Ellsworth – 191 fish, age 1 - 27; Kaw – 372 fish, age 1 – 25; and Waurika – 285 fish, age 0 - 21). Age frequencies were all significantly different between pre- and post- regulation change (Table 4, Figure 6). Populations were more heavily dominated by a single strong age class in the post-regulation than in the pre-regulation age-frequencies. Mean total length at age was greater at most ages for Ellsworth while Kaw and Waurika showed slower growth when compared to their pre- regulation mean lengths at age (Table 5, Figure 7). Annual mortality was significantly lower from pre- regulation change for Waurika (Table 6); no other lake exhibited any significant change in mortality. A summary of expected results for all these population level metrics are compiled in Table 7, demonstrating that few lakes exhibited the expected responses if the regulation were effective at meeting its goals.

Discussion

I found few metrics congruent with expectations of an effective trophy management regulation with the goal of decreasing harvest of larger fish and shifting existing harvest to smaller size classes. Furthermore, no metrics that I examined displayed significant changes for Blue Catfish ≥760mm, the size of fish meant to benefit. Blue Catfish at most lakes met few (e.g., Eufaula and Texoma) or no (Kaw and Keystone) expectations, while one (Oologah) responded in the opposite direction from what was hypothesized, and another (Waurika) had both anticipated and unanticipated results. However, Lake Ellsworth came the closest to exhibiting the hypothesized changes, with three of eight total metrics meeting expectations. Increases in PSD, Wr, and mean length at age suggest the Blue Catfish in Ellsworth have increased growth and condition since the regulation implementation. These results were not a consistent effect observed at other study lakes and could have been a product of chance or factors other than the regulation. Currently, the regulation has been ineffective at meeting its goals in a consistent manner.

In order for a regulation to be effective, it must change angler's behavior. In this specific case, the regulation change was intended to do two things. First, the regulation was intended to produce a meaningful increase in the number of preferred size fish by providing protection to larger Blue Catfish. Second, the existing harvest pressure was meant to be focused on smaller fish, to help accelerate their growth and increase their ability to reach preferred size (Noble and Jones 1999). In the current study, I found no significant changes in any metrics regarding larger fish, although Ellsworth did exhibit an increase in the Wr of Blue Catfish ≥760mm. However, this increase was the result of only one individual and confidence intervals were unable to be produced to fully evaluate the metric.

Complicating the ability to detect changes in the abundance of large fish is hampered by the low numbers of preferred sized Blue Catfish in these reservoirs generally, which hinders the effectiveness of the regulation at limiting their harvest (Stewart et al. 2016). While anglers that caught a preferred sized Blue Catfish had a high chance of catching additional large individuals, the proportion of anglers that caught large Blue Catfish overall was low (3.3%) compared to the number of anglers surveyed (Kuklinski and Boxrucker 2008). Moving this limited angler harvest from preferred-sized Blue Catfish to smaller individuals would not significantly increase harvest rates of smaller Blue Catfish as the number of larger fish released due to the regulation is minimal. Increasing growth rates in the reservoirs was key to producing higher abundances of preferred-sized Blue Catfish as just protecting a few individuals would not result in significant increases in abundance. Unfortunately, I was not able to estimate exploitation as part of this study, but the results of my study suggest that exploitation of smaller Blue Catfish did not increase appreciably (i.e., their abundance was similar before and after the regulation change). Recent estimates of exploitation for this species in Oklahoma's waters remains unknown and warrants future research.

While not significantly affecting the fisheries, a maximum-size regulation may still have utility. For example, high proportions of both harvest- and tournament-oriented Blue Catfish anglers make balancing stakeholder priorities challenging for managers (Hunt et al. 2012, Hutt et al. 2013, Hyman et al. 2017). Anecdotal evidence suggest there is a growing population of tournament catfish anglers within Oklahoma (Clayton Porter, ODWC, personal communication) and these groups are generally better connected to fisheries managers (Wilde et al. 1998), exerting a disproportionate-size voice with respect to regulations. Maximum-size regulation can thus appease both groups by still allowing liberal harvest of smaller fish while also protecting larger, trophy-size fish. In addition, most catfish anglers that harvest fish tend to prefer fish smaller than the preferred-size (Hunt et al. 2012), making a maximum-size regulation less likely to decrease their fishing satisfaction.

In addition to low abundance of large fish and a potential lack by anglers to meaningful increase their abundance through altered harvest behavior, I observed large fluctuations in year classes, indicating variable recruitment, which may potentially override density-dependent factors from fishing. Factors affecting recruitment of Blue Catfish in reservoirs is sparse, but the first recorded natural reproduction of Blue Catfish in Canton Lake, Oklahoma, for example, was attributed to a large influx of water bringing the lake levels up to normal pool after an extended drought (Snow et al. 2017). Additionally, large reservoirs (e.g., > 1466 ha) with low productivity and high water clarity (e.g., Secchi depths > 65 cm), along with small reservoirs with high productivity and moderate water clarity (Secchi depths < 65 cm) are generally less successful at recruiting Blue Catfish than large reservoirs with high productivity (Bartram et al. 2011). Moreover, at four tidal rivers in Virginia, Blue Catfish had variable recruitment indicative of landscape-level environmental processes (Greenlee and Lim, 2011). At the study lakes I examined where age data were available (Ellsworth, Kaw, and Waurika), all experienced large increases in water level coincident with their strong year classes (USACE 2020, USGS 2020. Ellsworth and Waurika both experienced large water lever changes in 2015, increasing lake elevations 4.2 meters and 6.1 meters respectively, ending the drought both lakes had experienced beginning in summer 2013. In these two systems, the largest age-classes (age-3) represented 39%-64% of all samples and corresponded to this 2015 increase in lake level. These year classes were 32x greater for Ellsworth and 3.2x greater than the previous year (2014). At Kaw Lake, a flood event from May to July 2010 increased lake elevation by 5.2 meters at its peak, which correlated to the large 7-year old age class that was 5.9x greater than the previous age class. The large age classes in each of these lakes – Ellsworth age-3, Kaw age-7, and Waurika age-3, accounted for 64%, 47%, and 39% of all age classes, respectively.

Managing agencies use regulations to maintain fisheries for multitudes of angling opportunities. Regulations oftentimes attempt to balance both stakeholder priorities and resource needs. Although significant changes in the abundance of preferred sized Blue Catfish were not found, regulations can still be an effective fisheries management tool when sufficient angling pressure is present. In the case of evaluating the Blue Catfish maximum-size regulation in Oklahoma, quantifying angling pressure and harvest characteristics would be valuable in determining the true effectiveness of this regulation.

Table 1. Lake size, mean secchi disk depth, and Chlorophyll-a levels for seven Oklahoma lakes where differences in Blue Catfish population demographics were assessed post-regulation change.

Lake	Size (ha)	Mean secchi disk depth (cm)	Chlorophyll-a (mg/m3)
Ellsworth	2,069	37	21.05
Eufaula	42,964	33	7.15
Kaw	6,895	53	16.5
Keystone	9,554	27	28.8
Oologah	11,922	56	10.75
Texoma	35,612	67	11
Waurika	4,092	53	15

Table 2. The expected change in a Blue Catfish population since implementation of a regulation change allowing harvest of only one Blue Catfish over 760mm (30 in) per day. + = expected increases and - = expected decreases.

Metric	Expected change
CPUE	+/-
CPUE – P	+
PSD	+/-
PSD – P	+
Condition (Wr)	+
Length at Age	+
Mortality (A)	+/-

Table 3. P-Values for Kolmogorov – Smirnov test between Blue Catfish length frequencies from before and after implantation of a regulation allowing only one Blue Catfish over 760mm (30 in) to be harvested per day.

Lake	D	P-Value
Ellsworth	0.19	< 0.01
Eufaula	0.44	< 0.01
Kaw	0.61	< 0.01
Keystone	0.23	< 0.01
Oologah	0.22	< 0.01
Texoma	0.23	<0.01
Waurika	0.34	<0.01

Table 4. P-Values for Kolmogorov – Smirnov test between Blue Catfish age frequencies pre- and post- trophy regulation.

Lake	D	P-Value
Ellsworth	0.72	< 0.01
Kaw	0.70	< 0.01
Waurika	0.27	< 0.01

Table 5. Mean total length (mm) at age (years) and standard error (SE) for three Oklahoma lakes post-trophy regulation change. Includes fish with estimated ages and ages assigned from age-length key.

	Post- Regulation					
	Ellsworth		Kaw		Waurika	
Age	N	Length	N	Length	N	Length
0					3	117 ± 2
1	95	242 ± 3	71	201 ± 2		
2	123	245 ± 2	73	262 ± 4	54	250 ± 5
3	560	255 ± 1	1	277	176	302 ± 3
4	16	263 ± 4	20	366 ± 11	53	307 ± 5
5	38	291 ± 7			5	327 ± 14
6	5	328 ± 34	8	418 ± 6	1	362
7	2	377 ± 13	343	447 ± 2	4	408 ± 10
8	1	404	59	468 ± 7	9	419 ± 11
9			11	478 ± 21	42	431 ± 5
10	14	474 ± 16	51	542 ± 9	35	418 ± 5
11	3	553 ± 37	3	515 ± 36	18	451 ± 10
12	1	450	37	591 ± 11	13	519 ± 19
13	1	544	15	662 ± 24	6	542 ± 21
14			4	720 ± 67	9	530 ± 13
15	2	435 ± 18	1	883	5	691 ± 66
16			20	705 ± 18	2	621 ± 114
17	5	627 ± 11	6	707 ± 61	14	633 ± 14
18	4	420 ± 20	5	735 ± 59	2	630 ± 51
19	1	488	1	734	3	638 ± 66
20						
21						
22						
23						
24						
25	1	444	1	885		
26	1	973				
27	1	505				

Table 6. Annual percent mortality (A) (%) of Blue Catfish in three Oklahoma Lakes pre- and post- regulation change. Significant differences between pre- and post- regulation periods for each lake are indicated with differing superscripts. (Pre-values were re-calculated with data using OFAA and differ slightly form values reported in Kuklinski and Patterson (2012) due to the use of interpolation in age-length keys and a weighted catch curve by the OFAA that were not employed by Kuklinski and Patterson (2012))

Lake	Pre	Upper 95% CI	Lower 95% CI	Post	Upper 95% CI	Lower 95% CI
Ellsworth	33.42[a]	21.33	43.65	17.87[a]	5.90	28.32
Kaw	35.61[a]	22.49	46.51	25.00[a]	12.30	35.87
Waurika	32.61[a]	27.86	37.05	14.82[b]	5.32	23.37

Table 7. Summary table of results comparing pre- and post- regulation change data. ✓ = expected change if 2010 regulation change met its objectives, **X** = unexpected change if 2010 regulation change met its objectives, **?** = not enough data to determine NA = no data, and no changes is indicated with =.

Lake	CPUE	CPUE ≥ 762	PSD	PSD-P	Wr	Wr ≥762	Mean Length at Age	A
Ellsworth	=	=	✓	=	✓	**?**	✓	=
Eufaula	=	=	=	=	✓	=	NA	NA
Kaw	=	=	=	=	=	=	=	=
Keystone	=	=	=	=	=	=	NA	NA
Oologah	=	=	=	=	**X**	=	NA	NA
Texoma	=	=	✓	=	✓	=	NA	NA
Waurika	✓	=	=	=	=	=	**X**	✓

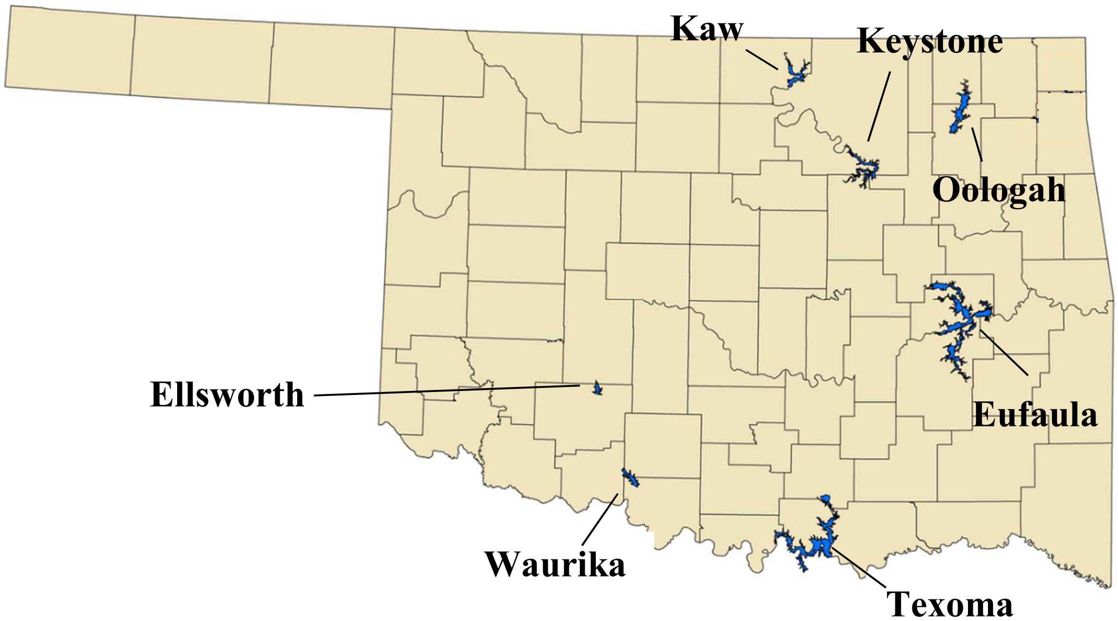


Figure 1. Map of study reservoirs in Oklahoma.

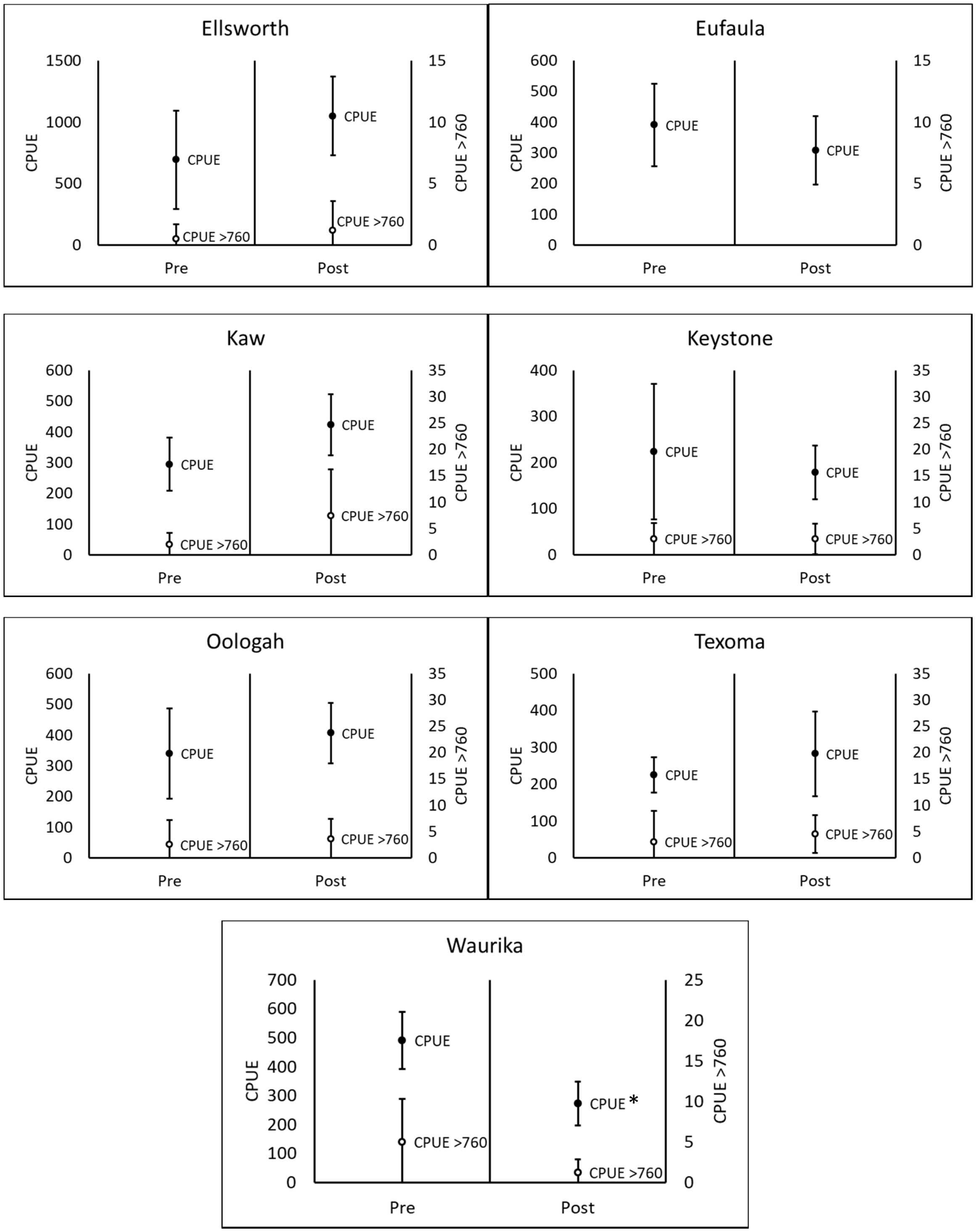
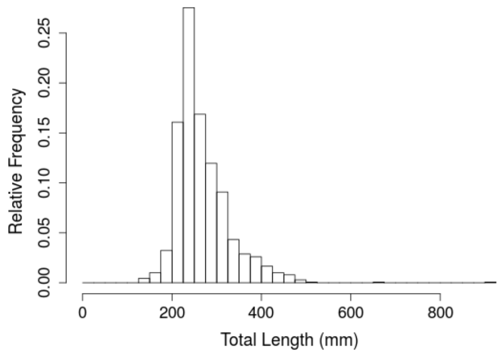
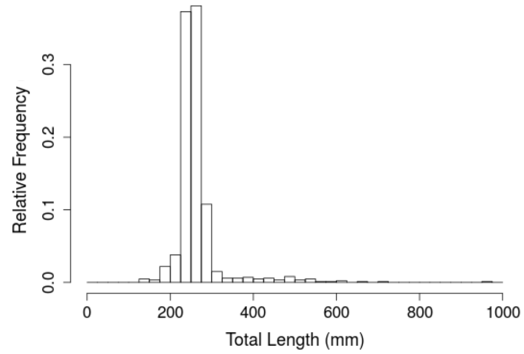


Figure 2. Catch per unit effort and catch per unit effort of Blue Catfish greater than 760mm in length. Significant differences are indicated with an *.

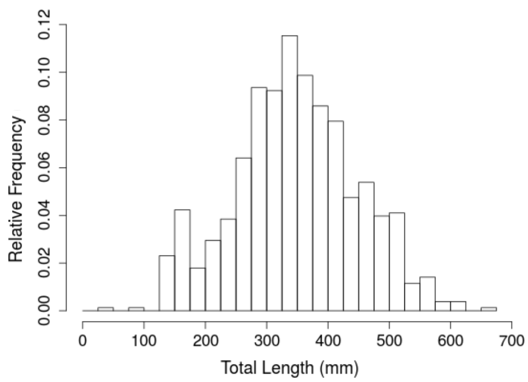
Pre **Post**

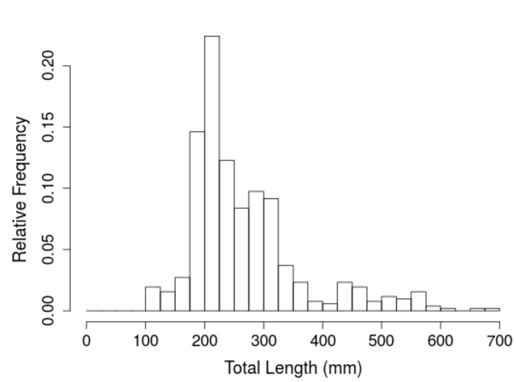
Ellsworth



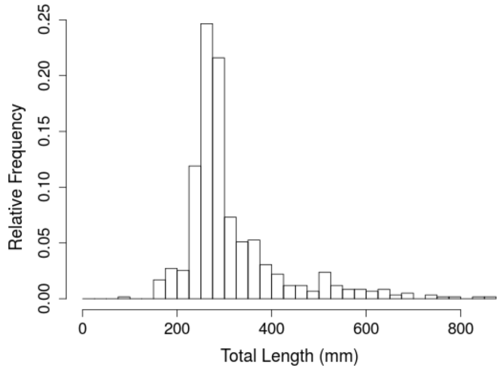


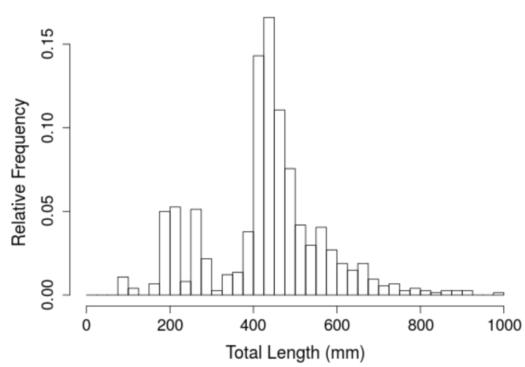
Eufaula



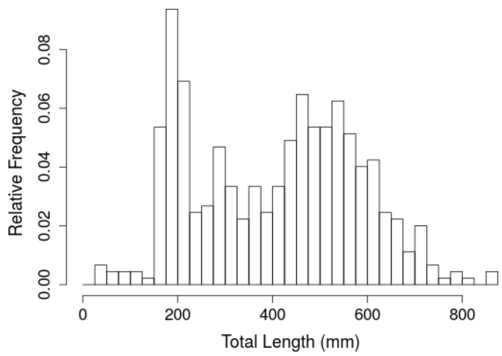


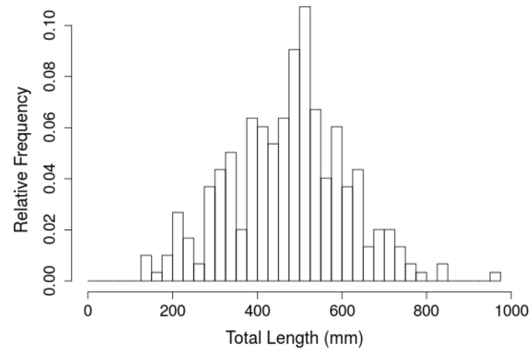
Kaw



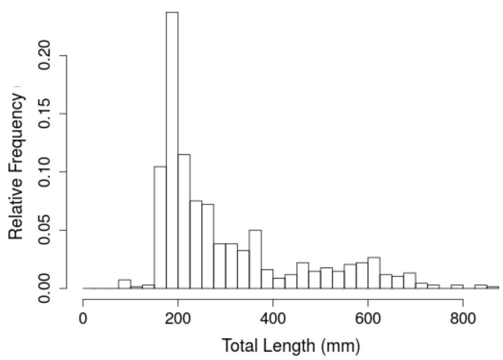


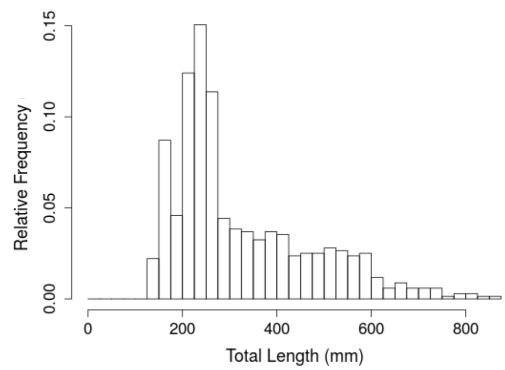
Keystone **Pre** **Post**



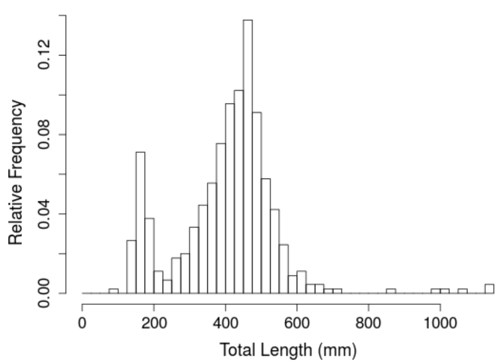


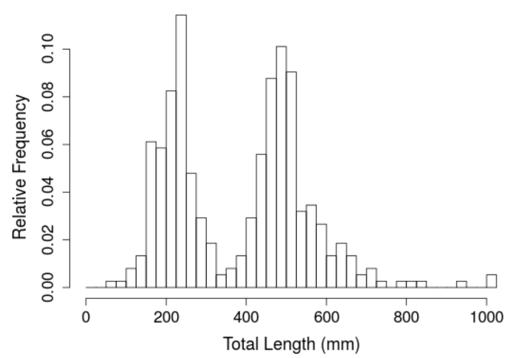
Oologah





Texoma





Waurika Pre Post

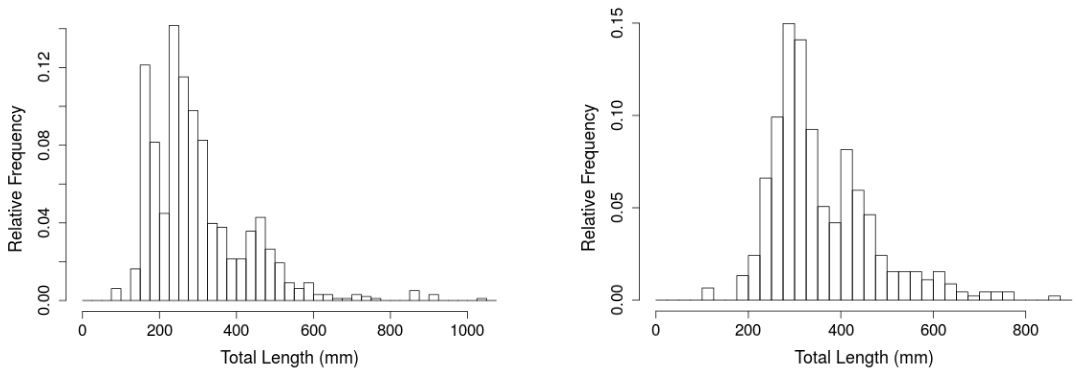


Figure 3**.** Blue Catfish length frequencies from seven lakes across Oklahoma before (pre) and after (post) a trophy regulation implemented in 2010.

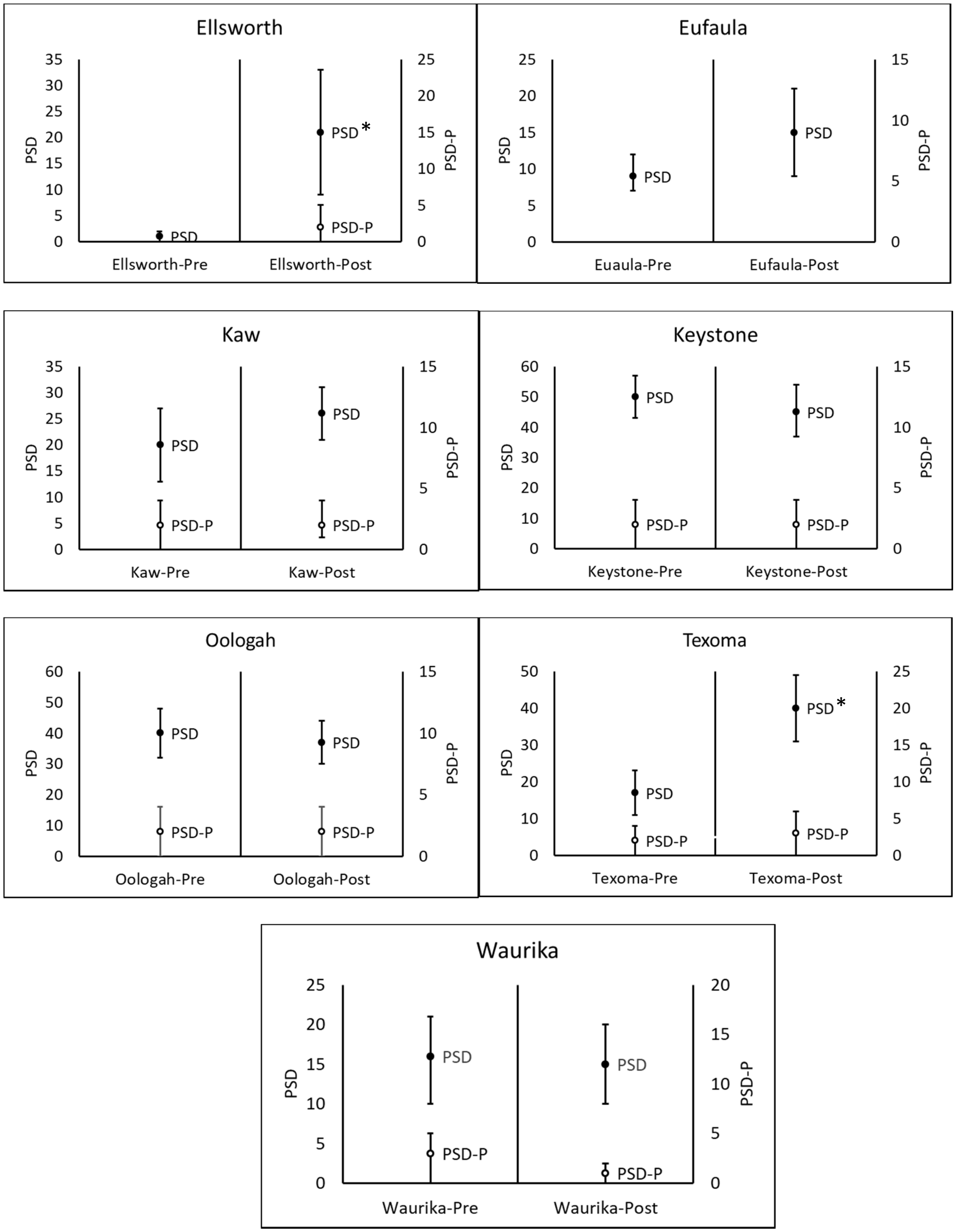


Figure 4. Proportional Size Distributions (PSD) and Proportional Size Distributions – Preferred (PSD-P) of Blue Catfish on seven lakes across Oklahoma. Significant differences are indicated with *.

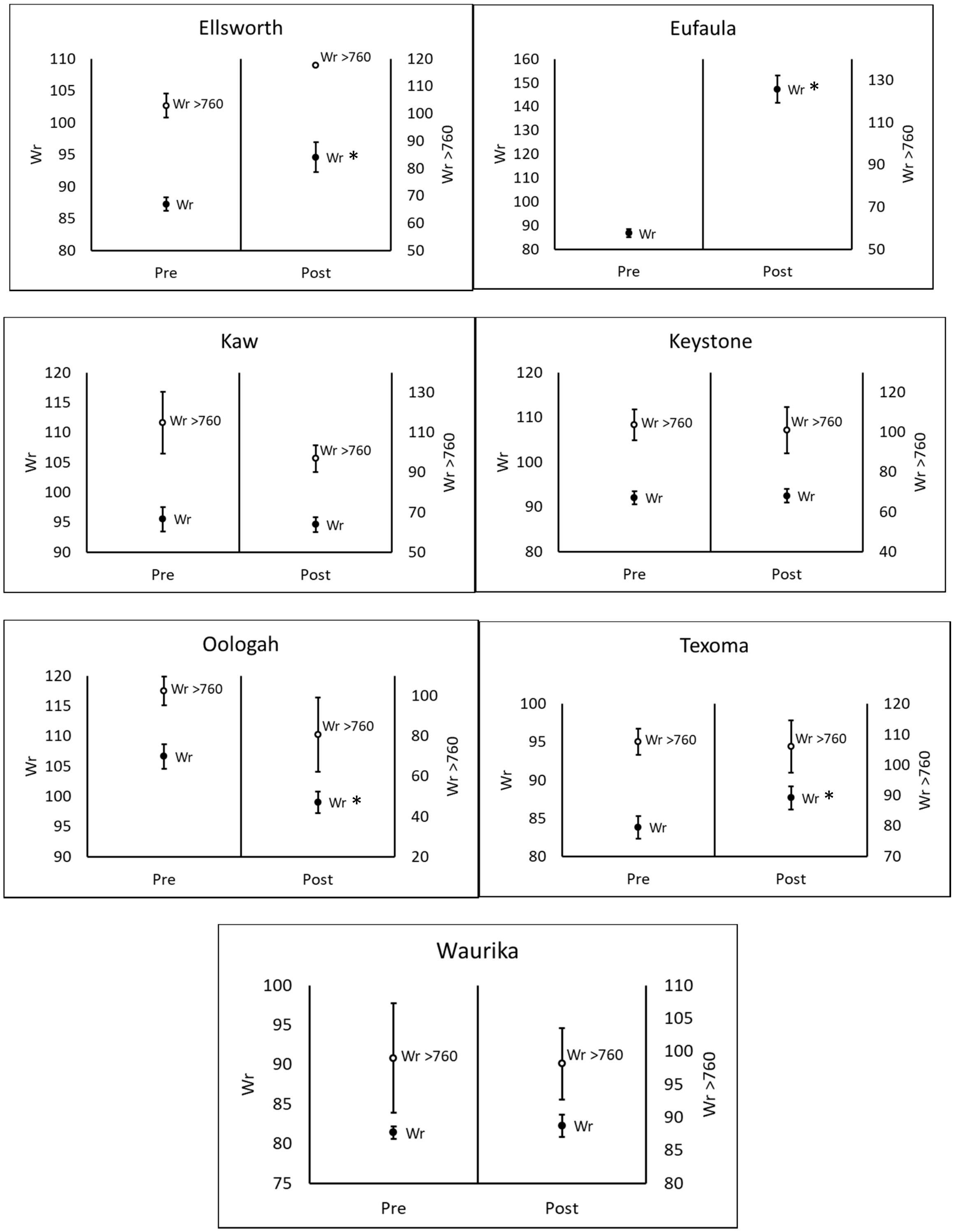
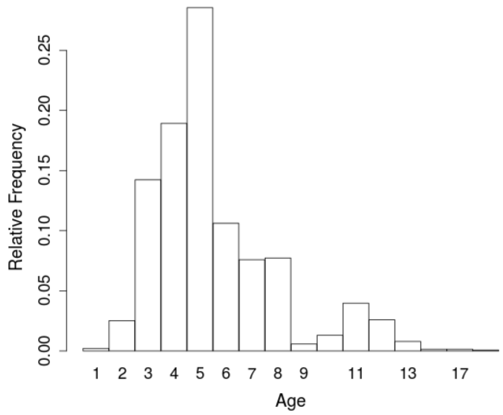
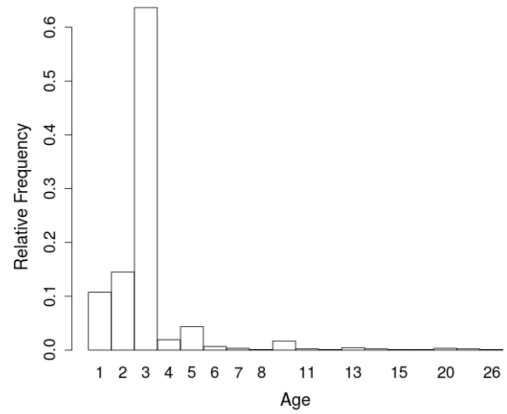


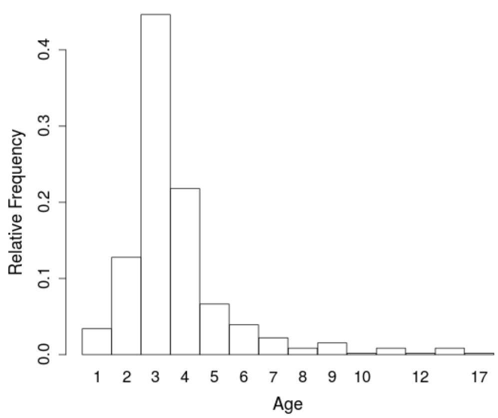
Figure 5. Relative weight of all Blue Catfish and Blue Catfish ≥760mm in seven lakes across Oklahoma. Significant differences are indicated with *.

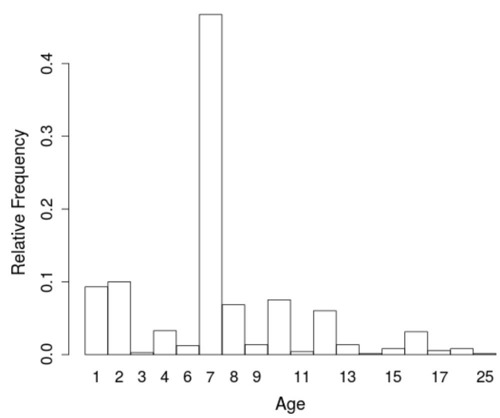
Ellsworth Pre Post



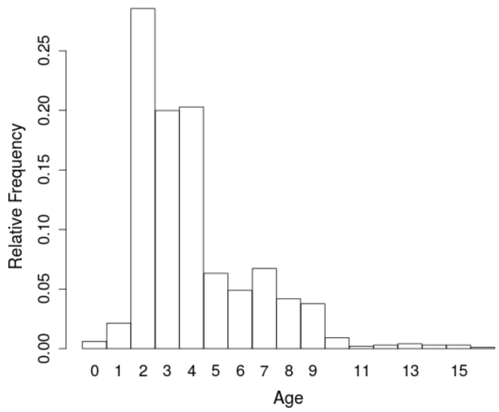


Kaw





Waurika Pre **Post**



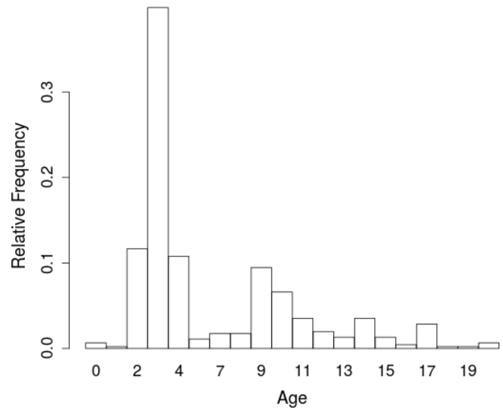
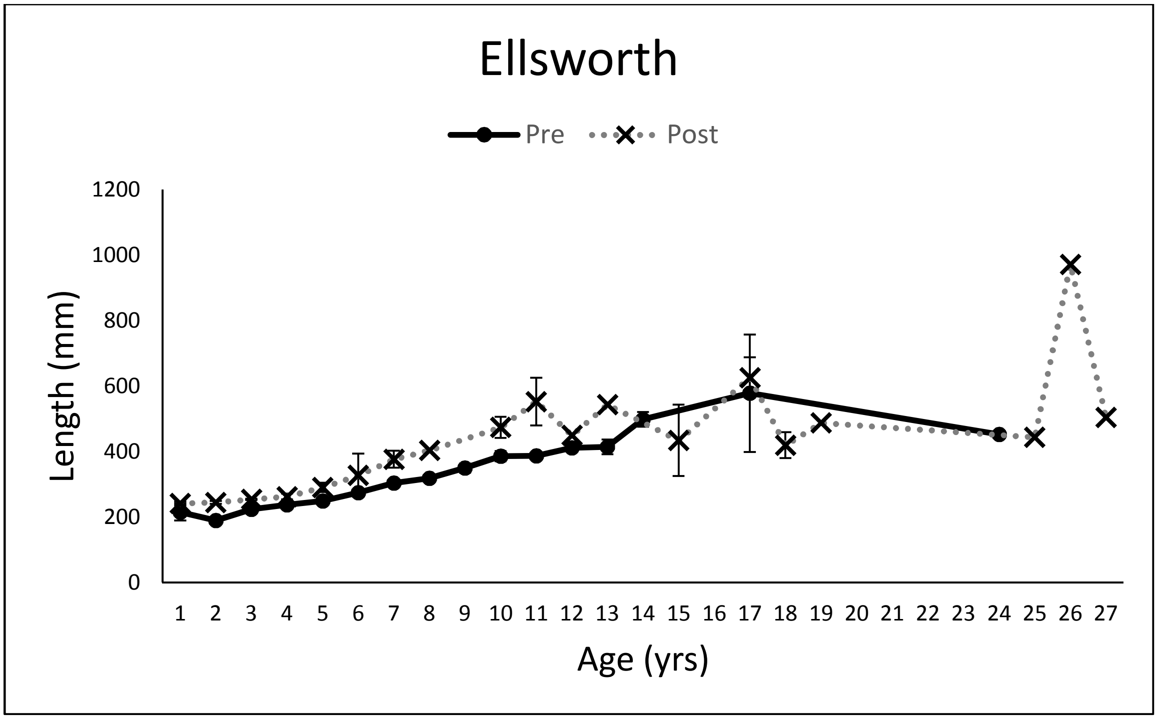
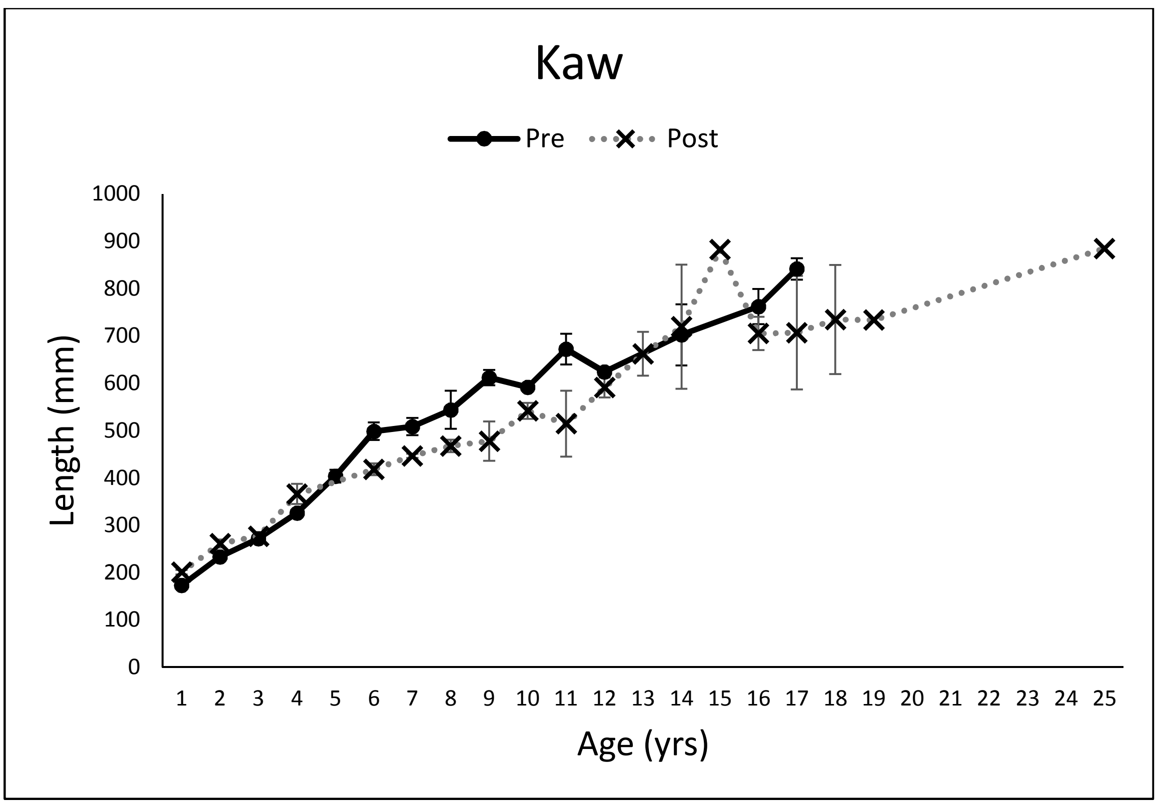


Figure 6. Age frequencies of Blue Catfish for Ellsworth, Kaw, and Waurika lakes pre- and post-regulation change. Pre and post age frequencies were significantly different from each other in all three lakes.


Ellsworth
Pre
Post
Length (mm)
1200
1000
800
600
400
200
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
Age (yrs)


Kaw
Pre
Post
Length (mm)
1000
900
800
700
600
500
400
300
200
100
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Age (yrs)

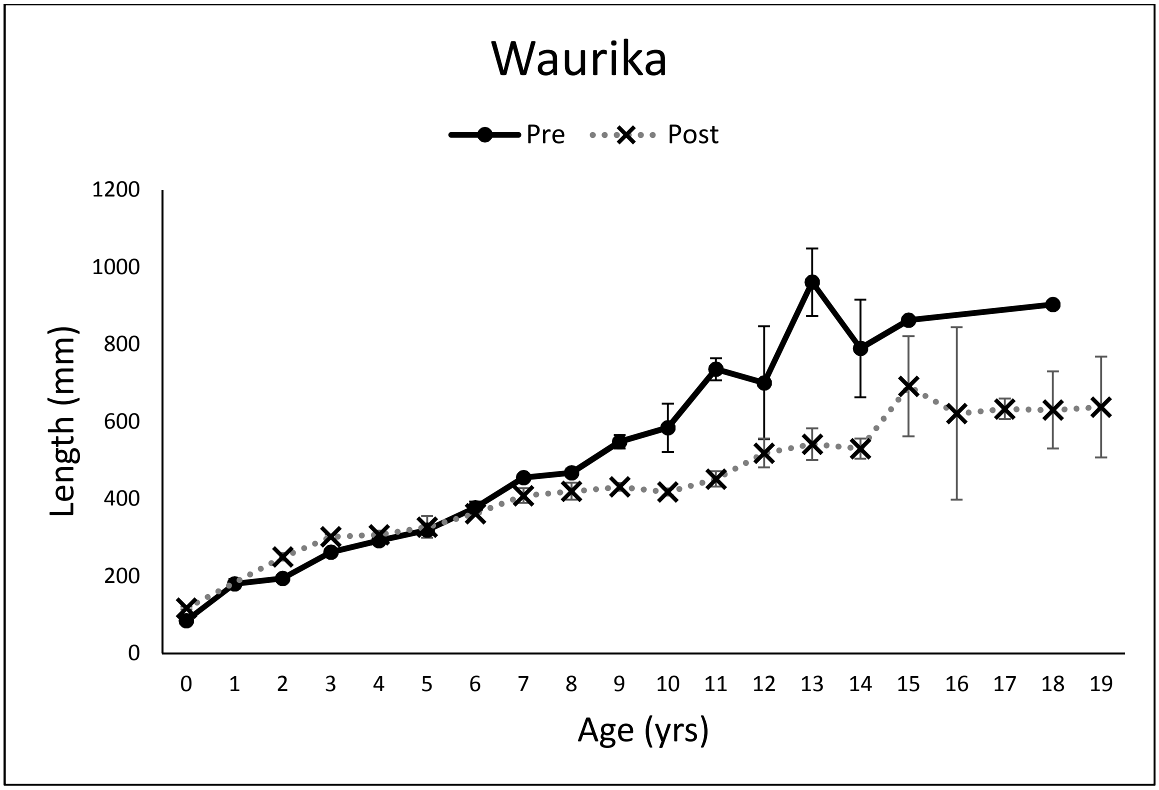


Figure 7. Mean length at age of Blue Catfish in three Oklahoma reservoirs sampled pre and post a trophy regulation change. Error bars represent to 95% confidence intervals.

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