A Comparison of Eight Channel Catfish Populations across the Central Region of Oklahoma

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Abstract: Channel catfish (*Ictalurus punctatus*) are a popular sportfish in Oklahoma, ranking as the 3rd overall most preferred species from 1985 - 2019. Due to this popularity, species-specific surveys are conducted, and stockings accrue to ensure population dynamics are within acceptable levels and abundances can meet angler demands. Therefore, the goals of this study were to: 1) compare catch rates and size distribution of fish caught using 25-mm mesh vs 12.5-mm mesh hoop nets to determine if populations are properly indexed and if bias occurs when only using 25-mm mesh nets and 2) explore population characteristics of Channel Catfish across eight small impoundments in central Oklahoma. Channel catfish were collected across 8 small impoundments during the months of July and August from 2020 - 2022 using baited hoop nets (tandem set of three nets consisting of two 25-mm bar mesh and one 12.5-mm bar mesh in random order or three 25-mm bar mesh nets per set run concurrently with sets of three 12.5-mm bar mesh nets). A combined total of 1985 Channel Catfish ranging from 25-657 mm TL were collected during this study with length distribution varying between systems. Weights ranged from 10-3,470 g with a mean W_r of 88. Fish ranged from 0-22 years of age and 95% of individuals reached maturity at 419 mm TL. Richards growth models indicated growth was relatively slow and mortality rates ranged from 13 to 52% depending on impoundment. Of the Channel Catfish sampled, 26% of them were captured with 12.5 mm mesh nets. Kolmogorov-Smirnov test results showed distributions from 25- and 12.5-mm mesh nets to differ significantly.

Introduction

Channel Catfish (*Ictalurus punctatus*) are a popular and commercially important sportfish native to the central drainages of the United States (Griffin et al. 2022; Bouska et al. 2011). Historically Channel Catfish were sought after as table fare; however, tournament and recreational trophy angling has become popular among

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some fishing enthusiasts (Shrader et al. 2003). In Oklahoma, Channel Catfish rank third in popularity since 1985, behind largemouth bass (*Micropterus salmoides*) and crappie (*Pomoxis* spp.) as the most desirable sportfish (York 2019). Due to this popularity, the Oklahoma Department of Wildlife Conservation (ODWC) has implemented stocking programs to create or supplement Channel Catfish populations within the 242,811 ha of public waters they are entrusted to manage.

Standardized sampling for Channel Catfish in small Oklahoma reservoirs is conducted using baited tandem hoop nets with 25-mm bar mesh (OFAA 2022). Data collected from these samples are used to monitor population trends, set regulations, and dictate stocking needs. Important assumptions of standardized sampling data are that relative catch from these samples is representative of the abundance and size structure of the fishery (Hubert and Fabrizio 2007). These assumptions are commonly assumed and rarely tested for passive gears relative to active sampling gears (Hubert et al. 2012). Prior study has suggested 25-mm bar mesh tandem hoop nets produce the most accurate relative catch and size structure information (see Bodine et al. 2013). However, 25-mm bar mesh tandem hoop nets may not accurately represent catch or size structure of small Channel Catfish, with bias suggested to occur < 150 (Michaletz 2001) or < 250 mm in total length (TL; Michaletz and Sullivan 2002; Buckmeier and Schlechte 2009) dependent on the system. One prior study, from Meeker Lake, Oklahoma determined that 25-mm mesh tandem hoop nets fail to detect abundant small Channel Catfish in the system and suggested small mesh sizes be incorporated into standardized surveys (Montague et al. 2022).

Failure to accurately represent small Channel Catfish in standardized sampling data may lead to mismanagement of high-density, slow-growing, and stunted populations. Currently, ODWC manages Channel Catfish in aggregate with Blue Catfish (*Ictalurus furcatus*) using a statewide regulation due to anglers having difficulty distinguishing between the species (Page et al. 2012). Given the statewide regulation, management of Channel Catfish populations is primarily done via stocking to supplement natural recruitment, especially in small reservoirs. This management technique is generally implemented to safeguard the population from recruitment overfishing. Recruitment overfishing generally occurs when high exploitation rates reduce the abundance of mature individuals such that recruitment is impaired (Myers et al. 2007). However, stocking generally has little effect on growth overfishing. Growth overfishing occurs when fishing mortality is high enough to limit the growth potential of a population or when harvest occurs at too young of an age (Slipke et al. 2002). Both recruitment and growth overfishing may occur simultaneously in a population (Slipke et al. 2002, Chestnut-Faull et al. 2021). To detect potential recruitment and growth overfishing managers require sampling techniques that can properly index size structure and relative abundance of fish populations (see Slipke et al. 2002). This is especially true in Oklahoma given current limitations for modifying the exploitation of Channel Catfish populations through size-based regulation.

Failure to properly index Channel Catfish populations in Oklahoma may result in overstocking. Overstocking in channel catfish population generally results in density-dependent responses. Density-dependent responses are thought to occur when the number of fish in the population exceeds or approaches carry capacity due to resource limitations (e.g., productivity, prey resources; Shoup et al. 2007, Michaletz 2009). Overstocking Channel Catfish has been documented to result in density-dependent responses such as increases in relative abundance and mortality, and decreases in condition, growth rate, and size structure (Michaletz 2009).

Given the limitations of Channel Catfish management strategies in Oklahoma and the potential for negative effects that may occur due to overstocking these populations, sampling strategies that properly index their population metrics and vital rates are critical. Especially since Montague et al. (2022) suggested small Channel Catfish may not be properly indexed using standard 25-mm mesh tandem hoop nets. Past standardized surveys for Channel Catfish may have failed to properly index their populations, especially if stunting (i.e., reduction in size) is occurring. This is especially concerning for small impoundments in the central region of Oklahoma as this is where Meeker Lake is situated. Therefore, the objectives of our study were to: 1) compare catch rates and size distribution of Channel Catfish caught using 25-mm mesh vs 12.5-mm mesh hoop nets and 2) describe size structure, condition, maturity schedule, and growth rate for Channel Catfish across and among small impoundments in the central region of Oklahoma.

Methods
Study Area

Channel Catfish were sampled from eight small (< 200 ha) lakes located in the Cross Timbers and Central Great Plains ecoregions of central Oklahoma (Woods et al. 2005). Descending from North to South these include Langston Lake (169.9 ha), Guthrie Lake (82.9 ha), Liberty Lake (79.7 ha), Lake El Reno (68.8 ha), Purcell Lake (63.5 ha), Lindsay Lake (8.9

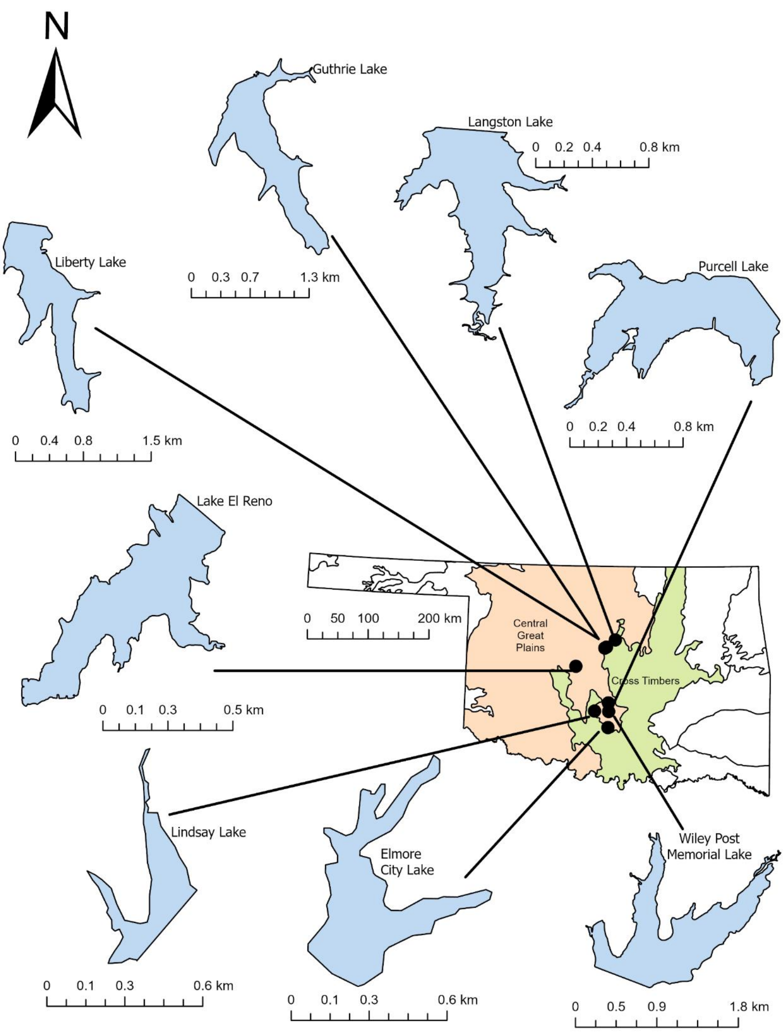

Figure 1. Location and outline of study lakes distributed across the Cross Timbers and Central Great Plains ecoregions.

ha), Wiley Post Memorial Lake (also known as Maysville Lake, 122.2 ha), and Elmore City Lake (23.1 ha; Figure 1). Each lake is associated with its namesake municipality and primary uses include municipal water supply, flood control, and recreation. Lake impoundment dates range from 1919 (Guthrie Lake) to 1971 (Wiley Post Memorial Lake; OWRB 2023) Each lake is affected by siltation to some degree within the river reservoir interface, contains limited aquatic vegetation, some standing timber/ brush piles, and a mixture of sandstone, coarse gravel, clay, and sand substrates with riprap rock primarily along the dam and fishing jetties. All lakes support recreational fisheries for Channel Catfish, White Crappie (*Pomoxis annularis*), and Largemouth Bass (*Micropterus salmoides*). Although not highly sought after, Common Carp (*Cyprinus carpio*) and Flathead Catfish (*Pylodictis olivaris*) are present at all lakes, and a stunted Blue Catfish (*Ictalurus furcatus*) population exists at Wiley Post Memorial Lake. Primary forage species include Gizzard Shad (*Dorosoma cededianum*), *Lepomis spp*., and in most cases Inland Silversides (*Menidia berylina*). Trophic class ranges from mesotrophic to hypereutrophic, pH is generally slightly alkaline (7.17-9.22), and turbidity varies from a mean secchi depth of 25 cm at El Reno Lake to 104 cm at Langston Lake (OWRB 2023).

Sampling

Channel Catfish were collected during the months of July and August in 2020 (Langston, Wiley Post Memorial), 2021 (Liberty, Guthrie, Purcell, El Reno, Elmore City), and 2022 (Lindsay) using baited hoop nets. In all lakes except Langston and Wiley Post Memorial, hoop nets were placed in tandem sets of three nets consisting of two 25-mm bar mesh, and one 12.5-mm bar mesh, 3.4-m long net tied 0.9 m apart in random order. In Langston and Wiley Post Memorial Lakes, three tandem sets of only 25-mm bar mesh hoop nets and three tandem sets of only 12.5-mm bar mesh hoop nets were used. The 12.5-mm mesh nets were used in conjunction with the 25-mm mesh nets to determine if they capture smaller sized fish in potentially stunted populations (Michaletz and Sullivan 2002, Montague et al. 2022). Nets were set in accordance with ODWC standardized sampling protocols and the methods of Montague et al. (2022). Dissolved oxygen (DO) and temperature (°C) were recorded adjacent to the bottom at each set to ensure that DO was ≥ 4 mg/L to avoid unnecessary mortality (YSI, model Pro 2030, Yellow Springs Instruments, Yellow Springs, OH).

Total length (TL; mm) and weight (g) were recorded for each captured Channel Catfish, apart from Langston and Wiley Post Memorial Lakes where only TL was recorded. Up to 20 fish per 25-mm TL group were sacrificed for age estimation. Sacrificed fish were euthanized using a 1:1 ice water slurry (Blessing et al. 2010) and brought back to the Oklahoma Fisheries Research Lab (OFRL), Norman, Oklahoma. At the OFRL, sex and maturity were determined via visual examination of the gonads (Davis and Posey 1958; Perry and Carver 1972). Lapilli otoliths were removed for age estimation (Buckmeier et al. 2002).

Otoliths were prepared according to the methods described in Buckmeier et al. (2002), save the browning process (Waters et al. 2020b). Otoliths were cut and polished in the transverse plane until all annuli were visible. Otoliths were then illuminated using a fiber optic filament attached to a light source and viewed under a dissecting microscope capable of 130x magnification (Buckmeier et al. 2002, Waters et al. 2020b). Two independent readers initially estimated ages for each otolith. Disagreements between readers' initial age estimates were resolved with a final consensus read (Hoff et al. 1997).

Analysis

Hoop net mesh size comparison

A Kolmogorov–Smirnov test (K-S test, Kolmogorov 1933, Smirnov 1939) was used to determine if 12.5-mm mesh hoop nets captured significantly different sizes of Channel Catfish relative to 25-mm mesh hoop nets across study lakes ($\alpha = 0.05$). Distributional overlap ($\hat{\eta}$, Pastore and Calcagnì 2019) was also estimated for this pooled comparison to determine the amount of similarity between the length distributions from 12.5- and 25-mm mesh hoop nets. Means and 95% confidence intervals (CI) of $\hat{\eta}$ were derived by bootstrapping the comparison 10,000 times. Estimates of $\hat{\eta}$ were interpreted based on their relationship to Cohen's d (Cohen 1988) with $\hat{\eta}$ = 0.20, 0.50, and 0.80 indicating the thresholds for small, moderate, and large overlap, respectively. Length-frequency histograms constructed using 10-mm length bins were created for 12.5- and 25-mm mesh hoop nets then overlaid and interpretated qualitatively to determine if there appeared to be a size threshold where 12.5-mm hoop nets captured more individuals. Mean catch per unit effort (CPUE; mean number of fish captured with a defined unit of sampling effort, in this case sampling effort is equal to one set of nets soaked for 72 hours) was estimated separately for 12.5- and 25-mm mesh hoop nets to determine if qualitative differences in Channel Catfish CPUE exist between mesh types. Mean CPUE for 12.5- and 25-mm mesh hoop nets was also compared for different size classes of Channel Catfish. Size classes used for this comparison were sub-stock (< 280 mm TL), stock (≥ 280 mm TL), quality (≥ 410 mm TL) and preferred (≥ 610 mm TL, Gabelhouse 1984). These size classes were selected as they are commonly used in fisheries management. Mean CPUE for 12.5- and 25-mm mesh hoop nets was estimated using combined data from Guthrie, Liberty, El Reno, Purcell Lake, Lindsay, and Elmore City Lakes. Mean CPUE for 12.5- and 25-mm mesh hoop nets was also estimated using combined data from Langston and Wiley Post Memorial Lakes. Mean CPUE was estimated separately for these systems due to differences between how 12.5- and 25-mm mesh tandem hoop nets were deployed (see Sampling).

Channel Catfish population metrics

To assess Channel Catfish size structure, weight-length relationships, and condition of fish sampled, data from 12.5- and 25-mm mesh hoop nets was pooled. Size structure for Channel Catfish from all lakes was described using length-frequency histograms and proportional size distribution (PSD, Gabelhouse 1984). Length category groupings used for PSD analysis were PSD S-Q (280.0-409.9 mm TL), PSD Q-P (410.0-609.9 mm TL) and PSD P-M (610- 709.9 mm TL, see Neumann et al. 2012). Simple linear regression was used to predict the weight-length relationships for Channel Catfish based on $\log_{10}$ transformed weights and TLs (Neumann et al. 2012). Relative weight (*Wr*) was used to assess body condition via the standard weight equation present in Neumann et al. (2012). Only Channel Catfish ≥ 70-mm TL were included in *Wr* calculations (Brown et al. 1995). All statistics were estimated for each individual study lake and across all lakes combined.

To assess Channel Catfish maturity, growth rates, and mortality sacrificed fish sampled via 12.5- and 25-mm mesh hoop nets were also pooled. Logistic regression was used to estimate TL at maturity for Channel Catfish using a binary system (0 = immature, 1 = mature). To determine if there were sex-specific differences in TL at maturity for Channel Catfish, logistic regression models were fit with and without a sex specific parameter and compared via a likelihood ratio test to determine if including sex significantly improved model fit (α = 0.05). Growth trajectories were described using Richards growth model (Richards 1959, Ricker 1975) as there were issues trying to fit the standard von Bertalanffy growth equation to populations. Weighted catch curves were used to estimate instantaneous mortality (*Z*; Maceina 1997). Catch curves for analysis were fit using the first fully recruited age class to the maximum age class in each sample (see Miranda and Bettoli 2007); with the first fully recruited age class varying between lakes (range 1-5 years old). Total annual mortality (*A*) was estimated based on its relationship with *Z* (i.e., $1 - e^{-Z}$, Ricker 1975). Growth and mortality calculations were performed using the Oklahoma Fisheries Analysis Application (OFAA 2022) and the Fisheries Stock Analysis R Package (Ogle 2023). All statistics were estimated for each individual study lake and across all lakes combined.

Results

In total, 1,470 and 515 Channel Catfish were captured in the 25-mm and 12.5-mm mesh nets respectively. K-S test results confirm that the two distributions differ significantly from one another (D = 0.59, $P < 0.01$, mean overlap = 0.47; Figure 2). Estimates of $\hat{\eta}$ suggest small-to-moderate overlap is present within these distributions. Length frequency distribution based on net size shows that fish ≤ 230 mm TL are underrepresented or altogether missing from the 25-mm mesh net sample (Figure 2). Catch per unit effort (CPUE) for 12.5-mm mesh nets (2.05) was 63.4 % of 25-mm mesh net catch rates (3.24) for Guthrie, Liberty, El Reno, Purcell, Lindsay, and Elmore City Lakes combined (Table 1). Conversely, in Langston and Wiley Post Memorial Lakes, CPUE from 12.5-mm mesh nets (4.94) was 172.5 % of the 25-mm mesh net catch rates (2.84), likely affected by the stunted population at Langston (Table 2, Figure 3). Overall catch rates for the 12.5 mm mesh were higher than that of the 25-mm mesh for substock Channel Catfish, but lower for stock-size and larger fish across all systems (Tables 1 and 2).

A total of 1985 Channel Catfish ranging from 25-657 mm TL (mean = 330 mm) were collected from all study lakes combined (Figure 3). Length frequency distributions were variable dependent on system, ranging from normal at Liberty, to multimodal distributions at Langston, El Reno, and Elmore City (Figure 3). Overall, the population was dominated by stock size fish with a PSD S-Q of 61, a PSD Q-P of 39, and a PSD P-M of 1 (Figure 3); though, this analysis excluded substock individuals. PSD S-Q and PSD Q-P range from 33-94 and 6-67 across study systems, with only Wiley Post Memorial Lake having fish with TLs falling into the PSD P-M category. Length-weight relationships exhibited exceptional fit (r^2 range = 0.94-0.98) and individual lake and pooled estimates suggested allometric growth (mean β range = 3.02 – 3.33; Figure 4). Weights ranged from 10-3,470 g (mean = 414 g) with W_r ranging from 82-94 (mean = 88).

Likelihood ratio tests suggested sex did not influence the TL-maturity relationship when the

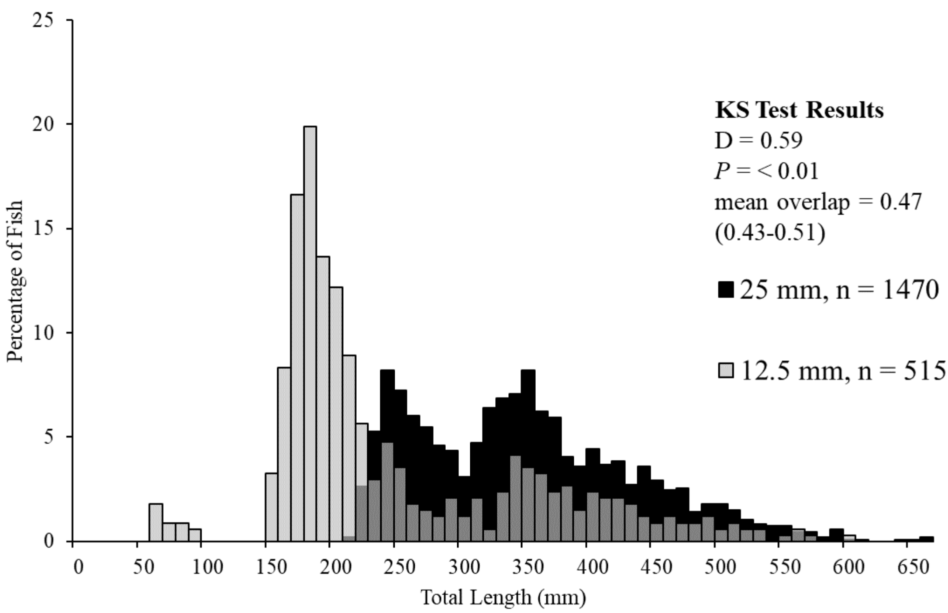

Figure 2. Length-frequency histograms for channel catfish captured from all study lakes using either 25- or 12.5-mm hoop nets. Included are K-S test results and the mean (95% confidence interval) for an overlap test.

Table 1. Catch per unit effort (CPUE; mean number of fish captured per set of nets) of Channel Catfish from 12.5 and 25-mm bar mesh hoop nets on Guthrie, Liberty, El Reno, Purcell Lake, Lindsay, and Elmore City Lakes. Included are CPUE estimates for sub-stock (< 280 mm TL), stock (≥ 280 mm TL), quality (≥ 410 mm TL) and preferred (≥ 610 mm TL) Channel Catfish from each bar mesh type.

Bar mesh	CPUE				
	Total	substock	stock	quality	preferred
12.5 mm	2.05	1.2	0.58	0.28	0.00
25 mm	3.24	0.57	1.73	0.94	0.01

model was fit for individual lakes or when all lakes were pooled (χ^2 range = 0.12-3.19, p range = 0.07 – 0.73). Ninety-five percent maturity was reached by 419 mm TL for all lakes combined and ranged from 348-425 mm TL dependent on the system (Figure 5). Channel Catfish ranged from 0 to 22 years of age (mean = 5 years) for all lakes. The majority of fish (76%) fell between ages 1-7. Pooled regional estimates from Richards growth models suggested growth was slow (k = 0.21), though this varied based on mean individual lake estimates (k range = 0.08 – 0.42; Figure 6). Theoretical mean maximum length also varied between systems (L_∞ range = 487 – 897) with a regional mean estimate of 531 mm (Figure 6). Regionally, the majority of Channel Catfish reached 75 % of L_∞ by age-7 (Figure 6). Mortality rates in lakes were highly variable (Z range = 0.13 – 0.52, A range = 14 – 41; Figure 7) with a pooled regional estimate of 0.31 for instantaneous mortality and 27 for annualized mortality. Age-catch frequencies suggest variable recruitment in populations based on the variability of catch for age classes occurring after the first fully recruited age reflected in fit statistics (r^2 range = 0.06 – 0.59; Figure 7)

Discussion

Our results confirm the suggestion by Montague et al. (2022) that 25-mm bar mesh hoop nets likely underrepresent the biomass of small Channel Catfish in central Oklahoma small impoundments. This is not surprising given the findings of other papers that suggest that 25-mm bar mesh hoop nets may be biased for smaller Channel Catfish (Michaletz 2001; Michaletz and Sullivan 2002; Buckmeier and Schlechte 2009). However, to the best of our knowledge, this size bias has received little attention in the literature. This is likely due to prior studies suggesting that 25-mm bar mesh hoop nets properly index Channel Catfish populations (see Bodine et al. 2013). To be clear, we do not believe the findings of prior studies to be incorrect as the size-based limitations of the gear are clearly stated. We hypothesize that the general acceptance of constant catchability (q) passive gears (Hubert et al. 2012) has resulted in an overreliance on the accuracy of CPUE data obtained from hoop nets. It is likely that q of hoop nets with different mesh sizes needs to be treated similarly to that of gillnets (e.g., Shoup and Ryswyk 2016). A better understanding of the changes in q for different sized bar mesh of hoop nets will allow

Table 2. Catch per unit effort (CPUE; mean number of fish captured per set of nets) of Channel Catfish from 12.5 and 25-mm bar mesh hoop nets on Langston and Wiley Post Memorial Lakes. Included are CPUE estimates for sub-stock (< 280 mm TL), stock (≥ 280 mm TL), quality (≥ 410 mm TL) and preferred (≥ 610 mm TL) Channel Catfish from each bar mesh type.

Bar mesh	CPUE				
	total	substock	stock	quality	preferred
12.5 mm	4.94	4.69	0.19	0.06	0.00
25 mm	2.84	1.6	1.11	0.11	0.01

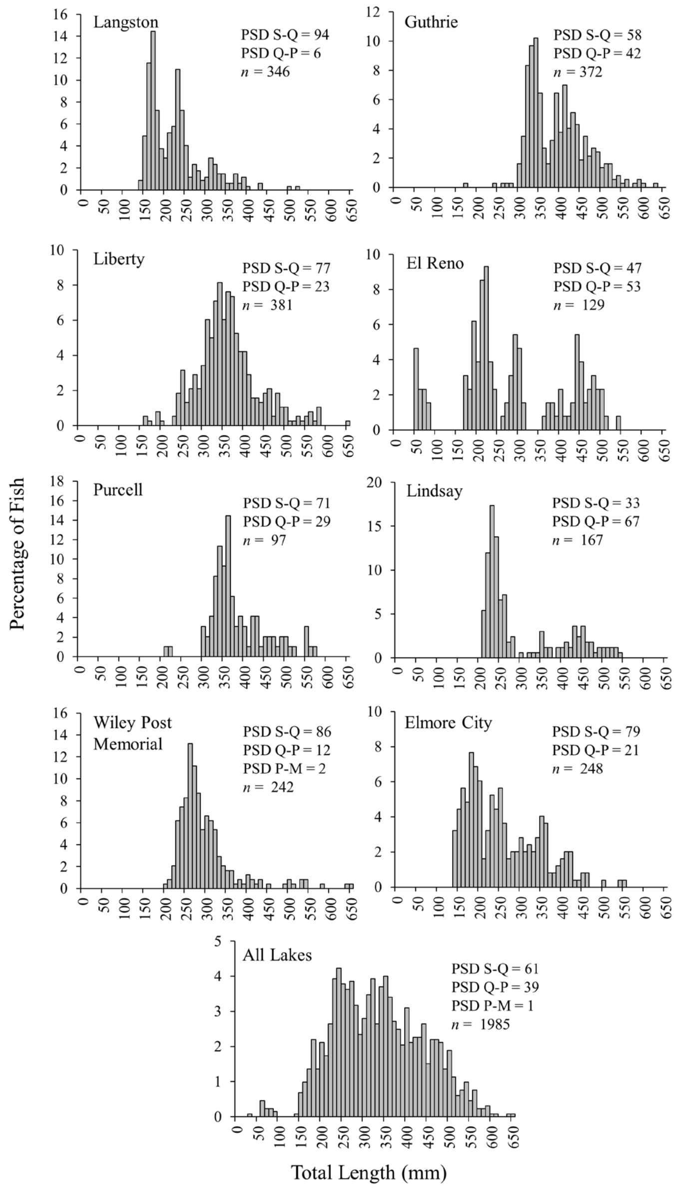

Figure 3. Length frequency histograms and proportional size distributions (PSD) of Channel Catfish collect from each study lake and all lakes combined from baited tandem hoop-nets.

for more accurate assessment of Channel Catfish populations in Oklahoma reservoirs.

The Richards growth model used in this study is less commonly applied than the more common relative growth functions (e.g., von Bertalanffy, Gompertz, *sensu* Quist et al. 2012). Richards growth model is advantageous due to its flexibility, containing von Bertalanffy, Gompertz, and logistic models in special cases (Richards 1959; Chiang 2004; Cerdenares-Ladrón De Guevara 2011). This flexibility allowed us to model slow early growth in some of our central Oklahoma Channel Catfish populations, perhaps most evident in Wiley Post Memorial Lake. Interestingly, Wiley Post Memorial Lake exhibited higher mean mortality estimates relative to the pooled estimate obtained for the region. Higher mortality rates have been noted prior for stunted channel catfish

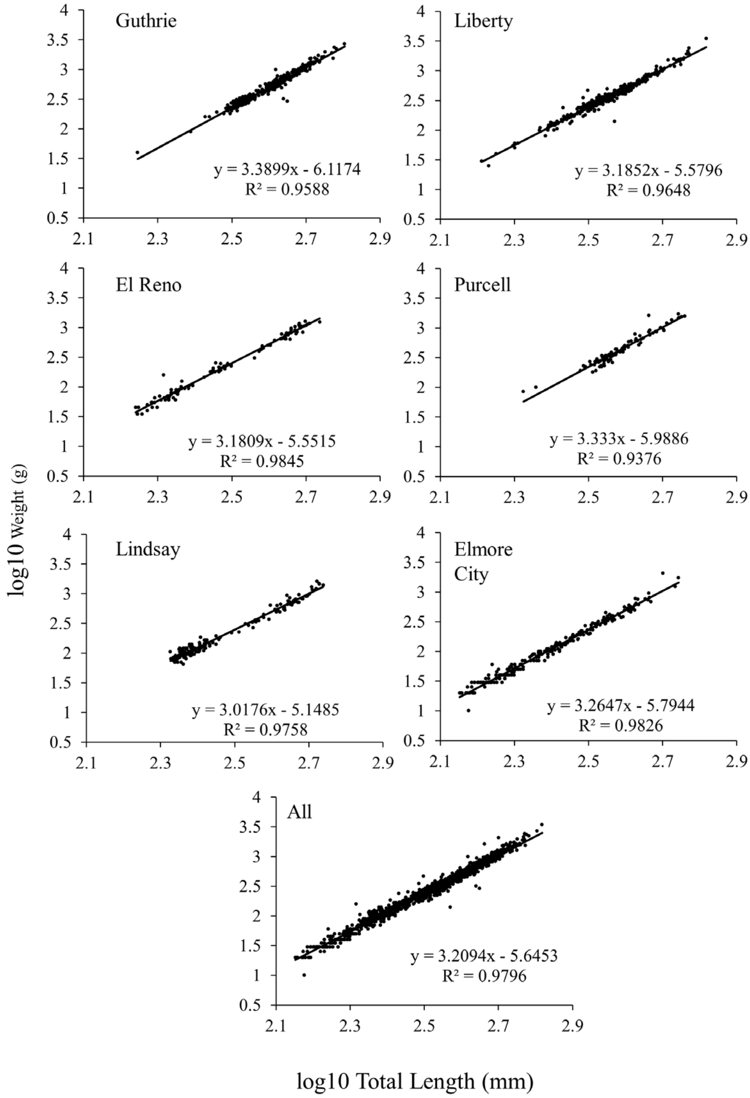

Figure 4. Length-weight relationships with associated r^2 and equations of Channel Catfish collected from each study lake (except Wiley Post and Langston due to lack of weight data) and all lakes combined.

populations (Michaletz 2009). This suggests overstocking may have occurred, likely due to the inability of 25-mm bar mesh hoop nets to properly index small Channel Catfish in this system. It's likely that a better understanding of harvest rates in these systems is needed to determine the best management strategy moving forward. Future research should focus on relating changes in growth with harvest rates in small impoundments.

Regionally, Channel Catfish populations in Oklahoma appear to be relatively long lived and slow growing. However, both growth rate and maximum observed age appeared to vary by system. Interestingly, large growth potential appears to be possible in these populations, as the maximum size and weight estimates from central region lakes is comparable to the 95th percental of statewide Channel Catfish populations (OFAA 2022). Regionally, PSD and *Wr* estimates appear to be average relative

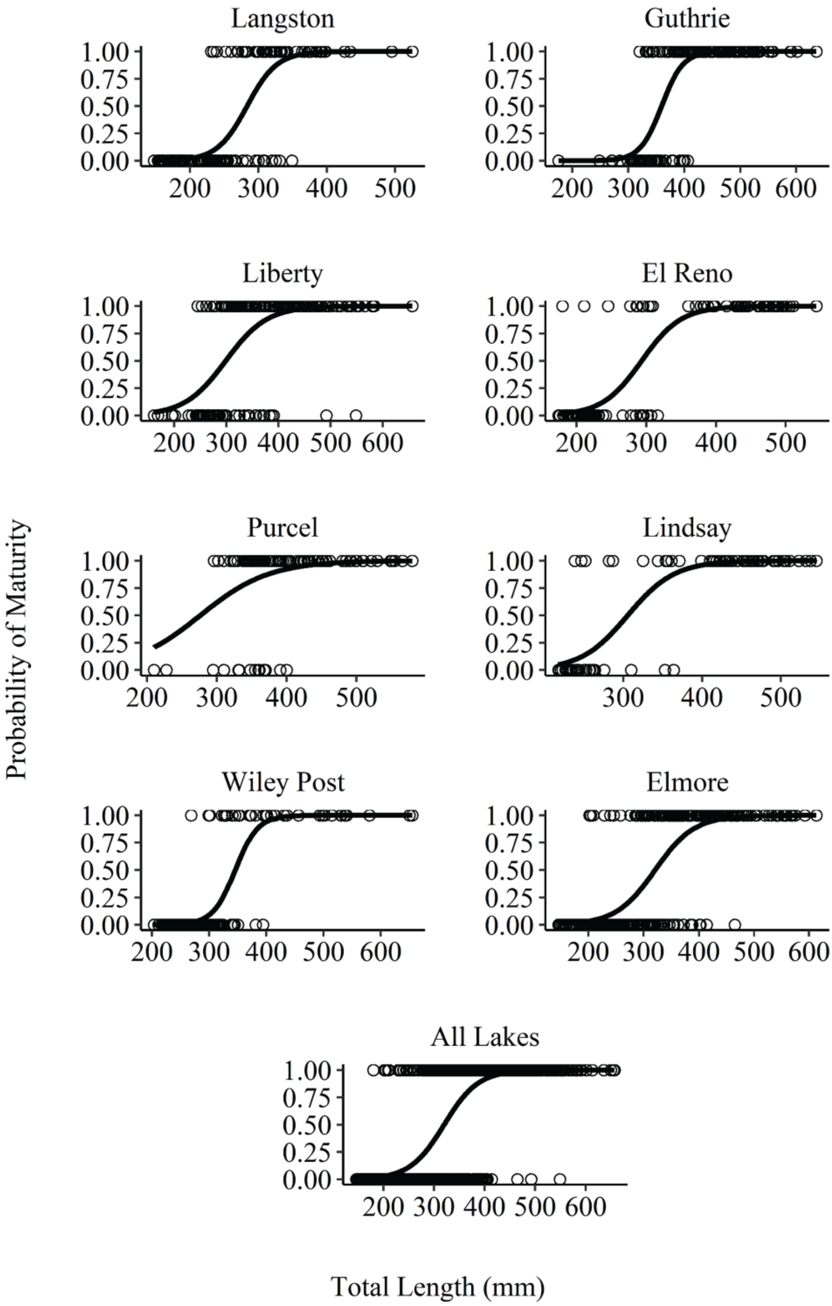

Figure 5. Channel catfish maturity curves for each study lake and all lakes combined. Included are raw data indicating the maturity information (0 = immature, 1 = mature) for each individual (circles).

to other Oklahoma reservoirs (OFAA 2022). However, these metrics were also variable across study systems. This is not surprising as Channel Catfish population dynamics and vital rates are known to vary based on abiotic and biotic variables (Shoup et al. 2007; Michaletz 2009). Furthermore, water level and resulting access to the riparian zones in lotic and semi-lotic systems

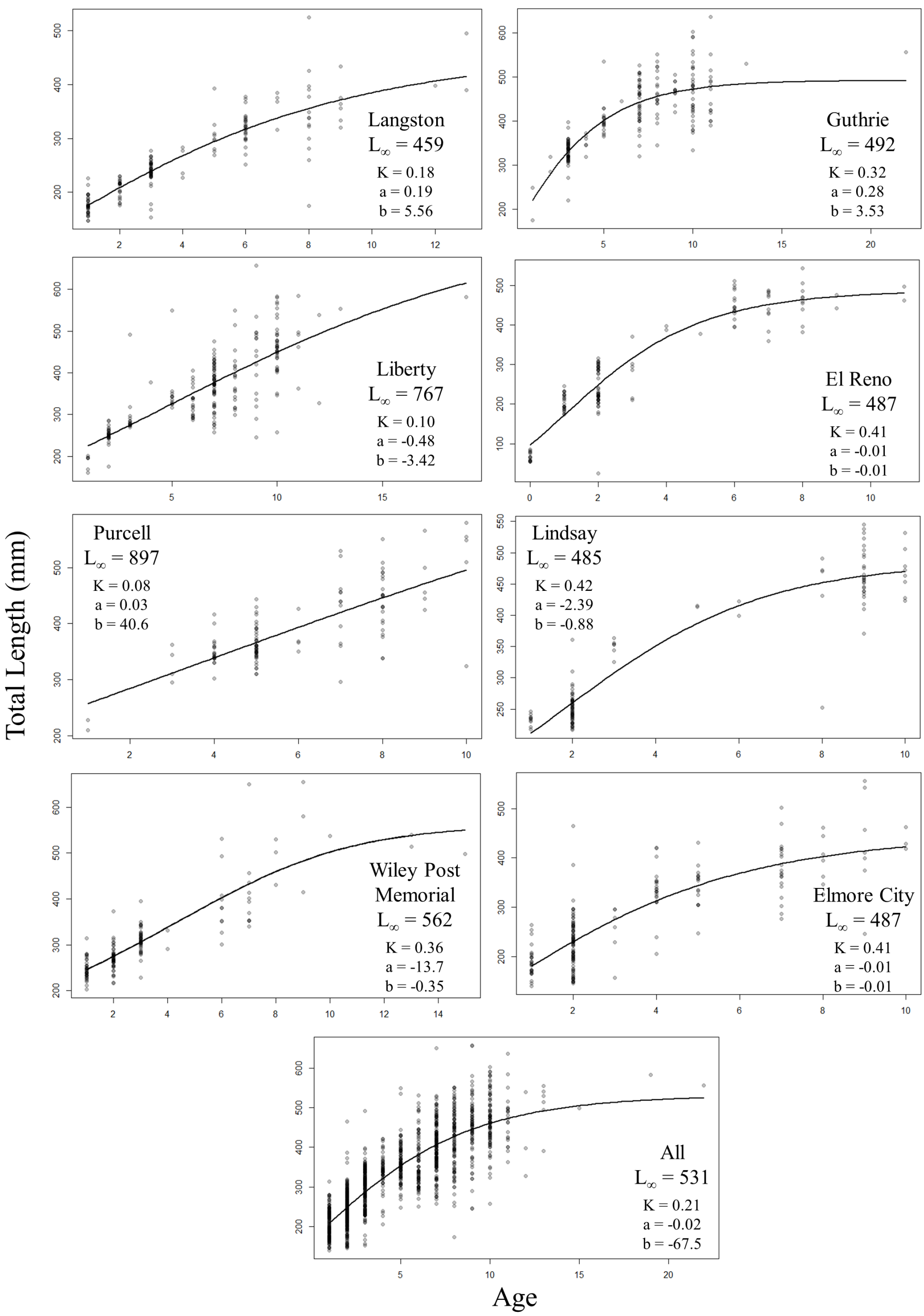

Figure 6. Channel catfish growth curves for each study lake and all lakes combined from baited tandem hoop nets. Circles indicate observed age estimates for each individual. Included are parameter estimates from the Richard's growth model (L_∞ = predicted maximum total length, K = growth constant, a =horizontal position of the inflection point, and b = vertical position of the inflection point).

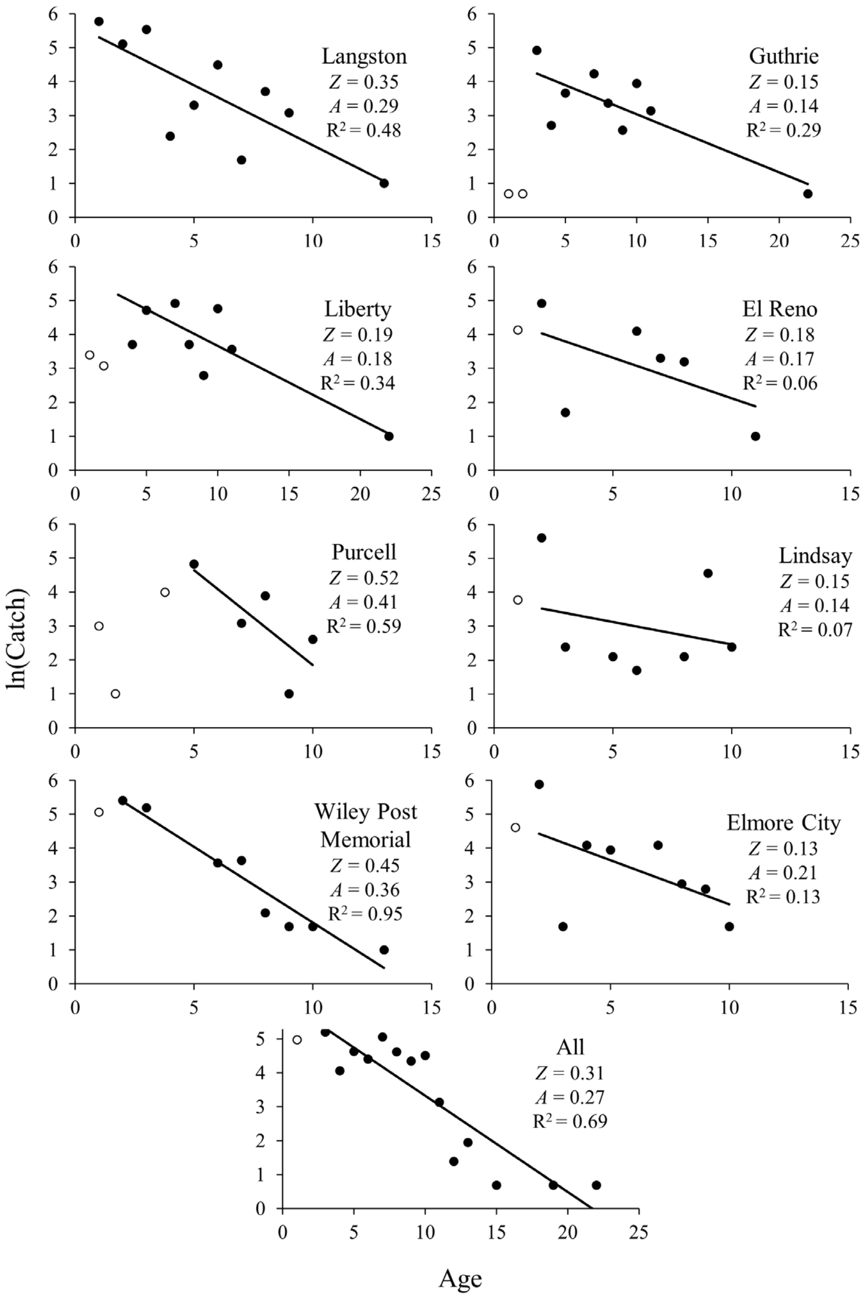

Figure 7. Weighted catch curves for Channel catfish for each study lake and all lakes combined. Age classes that were unrecruited (not used for estimation, white circles) and fully recruited (used for estimation, black circles) are provided. Estimates of instantaneous mortality (Z), total annual mortality (*A*), and fit (R^2) are provided.

are known to influence catfish condition (Schall and Lucchesi 2021). Further study of abiotic and biotic relationships with Channel Catfish dynamics and vital rates is likely needed in these systems to understand applicability of stocking and other management actions.

Manipulation of Channel Catfish populations in small impoundments through stocking is common and often necessary (Michaletz 2009). However, stocking rates are hard to determine when sampling bias is present as overstocking has the potential to result in stunted Channel Catfish populations (Michaletz 2009; Montague et al. 2022). Our results agree with prior studies that suggest lake specific effects and Channel Catfish population structure need to be appropriately accounted for prior to stocking to maximize the influence of stocking on Channel Catfish populations. This is especially true when Blue Catfish and Channel Catfish occur in high densities within the same small impoundment (Waters et al. 2020a, Montague et al. 2022), as these species exhibit high interspecific overlap in diet (Graham 1999, Hubert 1999, Bentley 2023). This interspecific competition may also be true for populations of Channel Catfish that occur with Common Carp, as small Channel Catfish and Common Carp overlap in diet prior to Channel Catfish becoming piscivorous (Hubert 1999; García-Berthou 2001, Kloskowski 2011). Further study of the effects of this potential interspecific competition is likely needed for Channel Catfish populations across Oklahoma.

Channel Catfish populations present a unique challenge to fisheries management in Oklahoma. Our results suggest that Channel Catfish populations within the central region of Oklahoma exhibit variable dynamics and vital rates. Several potential explanations exist to describe this variability (e.g., interspecific competition, abiotic variability; Waters et al. 2020a; Michaletz 2009; Schall and Lucchesi 2021). Further study will be needed to determine the influence of biotic and abiotic factors on these populations. The accuracy of future studies will rely on sampling methods that appropriately index these populations. For that reason, we recommend that sampling on these reservoirs incorporate 12.5-mm bar mesh hoop nets so smaller Channel Catfish are represented in the samples. Further study of the effects of different sizes of bar mesh on hoop net *q* are also warranted. Such studies will allow for management guidelines that avoid overstocking of Channel Catfish in small impoundments and allow fisheries managers to maintain robust Channel Catfish populations.

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